ORIGINAL RESEARCH

Bioimpedance Spectroscopy as a Practical Tool for the Early Detection and Prevention of Protein-Energy Wasting in Hemodialysis Patients

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Objectives: To evaluate whether body composition monitor (BCM) could be a practical instrument for nephrologists to assess nutritional status in patients on hemodialysis (HD) and whether it is more effective in identifying patients at highest risk of developing protein-energy wasting (PEW) alone or in combination with other tools currently used for that purpose.

Design: Observational cross-sectional study in 91 HD patients (60 ± 14 years, 70.3% male, 24 ± 4.1 kg/m^2 body mass index) from 2 different locations.

Methods: Nutritional status was evaluated by anthropometric methods (biceps and triceps skinfold thickness, waist circumference, and arm muscular circumference), biochemical nutritional markers, malnutrition-inflammation score (MIS), and BCM. The patients were grouped into those with and without PEW by using classical criteria and then classified as being adequately or inadequately nourished according to a BCM flow chart to detect those requiring preferential nutritional intervention. A multivariate approach was used to calculate the risk of developing PEW.

Results: Anthropometric measurements revealed significantly lower body mass index (<23 kg/m^2; odds ratios [OR] = 13.3 and $P = 0.001$) and arm muscular circumference < p10 (OR = 34, $P < 0.001$) in the PEW group. MIS was above 5 in all the patients classified as having PEW. BCM showed that fat tissue index < p10 was significantly lower in this group (OR = 1.52), and a decision tree using the lean tissue index < p10, fat tissue index < p10, and extracellular water > 15% revealed that 42.9% of the patients would need nutritional monitoring. On multivariate analysis, insufficient nutritional status detected by BCM decision tree was an independent prognostic factor for developing PEW. About 9.89% of the patients were classified as PEW, with MIS > 5, and insufficient nutritional status detected by BCM required preferential nutritional intervention.

Conclusion: BCM is a practical instrument for nephrologists to assess nutritional status in patients on HD and is useful for the early prevention and detection of PEW, as is able to identify differences in body composition, predict clinically important outcomes, and classify patients requiring preferential nutritional intervention.

Introduction

DEMOGRAPHIC CHANGES IN society are leading to progressive population aging, which in turn is giving rise to a growing proportion of elderly patients with advanced chronic kidney disease (CKD) and consequently a greater influx to dialysis treatment programs.[1] Moreover, CKD at its different stages of progression is associated with distinct abnormalities in calorie-protein metabolism, which may result in progressive loss of somatic and circulating body protein and energy reserves, decreasing muscle mass and fatty deposits.[2] Multiple terms have been used to describe this alteration in nutritional metabolism, and the term protein-energy wasting (PEW) has recently been proposed to include both the phenomenon of malnutrition and the increased catabolism observed in these patients, with or without inflammation.[3] PEW could currently be considered a new risk factor that underlies the inverse epidemiology

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phenomenon, whereby markers that are associated with a lower probability of cardiovascular events, such as lower body mass index (BMI) or low cholesterol in the general population, are associated with a higher presence of cardiovascular disease, higher morbidity, and lower survival in dialysis patients.[4]

The traditional prevalence of PEW in the dialysis population varies widely from 18% to 75%, depending on the method used for its estimation. The various methods encompass biochemical tools (albumin, prealbumin, total cholesterol, or normalized protein nitrogen appearance), anthropometric (BMI or arm muscular circumference [AMC]) and nutritional scoring tools[5] (Subjective Global Assessment [SGA], malnutrition-inflammation score [MIS]). In addition, prevalence estimates in distinct countries reflect their economic situation, degree of development, and the prevalence of malnutrition in the general population, making it very difficult to establish a more accurate prevalence in the dialysis population. In the latest consensus and update on PEW in CKD, this entity was found in up to 70% of dialysis patients,[6,7] with elderly patients on dialysis being much more vulnerable to its development.[4,8]

The detection and prevention of PEW in patients with CKD should involve individualized and integrated strategies specific to this population, as there are essential differences with the general population. Therefore, serial assessment of nutritional status for the detection and management of PEW is encouraged, but to date, there is no single, universally valid criterion for its diagnosis with acceptable sensitivity and specificity, and therefore, it is necessary to use a combination of the previously mentioned subjective and objective methods.[6]

Patients undergoing maintenance hemodialysis (HD) show a significant longitudinal decline in anthropometric nutritional parameters, such as weight, muscle mass, and fat mass. For this reason, some body composition parameters obtained by bioelectrical impedance such as the lean tissue index (LTI), fat tissue index (FTI), and overhydration (excess extracellular water [ECW] above 15%) could also be considered as potential tools to assess the nutritional status of patients and identify the presence of PEW.[3,9-11]

The aims of this study were to determine whether body composition monitor (BCM) using the bioimpedance spectroscopy (BIS) technique could be a practical instrument for nephrologists to assess the nutritional status of patients on HD and whether it is more effective in identifying patients at highest risk of developing PEW and therefore requiring preferential nutritional intervention when used alone or in combination with other currently used tools for that purpose (clinical, biochemical, anthropometric, and nutritional scoring systems).

Methods

Design and Patients

Ninety-one clinically stable HD patients were selected in this observational cross-sectional study in 2 different locations. Nutritional status was evaluated by anthropometric methods, distinct biochemical nutritional biomarkers, nutritional scoring system, and body composition monitor (BCM Fresenius®) in 75 patients on standard 4-5 hours online hemodiafiltration (OL-HDF) and 16 patients on every-other day nocturnal 7-8 hours OL-HDF, all of them with Fresenius 5008 machines. The patients were classified into those with and without PEW by using the criteria for the clinical diagnosis of PEW in CKD according to the latest consensus[6] and were then classified as adequately or inadequately nourished according to a BCM flow chart,[11] and data obtained with the MIS.[7]

CKD etiology consisted of diabetic nephropathy (22%), nephroangiosclerosis (14.3%), chronic glomerulonephritis (15.4%), polycystic disease (8.8%), obstructive uropathy and urologic malformations (7.6%), unknown origin (9.9%), interstitial nephropathy (5.5%), and other causes (16.5%). Each patient was assessed with the Charlson comorbidity index. The baseline characteristics are displayed in Table 1 and were all collected the same day as the BCM was performed.

Laboratory Evaluation

The following laboratory data were obtained immediately before the second dialysis session of the week: predialysis blood urea nitrogen, creatinine, bicarbonate, C-reactive protein, cholesterol, triglycerides, transferrin, albumin, prealbumin, and total protein. All laboratory determinations were performed locally by standard procedures in the certified laboratories of our hospital. Albumin was determined using bromocresol purple methods delivering ranges lower than bromocresol green methods.[12] Using predialysis and postdialysis blood urea nitrogen in a midweek dialysis session, we calculated the dialysis dose (Kt/V by Daugirdas' second-generation single-pool variable volume formula) and normalized protein nitrogen appearance using standard formulas.

Anthropometric Measurements

BMI was calculated by using a cutoff level of 23 kg/m^2 as a CKD-specific diagnostic criterion of PEW in comparison with the general population (<18.5 kg/m^2).[3]

Subcutaneous folds of the biceps and triceps were measured with a lipocaliper, and waist circumference and mid-upper arm circumference (MUAC) were measured with a nondeformable tape designed for such use. The AMC was also calculated using the bicipital fold (BF) and MUAC to provide an estimate of the protein reserves in the musculature.