Assessment of methods to identify protein-energy wasting in patients on hemodialysis

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This study was performed at the Hospital Universitário Pedro Ernesto / Universidade do Estado do Rio de Janeiro – HUPE/UERJ.

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Abstract

Introduction: The method capable of best identifying protein-energy wasting (PEW) in hemodialysis (HD) patients is controversial. Thus, we assessed the nutritional status of HD patients by use of different methods and verified which one identified the highest number of patients with PEW. **Methods:** The study assessed the nutritional status of 15 HD patients (age: 52.7 ± 10.1 years; males: 33.3%) by use of anthropometric measurements, subjective global assessment (SGA), serum albumin, and dietary intake (24-hour food recall). Body fat was assessed by use of anthropometry. The International Society of Renal Nutrition and Metabolism (ISRNM) criteria were used to diagnose PEW. **Results:** The body mass index (24.2 ± 4.4 kg/m²) and the percentage of standard value for mid-arm muscle circumference were within the normal limits (102.6 ± 13%). Nevertheless, the percentage of standard value for triceps skinfold was below the normal limits (females, 75.3 ± 40.4%; and males, 73.5 ± 20.6%), although a high body fat percentage was observed (females, 34.5 ± 7.3%; males, 23.6 ± 4.2%). When assessing the nutritional status by use of SGA, most patients (80%, n = 12) were malnourished, and SGA was the method that identified the highest number of patients with PEW. By using the ISRNM criteria, PEW was diagnosed in only two patients. **Conclusion:** All patients were diagnosed with PEW by use of one of the methods studied. The SGA was the method that, in isolation, could detect the greatest number of patients with PEW.

Keywords: chronic kidney failure, protein-energy malnutrition, nutritional assessment, dialysis.

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Introduction

Protein-energy wasting (PEW) can occur in 13% to 51% of hemodialysis (HD) patients.[1] Such high prevalence of PEW is of great concern because PEW is an important predictor of morbidity and mortality.[2] Several factors contribute to that nutritional condition, and an important one is the inflammatory process.[3] Other causes of PEW are as follows: low dietary energy and protein intake; loss of nutrients and amino acids through the dialysate; muscle catabolism induced by dialysis itself and by metabolic acidosis; the increased energy expenditure that occurs during HD and within the two hours following the procedure; resistance to insulin and anabolic hormones, such as growth hormone; oxidative stress and inflammation.[3]

Because of that high prevalence of PEW in HD, nutritional assessment should be performed to identify the risks and/or causes of deterioration of the nutritional status, and to establish a nutritional diagnosis. In addition, this will allow the establishment of nutritional goals to prevent and/or treat PEW.[4]

However, there is no isolated marker capable of assessing the nutritional status of patients with chronic kidney disease (CKD), because of the several abnormalities inherent in CKD itself.[5] Subjective global assessment (SGA) has been recently emphasized as a simple, inexpensive and validated method for assessing the nutritional status of that population.[6] In addition to SGA, the following are routinely assessed: nutrient intake, mainly by use of the three-day food recording or by use of 24-hour food recall; muscle and fat mass reserve by use of anthropometry or bioelectrical impedance; and biochemical markers by use of plasma albumin.[7-9] Renowned researchers in the area believe that it is necessary to jointly apply several parameters to properly assess the nutritional status of that population, to overcome the limitations of each of such methods when used in isolation. Despite all effort to establish a precise nutritional diagnosis, the normalization of nutritional parameters to be applied to patients with CKD still lacked. In this sense, an International Society of Renal Nutrition and Metabolism (ISRNM) expert panel has recently proposed a set of criteria to identify PEW in CKD patients. At least three out of the four categories and at least one test in each of the selected category shown in Chart 1 must be satisfied for the diagnosis of PEW.[10]

In clinical practice, however, some of those tools may not be available for the nutritionist. Thus, it is worth knowing which parameters used to assess the nutritional status can better identify the presence of PEW in CKD patients. The present study aimed at evaluating the nutritional status of CKD patients on chronic HD by use of different nutritional assessment parameters, and at verifying which can identify the greatest number of HD patients with PEW.

Patients And Methods

Patients

This study was carried out at the HD Unit of the Hospital Universitário Pedro Ernesto (HUPE), of the Rio de Janeiro State University (UERJ), from November 2008 to February 2009. Patients undergoing chronic HD treatment during that period were included in the study. The inclusion criteria were patient's age of 18 years and over, and HD treatment for at least two months. The exclusion criterion adopted was the presence of any of the following: acquired immunodeficiency syndrome (AIDS); cancer; pregnancy; hospitalization during the study; amputation; contact isolation; and degenerative disease. Of the 28 patients undergoing chronic HD at the HUPE, ten were excluded as follows: two pregnant women; one amputee; one patient in contact isolation; four patients undergoing HD for less than two months; one hospitalized patient; and one patient with Alzheimer's disease. Two patients died during the study and one patient was hospitalized during the second visit. Thus, 15 patients took part in the study. The CKD causes were as follows: glomerulopathy, n = 2; systemic lupus erythematosus (SLE), n = 1; bilateral diffuse parenchymal disease, n = 2; bilateral coraliform calculus, n = 1; nephrosclerosis, n = 1; hypertension (SAH), n = 1; and unknown cause n = 7. The comorbidities observed were as follows: hypertension, n = 14; hepatitis A, n = 1; hepatitis B, n = 2; hepatitis C, n = 1; and diabetes mellitus (DM), n = 4. All patients underwent HD three times a week, and the HD session length was 3.5 to 4 hours.

Study design and protocol

This is a cross-sectional study. After providing written informed consent, the patients were interviewed regarding their demographic data and dietary intake.

Chart 1	Criteria proposed by the International Society of Renal Nutrition and Metabolism expert panel to classify the nutritional status of CKD patients[10]

Body weight and fat (body mass)
- BMI < 23 kg/m²;
- Body fat percentage < 10%;
- Unintentional weight loss over time: 5% over 3 months or 10% over 6 months.*

Muscle mass
- Mid-arm muscle circumference: reduction > 10% in relation to 50th percentile of NHANES II;
- Reduced muscle mass: 5% over 3 months or 10% over 6 months.*

Serum chemistry
- Serum albumin < 3.8 g/dL (method: Bromocresol Green);
- Serum cholesterol < 100 mg/dL;
- Serum prealbumin (transthyretin) < 30 mg/mL.*

Dietary intake
- Unintentional low dietary protein intake < 0.8 g/kg/day for 2 months for dialysis patients;*
- Unintentional low dietary energy intake < 25 kcal/kg/day for 2 months.*

BMI: body mass index; *: criteria not considered for the diagnosis of PEW in this study, because they were not assessed during data collection. For dietary intake, assessment performed on one occasion was considered.

Data relating to CKD etiology, comorbidities, dialysis program, laboratory tests, and body weight in the previous three months were collected from the patients' records. Right after finishing the HD session (approximately 30 minutes), the following assessments were performed: anthropometric; SGA; and dietary intake.

Methods

All anthropometric measures were taken after HD session. Body mass was measured by use of an electronic scale (FILIZOLA®) with 100-gram subdivisions and maximum capacity of 150 kg. Height was obtained with the aid of a stadiometer coupled to the scale. The body mass index (BMI) was obtained by dividing body mass by the square of the height.[11] The triceps (TSF), biceps, subscapular, and suprailiac skinfolds were measured with a calibrated adipometer (Lange®). In addition, arm circumference (AC) was measured with an inextensible centimeter-graded measuring tape. Mid-arm muscle circumference (MAMC) was calculated by use of the following equation: MAMC = AC (cm) – 3.14 x [TSF (mm) ÷ 10].[12] The percentages of the standard values for TSF, AC, and MAMC were obtained by use of the reference table adapted by Blackburn & Thornton (1979).[13]

For assessing the body compartments (lean mass and body fat), the four skinfolds (biceps, triceps, subscapular, and suprailiac) were added, and the Durnin & Womersley equation (1974) was used for calculating body density and the Siri equation (1956) for assessing body fat percentage.[14,15] The calculations were performed for later classification according to Lohman *et al.* (1991).[16]

Regarding SGA, a model adapted and validated to HD patients was used.[6] In that model, the nutritional status was graded with a score ranging from 1 to 7, and values closer to 7 indicated well-nourished patients. According to that score, patients were classified as follows: score 7 and 6, well-nourished; 5 to 3, mild to moderately malnourished; 2 and 1 severely malnourished.[6] In this study, patients with SGA ≤ 5 were considered as having PEW.[6]

Data from the laboratory tests were collected from the medical records and comprised the following: albumin (g/dL); creatinine (mg/dL); cholesterol (mg/dL); and pre- and postdialysis urea (mg/dL). The samples for the laboratory tests were always collected before the HD sessions, except for urea, whose samples were collected before and after the HD sessions.

Dietary intake was assessed by use of 24-hour food recall on a day with HD and on another without HD, and data shown refer to the mean of the two days assessed. The Avanutri software was used for calculating the dietary energy intake and intake of three macronutrients.

Dietary energy and nutrient intakes were compared with the NKF/KDOQI (2000) recommendations to assess their adequacy.[17] The values of energy and protein intake were expressed in kg of current weight per day.

The criteria proposed by the ISRNM expert panel were used to classify the nutritional status of CKD patients undergoing dialysis treatment and are shown in Chart 1.[10] However, the following criteria listed in the original document were not considered for the diagnosis of PEW in this study, because they were not assessed: unintentional weight loss of 5% in three months or of 10% in six months; muscle mass reduction of 5% in three months or of 10% in six months; and serum prealbumin (transthyretin) < 30 mg/mL. For dietary intake, the assessment performed on one occasion was considered. Patients satisfying at least three out of the four categories (one test in each of the selected category) shown in Chart 1 were diagnosed with PEW.

This study was approved by the Committee on Ethics in Research of the HUPE under the protocol number 2258-CEP/HUPE.1

Statistical analysis

Data were shown as mean ± standard deviation, because they had a normal distribution. For comparing data obtained from male and female patients, independent sample Student *t* test was used. The significance level of 0.05 was adopted. The JMP IN© version 5.0 (SAS Institute Inc., Cary, NC, USA) statistical analyses package was used.

Results

As shown in Table 1, the patients' mean age was 52.7±10.1 years, and female patients predominated. Arteriovenous fistula was the venous access for HD in most patients, and the mean urea Kt/V indicated good dialysis adequacy. In addition, plasma albumin was below 3.8 g/dL.

For the comparison analysis, the anthropometric and body composition data were assessed according to sex, as shown in Table 2. The mean body weight of men did not differ from that of women. Regarding BMI, the mean of all individuals indicated eutrophy; however, when stratified according to sex, women showed a tendency towards a greater BMI, indicating

Table 1	Major clinical and demographic characteristics of patients undergoing chronic HD at the HUPE (n = 15)
Age (years)	52.7 ± 10.1 [a]
Male (n; %)	5 (33.3)
HD time (months)	7.7 ± 5.1
Vascular access	
AVF (n; %)	14 (93.3)
Catheter (n; %)	1 (6.7)
Serum creatinine (mg/dL)*	12.9 ± 18.7
urea Kt/V	1.4 ± 0.6
Cholesterol (mg/dL)*	171.5 ± 54.5
Albumin (g/dL)*	3.5 ± 0.4

[a]: mean ± standard deviation; *: laboratory tests prior to HD session; AVF: arteriovenous fistula.

overweight. Regarding AC, the sample was eutrophic; however, the male population showed, on average, mild malnutrition. When analyzing MAMC, the population was eutrophic even when stratified according to sex. When analyzing TSF, indicative of fat tissue reserve, moderate malnutrition was observed in both men and women. However, the fat percentage was above average for both sexes, and significantly higher in women.

Regarding dietary intake, the mean dietary energy intake was 22.7 ± 7.0 kcal/kg of current weight/day, which is below the value recommended for that population. Likewise, the mean protein intake (1.0 ± 0.6 g/kg of current weight/day) was also below the value recommended for HD patients.

According to SGA, most patients (n = 12; 80%) showed some degree of malnutrition; mild to moderate malnutrition was observed in ten patients (73.3%), while severe malnutrition was observed in two (6.7%). Only three patients (20%) were classified as well nourished.

When assessing the nutritional status, all patients were diagnosed with PEW according to at least one of the five methods used. The method that identified the greatest number of patients with PEW was SGA (n = 12; 80%), followed by serum albumin (n = 10; 66.7%), total body mass assessed by use of BMI (n = 9; 60%), dietary intake (n = 9; 60%), and, at last, muscle mass (n = 2; 13.3%). Figure 1 shows the presence of PEW diagnosed by more than one of the methods assessed. It is worth noting that all patients were diagnosed with PEW by at least one of those methods.

When using the criteria proposed by the ISRNM to classify PEW, which do not include SGA, only 13.3% (n = 2) of the patients were diagnosed with PEW (met three of the four criteria indicating malnutrition).

Discussion

This study assessed the nutritional status of CKD patients on HD by use of different nutritional assessment methods, including the criteria established by the ISRNM expert panel.[10] In this study, the presence of PEW ranged from 13% to 80% when assessed with the different methods in isolation. This shows that the presence of PEW, when assessed by use of only one single method, can pass unnoticed, leading to mistaken nutritional diagnoses. It is worth noting that, even in a small sample, all patients assessed were diagnosed as undernourished by use of at least one of the methods, emphasizing the high nutritional risk of the population studied.

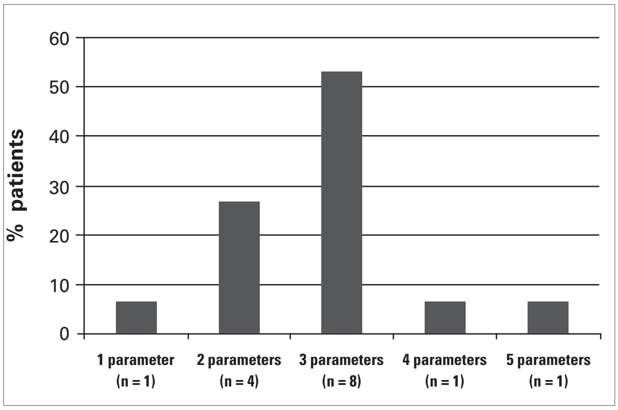
Our results are similar to those of other studies, in which a high prevalence of PEW was found among

Table 2 Anthropometric and body composition data of patients undergoing chronic HD at HUPE (n = 15)

	Total (n = 15)	Male (n = 5)	Female (n = 10)
Body weight (kg)[a]	60.80 ± 12.63 [b]	64 ± 6.14	59.2 ± 14.9
BMI (kg/m²)	24.2 ± 4.4	22.5 ± 1.0	25 ± 5.2
Percentage of standard value for AC	96.0 ± 13.8	89.1 ± 6.7	99.5 ± 15.4
Percentage of standard value for MAMC	102.6 ± 13	92.4 ± 9.4	107.6 ± 11.7*
Percentage of standard value for TSF	74.7 ± 34.2	73.5 ± 20.6	75.3 ± 40.4
Body fat (%)	30.9 ± 8.2	23.6 ± 4.2	34.5 ± 7.3*

[a]: body weight after HD session; b: mean ± standard deviation; * $p < 0.05$ (Student t test): male vs female; BMI: body mass index; AC: arm circumference; MAMC: mid-arm muscle circumference; TSF: triceps skinfold.

Figure 1. Diagnosis of PEW in HD patients by use of more than one of the methods assessed (n = 15).



HD patients.[1,4,18] This is of concern because of the strong association between PEW and increased morbidity and mortality,[1,2] higher hospitalization rate, and worse quality of life.[18]

Nutritional assessment aims at identifying the risks or causes of the nutritional status deterioration, helping with the specific therapy and determination of the nutritional needs of each nutrient. Knowing and properly characterizing the nutritional status of a population on dialysis is fundamental to treat and prevent the development and worsening of PEW, and to determine and assess the impact of dietary therapy on nutritional outcome.[4]

Recently, several nutritional parameters have been used to implement the diagnosis of malnutrition in CKD individuals, the most common being anthropometry, bioelectrical impedance, serum albumin, and 24-hour food recalls.[19] However, which of those methods should be used to detect more precisely a patient with PEW is yet to be determined. The difficulty in establishing the best method to assess PEW lies in the fact that all such parameters have limitations when used in isolation.[5] In this sense, SGA has shown to be effective because it assesses the patient's medical history, and clinical and physical examinations (body fat and muscle reserves). A recent study with HD patients has shown good concordance between assessing body reserves by use of SGA and assessing fat and muscle reserves by use of objective measurements.[20] In our study, SGA applied to HD patients showed a predictive power for the occurrence of hospitalizations.[6] The major limitations of SGA comprise low sensitivity to assess small changes and interindividual variation when SGA is performed by a team. It is worth mentioning that the SGA model applied in the present study has been recently validated for that population, and, as it includes the possibility of classifying the nutritional status into levels, it attenuates the low sensitivity for small changes in the nutritional status.[6] In the present study, SGA was the method that, in isolation, detected the highest number of patients with PEW.

Regarding dietary intake, the greatest difficulty lies in factors leading to the interviewee's and interviewer's mistakes. The following are related to the interviewee's mistakes: understanding of the questions; omission or overestimation of dietary intake; failure in food portion size estimation; and interviewee's memory failure. The following are related to the interviewer's mistakes: incorrect recording of the answers; intentional omission; incomplete description; distraction due to inappropriate interview environment; empathy with the interviewee; and mistakes in food measure conversion into grams.[12] The change experienced by HD patients in their dietary pattern between days with and without dialysis is particularly difficulty, because on dialysis days, patients can skip one of their daily meals.[5]

Of the several biochemical parameters available for nutritional status assessment, albumin has been the most commonly used, because of its close association with the morbidity and mortality rates in that population.[21] However, both biochemical and immunological parameters can change according to the patient's inflammation grade.[21,22] In fact, it has been well described in the literature that a significant percentage of HD patients have high C-reactive protein levels, which indicate inflammation. Because albumin is a negative acute phase protein, whose hepatic synthesis is reduced in inflammatory conditions, it is yet to be clarified whether its close association with the morbidity and mortality rates results from PEW or from inflammation or even from the combination of both conditions.[21] Thus, the isolated use of serum albumin as a marker of malnutrition in the HD population might not be appropriate.[21,22] In our study, ten patients showed serum albumin levels below 3.8 g/dL, and all of them also had a SGA indicating some degree of PEW.

Because of the difficulty in diagnosing a patient with PEW, the ISRNM expert panel convened aiming at creating criteria capable of diagnosing PEW. The criteria suggested by that expert panel (Chart 1) include the assessment of body mass, muscle mass, biochemical parameters, and dietary intake. Thus, they tried to overcome the difficulties of using a single method for nutritional status assessment.[10] In the present study, three criteria proposed in the original document were not considered, although all parameters proposed by the ISRNM expert panel (body mass, muscle mass, serum biochemistry, and dietary intake) were assessed. When the criteria proposed by the ISRNM expert panel were applied, only two patients (13.3%) of the sample assessed were considered malnourished. Thus, we emphasize the need for further studies assessing the nutritional status of HD patients by use of those criteria.

Of the HD patients assessed in this study, 80% (n = 12) were diagnosed with malnutrition according to SGA. Until a gold standard method for diagnosing malnutrition in that population is established, the SGA seems to be the method capable of detecting the highest number of patients with PEW. The low sensitivity of the SGA to detect small changes in the nutritional status is a known limitation that deserves to be studied in order to longitudinally improve its nutritional status assessment power.

Considering the importance of identifying malnutrition to start the patient's health control and monitoring measures, SGA is comprehensive enough to identify truly malnourished individuals to ensure they will receive special attention.

Conclusion

In conclusion, of the nutritional parameters used to assess the HD patients' nutritional status, SGA, which is a simple and inexpensive method of high applicability in clinical practice, detected the highest number of patients with PEW.[2]

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