ORIGINAL RESEARCH

Body Composition and Mortality Predictors in Hemodialysis Patients

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Objective: To evaluate how different compartments of body composition can affect survival in hemodialysis (HD) patients.

Design: Multicenter longitudinal observational study of a cohort of patients in HD with 12 months of follow-up.

Setting: Patients from 34 nephrocare dialysis units in Portugal were included.

Subjects: A total of 697 patients on maintenance HD during 4 hours 3 days per week were enrolled.

Intervention: Dry weight, presence of diabetes, body mass index (BMI), lean tissue index, fat tissue index (FTI), body cell mass index (BCMI), albumin and hydration status were recorded at baseline. In all patients, the assessment of body composition was carried out using the Body Composition Monitor (BCM; Fresenius Medical Care Deutschland GmbH, Germany).

Main Outcome Measure: Survival during a 12-month period of follow-up.

Results: Patient's mean (±standard deviation) age was 65.4 ± 14.3 years, and median (interquartile range) HD vintage was 41 (19-81) months. Patients who died during the study period, had higher age ($P < .001$), lower dry weight ($P = .001$), BMI ($P < .001$), albumin ($P < .001$), lean tissue index ($P = .015$), and also lower BCMI ($P = .046$). Patients with diabetes ($P = .045$), BMI < 18.5 kg/m^2 ($P < .001$), albumin < 4.0 g/dL ($P < .001$), relative overhydration ≥ 15% ($P = .001$), low FTI ($P = .019$), and also those in the lowest tertile of BCMI ($P = .022$) displayed a significantly worse survival. In the Cox regression analysis, the overall mortality of patient was related to low FTI, relative overhydration, BMI < 18.5 kg/m^2, BCMI ≤ 5.2 kg/m^2, and albumin < 4.0 g/dL.

Conclusions: Several body composition parameters demonstrated to have an important role in predicting 1-year mortality in HD patients. Albumin, FTI, and BMI were useful predictors of mortality in these patients.

Introduction

DIALYSIS PATIENTS ARE subject to multiple metabolic and nutritional derangements leading to chronic and persistent negative nutrient balance. On the other hand, patients on hemodialysis (HD) with better nutritional status are more capable of withstanding cumulative stress, inflammation, chronic acidosis, infections, vascular access failures, and hospitalizations[1].

HD patients experience several changes in body composition and in whole body energy expenditure as a result of the multiple comorbid conditions, metabolic acidosis, chronic inflammation, and dialysis procedure itself.[1,2] The distribution of the body composition and patients' clinical parameters condition their survival.[3,4] Monitoring the nutritional status of these patients is extremely important to prevent malnutrition and improve the care provided, contributing to their quality of life and survival time.[5]

Although an increased body mass index (BMI) is associated with higher mortality in general population, many epidemiologic studies have shown that overweight and obesity may play a protective role in HD patients, a phenomenon called "obesity paradox".[2,3] Although the reason for this is unknown, 1 potential explanation is that the BMI is not able to differentiate between fat and fat-free mass (FFM).[3] For this reason, it is well recognized that BMI is a nutritional parameter that cannot, reflect the real nutritional status in HD patients, *per se*.[3,6–9] On the other hand, the assessment of body composition with bioimpedance spectroscopy (Body Composition Monitor®; Fresenius Medical Care, Deutschland GmbH, Germany) allows differentiating the distribution of body compartments such as fat mass, lean mass, body cell mass, and also hydration status.[10] Moreover, this seems to be a valid method for assessing and monitoring hydration and nutritional status in HD patients.[11–13] Some studies have shown that both, fat tissue and lean tissue are strong predictors of outcomes in dialysis patients and may influence survival time.[3,6,14]

Although in the general population, increased body fat is a risk factor for cardiovascular disease and other health problems, some studies have reported that a low, rather than a high, body fat mass is an independent risk factor of poor survival in maintenance HD patients.[2–4] In addition,

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lower muscle mass is also associated with worse survival, probably due to its relation with poorer nutritional status.[3]

The body cell mass, which is defined as the FFM without the bone mineral mass and extracellular water (ECW), is the most metabolically active compartment of the body.[5,6] Some authors consider it an adequate nutritional status predictor because it does not include ECW, which is often increased in HD patients, and can overestimate the nutritional status.[5,7]

In these patients, the hydration status may mask the anthropometric assessment, and normal hydration is one of the essential targets of dialysis therapy.[5] Among HD patients, overhydration (OH) has a high predictive value for an increased cardiovascular morbidity and mortality risk.[15–19]

To our knowledge, there are few studies investigating the role of whole body compartments, including body cell mass in HD patients. The purpose of this study was to evaluate how different compartments of body composition can affect survival in HD patients.

Methods

Study Design

This was a multicenter longitudinal observational study of a cohort of maintenance HD patients with 12 months of follow-up.

Study Population

In this study, 697 patients were recruited between August 2013 and December 2013 from 34 nephrocare dialysis units in Portugal (located throughout the country) and were monitored for 1 year.

Inclusion criteria included age ≥ 18 years and 3 times weekly in-center HD for ≥3 months (with an online hemodiafiltration technique). All patients were dialyzed with high-flux (Helixone®; Fresenius Medical Care) membranes and ultrapure water in accordance with the criteria of International Organization for Standardization regulation 13959:2009—Water for hemodialysis and related therapies.

Variables of Interest

Age, gender, HD vintage, dry weight, presence of diabetes, BMI, lean tissue index (LTI), fat tissue index (FTI), body cell mass index (BCMI), albumin, and relative OH (overhydration/extracellular water [OH/ECW]) were recorded once between August 2013 and December 2013.

Body Composition Measurements

In all patients, the assessment of body composition was carried out using the Body Composition Monitor (BCM®; Fresenius Medical Care Deutschland GmbH, Germany). The BCM takes measurements at 50 frequencies in a range of 5 to 1000 kHz. The measurement was performed approximately 30 minutes before the midweek HD session, with 4 conventional electrodes being placed on the patient, who was lying in supine position: 2 on the hand and 2 on the foot contralateral to the vascular access. Regarding the quality of measurements, all exceeded 95%.

The parameters obtained with the BCM were FTI, LTI, BCMI, and OH/ECW. The BCMI corresponds to FFM without the bone mineral mass and ECW, and it is the most metabolically active compartment of the body.[8] The LTI and FTI reference ranges given by the BCM are based on gender. Severe OH was considered if OH/ECW > 15%.

Outcome Variable

The outcome variable was all-cause mortality, and participants were censured at the time of death, transplantation, transference to other dialysis unit, or study end date (between August 2014 and December 2014).

Statistical Methods

Patient characteristics were summarized using standard descriptive statistics. Kolmogorov-Smirnov test was used to test for normality of the variables distributions. Patients were categorized according to their status at the end of the 12 months of follow-up: alive or dead.

Categorical variables were presented as frequencies and percentages and continuous variables as mean ± standard deviation or as median and interquartile ranges, as appropriate. Baseline differences between alive and dead patients were evaluated using independent samples *t-test* for continuous variables and chi-square tests for categorical variables.

The prognostic differences of risk stratification in the study population were evaluated using Kaplan-Meier curves and log-rank test, and Cox's hazard proportion analysis was used to estimate the hazard ratios for all-cause mortality.

Univariate analysis was performed to examine the relationship between HD vintage, BMI, FTI, LTI, BCMI (divided into tertiles), OH/ECW, albumin, and diabetes with all-cause mortality. Two incremental levels of multivariate adjustment were conducted: 1—demographic-adjusted models included age, gender, HD vintage, and diabetes; 2—albumin-adjusted models included all the aforementioned covariates plus albumin.

All statistical tests were performed using the Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS, Inc., Chicago, Illinois). Statistical significance was defined as $P < .05$.

Results

Patients' Characteristics

This study included 697 patients of whom 66 (9.5%) died, 23 (3.3%) were transplanted, and 15 (2.2%) were transferred to other dialysis units during the study period. Patient's median (interquartile range) age and HD vintage were, respectively, 67 (55.5-76) years and 41(19-81) months. Of the whole sample, 43.5% were female, and 35.6% were diabetics. Patient's baseline characteristics are summarized in Table 1.