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Preliminary Report

A modified quantitative subjective global assessment of nutrition for dialysis patients

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Abstract

Background. Malnutrition, a predictor of increased mortality in dialysis patients, can be estimated using the subjective global assessment (SGA), a semi-quantitative scale with three severity levels. This semi-quantitative feature restricts the SGA's reliability and precision.

Methods. Using the components of the conventional SGA, we developed a fully quantitative scoring system (the dialysis malnutrition score) consisting of seven variables: weight change, dietary intake, gastrointestinal symptoms, functional capacity, comorbidity, subcutaneous fat and signs of muscle wasting. Each component was assigned a score from 1 (normal) to 5 (very severe). The sum of all seven components in this malnutrition score lies between 7 (normal) and 35 (severely malnourished). To evaluate nutritional status in chronic dialysis patients, anthropometric measurements including mid-arm circumference (MAC), triceps skin-fold thickness, calculated mid-arm muscle circumference (MAMC), body mass index (BMI, ratio of weight to square of height) and laboratory parameters were used. Forty-one patients (20 men and 21 women) were randomly selected from a pool of 120 haemodialysis patients. Patients were aged between 26 and 81 years (mean $\pm$ SD, 57 $\pm$ 12 years) and had undergone haemodialysis for between 7 months and 12 years (mean $\pm$ SD, 3.0 $\pm$ 2.1 years).

Results. The malnutrition score of each patient was assessed by a dietitian within 5–20 min (12.0 $\pm$ 3.5 min) with no knowledge of anthropometric findings. Pearson correlation coefficients between the malnutrition score and biceps skin-fold ($r = -0.32$) MAC ($r = -0.55$), MAMC ($r = -0.66$), BMI ($r = -0.35$), total iron-binding capacity (TIBC, $r = -0.77$), the serum albumin concentration ($r = -0.36$) and total protein ($r = -0.33$) were all significant, whereas the conventional SGA had significant correlation only with TIBC ($r = -0.35$) and MAMC ($r = -0.37$). Malnutrition score showed a significant correlation with age ($r = +0.34$) and years dialysed ($r = +0.28$). Multiple regression analysis showed a significant correlation between the malnutrition score and the combination of the MAMC, BMI, serum albumin concentration and TIBC ($r = 0.81$, $P < 0.001$). There was no correlation between the malnutrition score and sex, urea reduction ratio, protein catabolic rate, and the absolute lymphocyte count.

Conclusions. We conclude that our invented malnutrition score, which can be performed in minutes, reliably assesses the nutritional status of haemodialysis patients. We suggest that our malnutrition score may be superior to the SGA. More comparative and longitudinal studies are needed to confirm the validity of this scoring system in nutritional evaluation of dialysis patients.

Key words: albumin; anthropometric measurements; dialysis; malnutrition score; subjective global assessment (SGA); transferrin

Introduction

Protein–calorie malnutrition is common in haemodialysis patients and is linked to increased morbidity and mortality [1–4]. Nutritional status is all too frequently ignored in many dialysis centres, although simple methods of nutritional assessment could have a favourable impact on patient management. Several indices of malnutrition are available ranging from the well-known anthropometric measurements such as skin-fold thickness, mid-arm circumference (MAC) and mid-arm muscle circumference (MAMC), to skin testing for anergy and other indices of immune deficiency [1,5]. However, the sensitivity of these methods in detecting early malnutrition, their practicability and their applicability to haemodialysis patients, have not been convincing. More elaborate methods, such as dual energy X-ray absorptiometry (DEXA), bioelectrical impedance [6], near-infrared interactance [7], total body nitrogen determinations and total body potas-

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sium estimates, may give reliable results [8,9]; however, the techniques are costly and their use is confined to a few major research centres.

The subjective global assessment (SGA) was designed to circumvent many of these problems [10,11], but its semi-quantitative scale consisting of only three discrete severity levels restricts its reliability and precision. Using the components of the conventional SGA, we developed a fully quantitative scoring system for dialysis patients. To evaluate nutritional status in chronic haemodialysis patients, we compared it with anthropometric measurements, biochemical parameters and the conventional SGA.

Patients and methods

Patients

Our university hospital affiliated dialysis programme currently serves over 120 patients. We randomly selected 41 dialysis patients from those who had never changed their modality of treatment (changed to peritoneal dialysis or transplantation), had not required hospitalization in the month prior to the study, had no signs of infection or disease activity (collagen vascular disease) and who agreed to participate. Forty-one patients (20 male and 21 female) were enrolled in the study, including 15 diabetic patients. Our institutional review committee approved the protocol and written, informed consent was obtained from all participants.

Patients ranged in age from 26 to 81 years (mean $\pm$ SD, 57 ± 12 years). They had undergone haemodialysis for between 7 months and 12 years (3.0 ± 2.1 years). All received erythropoietin, 1000–10 000 units (5353 ± 3184 units) thrice weekly, as well as oral or intravenous iron supplementation for at least 2 months prior to the study. The 'dry' body weight (70.7 ± 19.4 kg) was the average oedema-free weight immediately at the end of the haemodialysis sessions. Patients' intradialytic weight gain was 2.8 ± 0.9 kg.

Conventional SGA

The SGA was originally developed to assess post-operative nutritional status in hospitalized patients [12], but it has also been applied to nutritionally deprived patients in other clinical settings, including haemodialysis [10,11]. The assessment is based on the patient's history and a physical examination [11]. The history consists of five criteria and focuses on weight loss in the preceding 6 months, gastrointestinal symptoms such as anorexia, nausea, vomiting, diarrhoea, dietary food intake, functional capacity and comorbidities. Each of these features is scored separately as A (normal or well-nourished), B (partially abnormal or moderately malnourished) or C (extremely abnormal or severely malnourished). The physical examination includes three items that focus on loss of subcutaneous fat over the triceps and mid-axillary line of the lateral chest wall, muscle wasting in the deltoids and quadriceps and the presence of ankle oedema and/or ascites. These features are classified as 0 = normal, 1 = mild, 2 = moderate and 3 = severe. The data are weighted and the patients are then classified in terms of three major SGA scores: A = well nourished, B = moderate malnutrition or C = severe malnutrition. The conventional SGA scoring sheet adopted from Baxter SGA Training Packet, (Baxter Healthcare Corporation—Renal Division, in collaboration with K. N. Jeejeebhoy, Toronto, Canada) may be accessed on the web site http://www.ajkdjournal.org/abs31_2/ScoreSheet.htm [11].

Invented malnutrition score

Using the components of the conventional SGA, we developed a fully quantitative scoring system (dialysis malnutrition score) consisting of seven features: weight change, dietary intake, gastrointestinal symptoms, functional capacity, comorbidity, subcutaneous fat and signs of muscle wasting. Each component has a score from 1 (normal) to 5 (very severe). Thus, the 'malnutrition score' (sum of all seven components) is a number between 7 (normal) and 35 (severely malnourished). Therefore, a lower score denotes tendency towards a normal nutritional status. A higher score, however, is considered to be an indicator of the presence of malnutrition elements, i.e. the higher the nutritional score the stronger the tendency towards protein–calorie malnutrition.

Table 1 shows the scoring sheet developed, consisting of two parts and seven elements as described above. During each patient's evaluation, a questionnaire regarding the first five components or 'patient's related medical history' was obtained to facilitate the optimal evaluation. For 'weight change', the overall change in the post-dialysis dry weight in the past 6 months was considered. The lowest score (1) was given if there was no weight change or if patient had gained weight. Scores of 2–5 was given for minor weight loss (< 5%), weight loss of 5–10%, weight loss of 10–15% and any weight loss over 15% during the last 6 months, respectively. 'Dietary intake', which was reported by the patients during interview, was scored 1 (normal) if it was considered as a regular (conventional) solid intake with no recent change in the

Table 1. Malnutrition score adapted from the SGA. Five scale parameters are employed and the values are summed. Maximum Duration of Haemodialysis = MDH. A value of 7 is normal, while 35 is severest malnutrition.

(A) Patients related medical history:					
1- Weight change (overall change in past 6 months)					
1 no weight change or gain	2 minor Wt loss (<5%)	3 Wt loss 5 to 10 %	4 Wt loss 10 to 15%	5 Wt loss > 15% in	
2- Dietary intake					
1 no change	2 sub-optimal solid diet	3 full liquid diet or moderate overall decrease	4 hypo-caloric liquid	5 starvation	
3- Gastrointestinal symptoms					
1 no symptoms	2 Nausea	3 vomiting or moderate GI symptoms	4 diarrhea	5 severe anorexia	
4- Functional capacity (nutritionally related functional impairment)					
1 none (improved)	2 difficulty with ambulation	3 difficulty with normal activity	4 light activity	5 bed/chair-ridden with no or little activity	
5- Co-morbidity					
1 MDH<12 months and healthy otherwise	2 MDH: 1-2 yrs or mild comorbidity	3 MDH: 2-4 yrs or age>75 or moderate co-morbidity	4 MDH>4 yrs or severe co-morbidity	5 very severe multiple comorbidity	
(B) Physical Exam:					
1- Decreased fat stores or loss of subcutaneous fat (below eyes, triceps, biceps, chest)					
1 none (no change)	2	3 moderate	4	5 severe	
2- Signs of muscle wasting (temple, clavicle, scapula, ribs, quadriceps, knee, interosseous)					
1 none (no change)	2	3 moderate	4	5 severe	
Malnutrition Score: *(sum of all)*					

amount or quality of the meals, 2 for sub-optimal solid diet, 3 for full liquid diet or any moderate overall decrease, 4 for hypocaloric liquid and 5 for starvation. 'Gastrointestinal symptoms' were scored 1 if there was no symptoms, 2 for nausea, 3 for vomiting or any moderate GI symptoms, 4 for diarrhoea and 5 for severe anorexia. 'Functional capacity' (nutritionally related functional impairment) was scored 1 for normal functional capacity and/or any considerable improvement in the level of previous functional impairment, 2 for any mild to moderate difficulty with ambulation, 3 for difficulty with normal activity, 4 for restriction to solely light activity and 5 for a persistent bed/chair-ridden state. We modified the 'comorbidity' component of the SGA criteria by incorporating the time on dialysis and advanced age; both these features have a bearing on nutrition [11,13,14]. Thus, comorbidity was scored as 1 if there were no other medical problems (otherwise healthy) and if the patient had been haemodialysed for less than 1 year; 2 if there was mild comorbidity or if the patient had been dialysed for 1–2 years; 3 if there was moderate comorbidity or if the patient had been dialysed for 2–4 years, or if the patient was >75 years of age; 4 if there was severe comorbidity or if the patient had been dialysed for over 4 years; and 5 if there were very severe, multiple comorbidities.

The 'physical examination' consisted of two components. 'Body fat stores' (subcutaneous fat) was scored by assessing subcutaneous fat deposition in four body areas: below the eyes, triceps, biceps and in the chest area. Signs of 'muscle wasting' were obtained by briefly examining seven sites: temple, clavicle, scapula, ribs, quadriceps, knee and interosseous muscles. For each of these two components a score of 1–5 representing normal to very severe changes, was assigned according to subjective assessment of the examiner in keeping with our predetermined guidelines based on the criteria specified in the Baxter SGA Training Packet [11].

In our study, total nutritional scoring for each patient was assessed by a dietician within 5–20 min (12.0 ± 3.5 min) without knowledge of anthropometric findings. Nutritional assessment by means of the modified, quantitative SGA was performed on all 41 dialysis patients by a single dietician who was very experienced with the SGA scoring system. To evaluate the degree of inter-observer agreement, a trained physician assessed a subset of 12 patients, by using the same nutritional scoring system. Results were different in only 2 of 12 patients (kappa of agreement of 0.83). The differences were resolved by consensus.

Anthropometric measurement

Body dry weight and skin-fold measurements were performed between 10 and 20 min after termination of the dialysis session. Biceps skin-fold (BSF) and triceps skin-fold (TSF) were measured with a conventional skin-fold caliper. MAC was measured using a metal tapemeasure. All the above measurements were performed three times on the non-access arm of each dialysis patient and the average result of the three measurements was registered as the final result. MAMC was derived according to the following formula:

$$\text{MAMC} = \text{MAC} - (3.1415 * \text{TSF}).$$

BMI was calculated as the ratio between end dialysis body weight in kg and the square of height in m (kg/m^2).

Laboratory evaluation

The following laboratory parameters were measured on all patients immediately prior to the dialysis session: serum albumin, total protein, cholesterol, triglyceride, total iron binding capacity (TIBC) to estimate transferrin, serum iron, transferrin saturation ratio (iron saturation ratio), serum ferritin, serum creatinine and blood urea nitrogen. Post-dialysis blood urea nitrogen of the same dialysis session and predialysis blood urea nitrogen of the following dialysis session were also measured, to calculate the urea reduction ratio (URR) and protein catabolic rate. Red blood cell indices and haemoglobin, as well as albumin, cholesterol and TIBC values (colorimetric method) were obtained by automated methods. The haematocrit was measured by centrifugation. Serum ferritin was measured by an immunoradiometric assay. Serum TIBC concentrations were used to calculate transferrin values [15] as described earlier [11]: serum transferrin (mg/dl) $\times 1.25 =$ TIBC (mg/dl). The URR was obtained by calculating the percentage of intradialytic reduction of blood urea nitrogen [15]. The URR correlates closely with k_t/v in haemodialysis patients [3]. Thus, the URR was used as the indicator of haemodialysis efficacy in our study. The protein catabolic rate was calculated using the equation of Gotch and Sargent based on the interdialytic urea appearance rate [16].

Statistics

To assess the strength of associations between variables, we used Pearson's correlation r and the Spearman rank correlation coefficient (non-parametric testing with Spearman rho) for selected analysis. A two-sample Student's t-test was used for group mean comparisons between male and female patients. Multiple regression analysis was performed with the malnutrition score as the dependent variable. Kappa of agreement was calculated to denote the degree of inter-observer agreement. Descriptive statistics and regression analyses were carried out with the statistical software (Statistica for Windows, Release 5.1, Statsoft, Inc, Tulsa, OK, USA). Fiducial limits are given as mean $\pm$ SD. A P-value of <0.05 was accepted as statistically significant.

Results

Table 2 shows the patient data. On average, the women were 10 years older than the men. Quantitative nutritional scores were significantly different between men and women. The average malnutrition score in women (12.1 ± 4.9) was 2.5 units higher than in men (9.6 ± 2.1), suggesting that women had a stronger tendency towards malnutrition. However, when the gender groups were corrected for age, the malnutrition scores between male and female groups were no longer significantly different. The men were significantly taller and heavier; however, their body mass index (BMI) was almost equal to the average BMI in women. There were no gender-specific significant differences in MAC, BSF and TSF, calculated MAMC, URR or protein catabolic rate. Similarly, the biochemical parameters did not show significant differences except for serum albumin which was 0.3 g/dl lower in women.

Table 3 shows Pearson correlation coefficients (r) between the patients' quantitative nutritional scores and nutritionally relevant parameters. Table 2 also gives the same set of correlation coefficients for the conventional SGA for comparison. Pearson correlation

Table 2. Summary of data

Parameter	All patients $n=41$	Male $n=20$	Female $n=21$	P-value
Malnutrition score	10.9±4.0	9.6±2.1	12.1±4.9	0.04*
Age (years)	57.2±12.9	52.1±13.4	62.1±10.4	0.01*
Weight (kg)	70.7±19.4	78.7±17.3	65.1±18.7	0.01*
Height (m)	1.69±0.12	1.77±0.12	1.61±0.07	0.001*
BMI (kg/m^2)	24.7±5.9	25.1±4.6	24.3±7.0	0.65
Triceps SF (mm)	10.8±9.4	8.7±3.9	12.8±12.3	0.16
Biceps SF (mm)	7.3±3.9	6.2±2.7	8.4±4.5	0.06
Arm circ. (cm)	28.6±5.2	28.8±3.1	28.4±6.7	0.85
MAMC (cm)	25.2±3.9	26.0±2.7	24.4±4.8	0.20
Years on dialysis	3.00±2.18	2.56±1.91	3.41±2.38	0.22
Albumin (g/dl)	3.8±0.3	4.0±0.3	3.7±0.4	0.03*
TIBC (mg/dl)	219±43	228±39	210±46	0.18
Cholesterol (mg/dl)	175±45	169±46	181±45	0.37
Creatinine (mg/dL)	10.3±3.6	11.3±4.2	9.2±2.6	0.06
Haematocrit (%)	34.3±4.9	34.1±2.5	34.4±6.5	0.85
Lymph count	23.8±12.7	21.3±8.1	26.1±15.7	0.22
URR (%)	64.1±11.4	66.2±9.1	62.2±13.1	0.27
PCR	0.942±0.287	0.956±0.145	0.929±0.380	0.76

SF, skin-fold; BMI, body mass index; HD, haemodialysis; circ, circumference; TIBC, total iron binding capacity; PCR, protein catabolic rate; lymp, lymphocyte; URR, urea reduction ratio.

Table 3. Left column: Pearson correlation coefficients (r) between the malnutrition score (MS), which is the modified quantitative version of the SGA, and other parameters. Right column: Pearson correlation coefficients between the conventional SGA and other parameters (marked correlations are significant at $P<0.05$)

	Malnutrition score		Conventional SGA	
	r	P	R	P
TIBC (transferrin)	−0.766	0.001*	−0.354	0.023*
Albumin	−0.355	0.023*	0.259	0.102
Total protein	−0.332	0.034*	−0.051	0.752
Cholesterol	−0.206	0.197	−0.025	0.876
Triglyceride	−0.284	0.072	0.123	0.445
Creatinine	−0.208	0.192	0.163	0.308
Haematocrit	0.234	0.140	−0.187	0.241
Lymphocyte count	0.211	0.186	0.037	0.821
MAC	−0.549	0.010*	−0.111	0.489
MAMC	−0.656	0.010*	−0.371	0.017*
Triceps	−0.096	0.550	−0.299	0.058
Biceps	−0.319	0.042*	−0.033	0.836
BMI	−0.351	0.024*	−0.046	0.774
URR	−0.083	0.604	−0.112	0.488
PCR	0.115	0.476	−0.158	0.323
Age	0.343	0.028*	0.121	0.452
Years on dialysis	0.275	0.043*	0.044	0.783
Race	−0.080	0.627	0.120	0.466
Gender	0.319	0.042	−0.164	0.305

MAMC, mid-arm muscle circumference; BMI, body mass index; MAC, mid-arm circumference; URR, urea reduction ratio; PCR, protein catabolic rate.

coefficients (r) between the malnutrition score and other parameters were highly significant ($P<0.01$) for TIBC ($r=-0.77$), MAC ($r=-0.55$) and MAMC ($r=-0.66$) indicating a lower TIBC and a smaller MAMC for those patients having a higher nutritional score or a stronger tendency towards malnutrition.

The malnutrition score was also significantly correlated ($P<0.05$) with serum albumin ($r=-0.36$), total protein ($r=-033$), BMI ($r=-0.35$), BSF ($r=-0.32$), age ($r=+23$) and dialysis years ($r=+0.28$). However, no significant correlation was found between the malnutrition score and TSF, gender, race or other laboratory parameters. No correlation with protein catabolic rate or URR was identified. Figures 1–3 show the relationship between the malnutrition score and TIBC, serum albumin and MAMC respectively.

In order to evaluate a comparable correlation analysis on conventional SGA, three numeric scores of 1, 2 and 3 were given to semi-quantitative SGA levels of A, B and C, respectively. The conventional SGA showed lower correlation coefficients than the malnutrition score for MAMC ($r=-0.37$) and serum TIBC ($r=-0.35$). There was no correlation between the conventional SGA and any other parameter.

By using multiple regression analysis, we studied the relationship between the malnutrition score (MS) and some of the significantly correlated variables. The MAMC, BMI, serum albumin concentration and TIBC entered the relationship below ($P<0.001$) with $R^2=0.81$ (F-test):

$$MS=45.02–0.16*MAMC–3.6*albumin$$
$$–0.05*TIBC–0.15*BMI.$$

The same analysis for the SGA permitted only MAMC and TIBC concentration to enter the equation ($P=0.031$) with $R^2=0.41$:

$$SGA=5.10–0.061*MAMC–0.009*TIBC.$$

Discussion

Using the components of the conventional SGA, we developed a fully quantitative malnutrition scoring

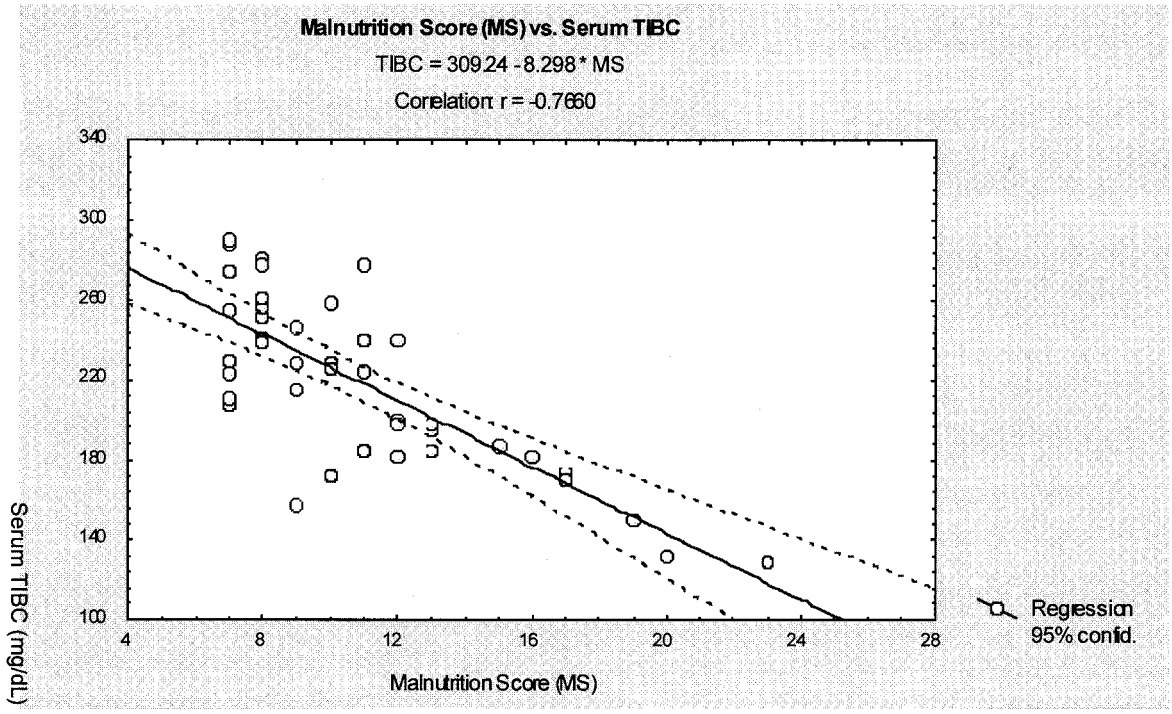

Fig. 1. Correlation between the dialysis malnutrition score and serum total iron-binding capacity (TIBC) concentration.

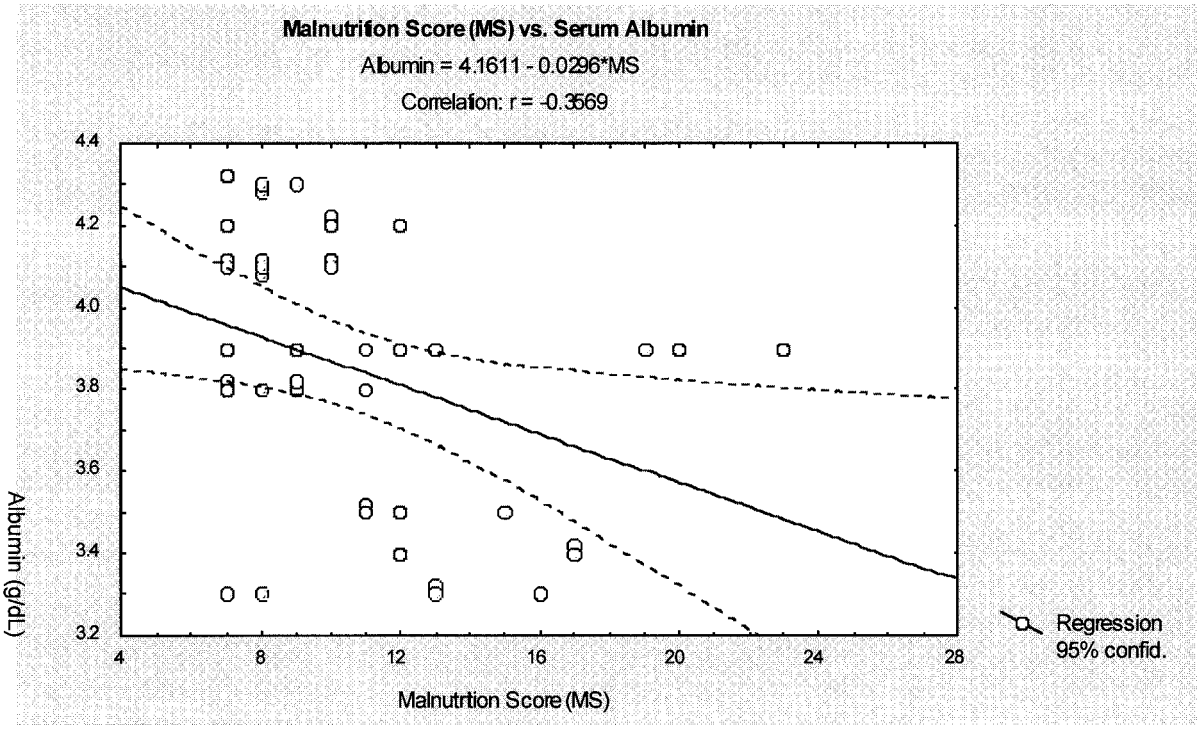

Fig. 2. Correlation between the dialysis malnutrition score and serum albumin concentration.

system (dialysis malnutrition score) with easy and practical, yet reproducible, guidelines for each single scoring component. Our malnutrition score is more objective than the SGA. We found that the malnutrition score was correlated with, among others, the MAMC, BMI, TIBC and serum albumin concentration, either singly or in terms of a multiple regression analysis. Our data support the notion that our malnutrition score may offer more precision than the SGA. The multiple regression analysis suggested a more robust correlation for the malnutrition score (almost double that of the conventional SGA) with more

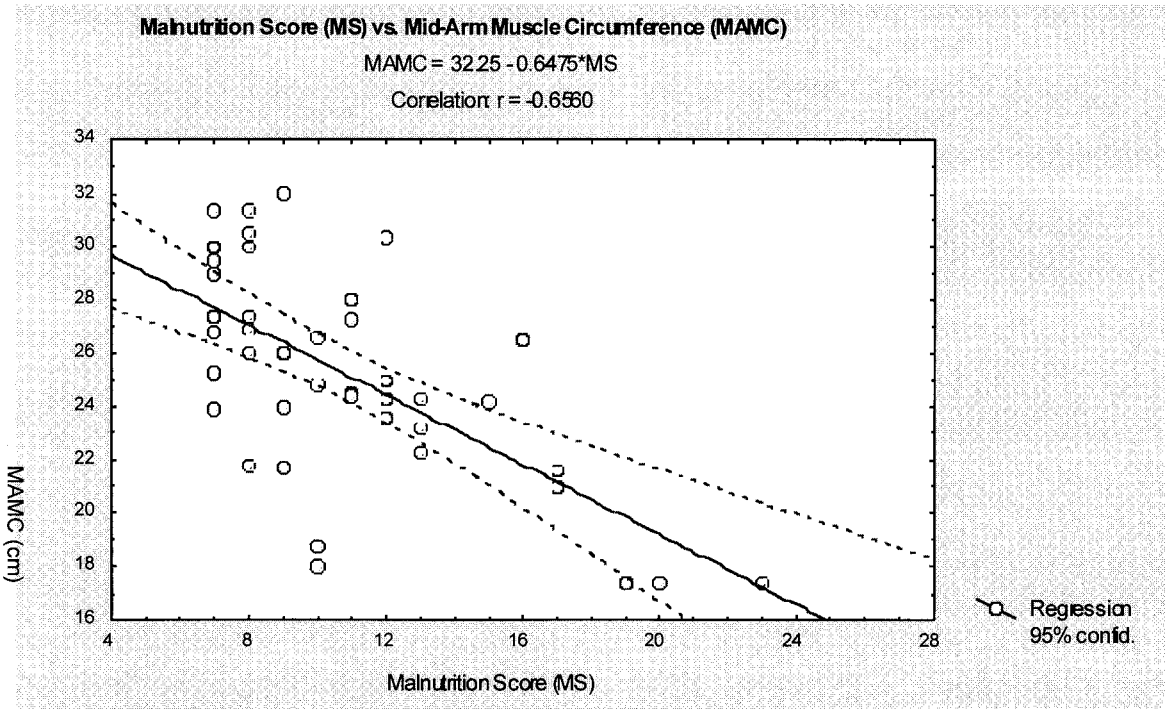

Fig. 3. Correlation between the dialysis malnutrition score and mid-arm muscle circumference (MAMC).

independent variables entering the relationship, compared with the SGA. Moreover, the test is practical and convenient and can be performed easily by a dietician, trained nurse or physician within minutes.

Malnutrition is common in dialysis patients [1,2,17] and predicts morbidity and mortality [3,18]. Nevertheless the nutritional status of dialysis patients is frequently ignored [5]. Several indices of malnutrition are available ranging from the well-known anthropometric measurements [19] to more elaborate techniques such as DEXA and bioelectrical impedance [6,20]. However, the reliability of these methods in detecting protein–calorie malnutrition and their practicability has not been shown [4,11]. Moreover, the more elaborate methods are costly and time-consuming, factors which confine their use to a few research centres. Kelly *et al.* [21] developed a haemodialysis prognostic nutrition index (HD-PNI), which incorporated the number of days hospitalized for each patient; however, the calculations required are cumbersome.

The SGA, which was designed to circumvent many of these problems, is easy to use and reliable [10,11]. The test uses a simple history and physical examination, which can be performed by a physician, dietician or trained nurse [11,12]. The method is closely correlated with more objective measures [12]. Moreover, the SGA has been validated prospectively in both uraemic and non-uraemic patient populations [19,22]. Studies by Baker *et al.* [23], Detsky and colleagues [24] and Jeejeebhoy and colleagues [25,26], suggest that the SGA not only determines the nutritional status, but also predicts the likelihood of complications in terms of 'sickness'.

Enia *et al.* showed that the SGA is a reliable prognostic indicator [10]. In an earlier study, we showed that the SGA correlates well with biochemical parameters such as serum TIBC (transferrin) and albumin concentrations [11]. In that study, which included far more patients than the present investigation, we found TIBC to be a more sensitive indicator of nutrition than the serum albumin concentration. Recently, the Dialysis Outcome quality Initiative (DOQI) has strongly advocated the SGA to assess CAPD patients [27]. However, the SGA is a semi-quantitative scale and consists of only three nutritional levels (normal, mildly to moderately malnourished, and severely malnourished). This semi-quantitative feature restricts the SGA's reliability and precision. Moreover, most components of SGA do not have clear-cut definitions and concrete guidelines do not exist [11]. The final assessment of each SGA criterion is solely based on the subjective impression of the evaluator.

We found no correlation between the malnutrition score and the urea reduction ratio or the protein catabolic rate. Urea modelling depends on many assumptions, such as constant protein intake, absence of intercurrent catabolic factors and other short-term parameters [28]. The protein catabolic rate is more an indicator of momentary protein intake and may not reflect the overall nutritional status [28]. Furthermore, we used only the urea reduction ratios and protein catabolic rates calculated at the time the malnutrition score was assessed. Conceivably, had we averaged URRs and protein catabolic rates over a longer period, we might have found a correlation with the malnutrition score.

Nutritional assessments in dialysis patients are imperative, although the task is not necessarily easy [28]. The purpose of such an assessment is obviously the identification of patients at risk for complications and a poor outcome before such complications have developed. Such a strategy allows the implementation of preventative interventions, such as additional nutritional counselling, dietary supplements or psychosocial interventions. The SGA provides a standardized method, with which large numbers of patients can be assessed repeatedly by any member of the dialysis care team. Our malnutrition score incorporates these advantages of the SGA, while extending the reliability and precision. The time commitment and level of staff training are not increased. It is likely that an initiative such as the DOQI will call for regular and uniform assessments of nutrition for all dialysis patients. We believe that improved patient outcome with increased attention to the nutritional status is highly likely. This hypothesis could be tested by means of a randomized controlled trial in dialysis patients. Before such an intervention could be tested, a standardized, uniform, generally accepted method of assessing nutrition must be adopted. We suggest that our malnutrition score may be a means to that end. However, more comparative and longitudinal studies are needed to confirm the validity of this nutritional scoring system in nutritional evaluation of dialysis patients.

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