Body composition analysis in chronic dialysis patients: a longitudinal study

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Abstract

Objective: Nutritional status is an important determinant of morbidity and mortality in dialysis patients. Body composition analysis bioelectrical impedance techniques are becoming commonplace in the clinical setting. Our objective is to report our clinical experience using bioelectrical impedance analysis for the prospective nutritional surveillance of dialysis patients.

Methods: A total of 204 patients, 157 on hemodialysis and 47 on peritoneal dialysis were followed for a median of 21 months. Values from the first trimester were averaged and compared to those obtained in the last trimester. Bioelectrical impedance values were obtained using a single frequency (50 kHz) bioimpedance analyzer.

Results: Baseline values for body weight, height, body mass index and body surface area were similar in both treatment modalities. Hemodialysis patients lost a discreet amount of body weight (1.5%, p=0.0334). Body weight did not change in peritoneal dialysis patients. Significant decreases in resistance (p=0.10023) and phase angle (p=0.0481) were noted in hemodialysis but not peritoneal dialysis patients. A small but significant decrease in fat free (1.8%; p=0.0028) and body cell free (3.3%; p=0.0036) mass was noted in hemodialysis but not peritoneal dialysis patients.

Conclusions: 1. Bioelectrical impedance analysis may detect losses in fat free mass and body cell mass that are not apparent by body weight monitoring. 2. Bioelectrical impedance analysis is a practical clinical tool for evaluating body composition in dialysis patients.

Key words: Bioelectrical impedance, Body composition, Dialysis, Nutrition
**INTRODUCTION**

Nutritional status is an important determinant of morbidity and mortality in dialysis patients (1-6). The underlying causes of malnutrition are multiple, but recent attention has focused on decreased caloric and protein intake, chronic inflammation and concurrent chronic conditions such as diabetes mellitus and congestive heart failure (9-17). Unlike hemodialysis patients in whom protein malnutrition and weight loss may predominate, peritoneal dialysis patients often gain body weight and fat mass that may mask actual loss of muscle mass.

Nutritional status is clinically evaluated by subjective global assessment, anthropometry including skin-fold measurements, or by means of quantitative biochemical parameters such as albumin and transferrin concentrations. Densitometric measurements of body density (fat content) and deuterium-isotope dilution measurements of total body water are impractical for surveillance of large patient populations. Noninvasive techniques, such as dual energy x-ray absorptiometry and bioelectrical impedance analysis are becoming commonplace in the clinical setting. The latter is simple, reproducible, easy to use and transportable making it attractive in the routine clinical setting (28,32-35). The bioimpedance parameters resistance, reactance and phase angle correlate closely with total body water, intracellular water, body cell mass, and fat free mass.

The objective of this study is to report our clinical experience using bioelectrical impedance analysis in the prospective nutritional surveillance of dialysis patients.

**PATIENT AND METHODS**

A total of 204 patients (median duration on dialysis therapy was 12 months) were followed for a median of 19 months. Values from the first trimester were averaged and compared to those obtained in the last trimester. The treatment modality was hemodialysis in 157 (77%) and peritoneal dialysis in 47 (23%) patients.

Bioelectrical impedance values were obtained using a single frequency (50 kHz) bioimpedance analyzer. Studies were done at 15 minutes post hemodialysis or during a dry period in peritoneal dialysis patients. All patients were evaluated while sitting up in a hemodialysis chair. Care was taken to ensure that arms and hands were not touching the torso and that thighs were not in contact with each other. Disposable tetrapolar electrodes were placed over the bony aspect of the wrist and the ipsilateral ankle. The coefficient of variation for the impedance measurements with this technique is 0.5%, and the interoperator variability 1%. In hemodialysis patients the non-access side was used for placement of electrodes. Calculations were made using a parallel impedance model provided by the manufacturer (Cyprus 1.2 program, RJL Systems, Clinton Township, MI, US).

Bioelectrical impedance vector analysis was carried out as previously described and compared to data obtained as part of the National Health and Nutrition Examination Survey III (31).

Biochemical data was obtained monthly pre hemodialysis or during a peritoneal dialysis clinic visit, and the average parameter value for the entire period of observation used for analysis.

Results are expressed as mean ± standard deviation and as percentages where appropriate. Statistical comparisons were made using unpaired and paired T tests.

**RESULTS**

Demographic characteristics of the study population are shown in Table 1. Peritoneal dialysis patients were younger than those on hemodialysis (50 ± 13 vs. 62 ± 15 years; \(p<0.0001\)). Sex and race distributions were similar in both treatment modalities.

Morphometric parameters are shown in Table 2. Baseline values for body weight, height, body mass index, and body surface area were similar in both treatment modalities. Hemodialysis patients lost a discreet (1.5%) but significant amount of body weight (\(p=0.0334\)). Body weight did not change in peritoneal dialysis patients.

Bioelectrical impedance parameters are shown in Table 3. Initial parameter values were similar in hemodialysis and peritoneal dialysis patients. However, at the end of the observation period significant decreases in both resistance (\(p=0.0023\)) and phase angle (\(p=0.0481\)) were noted in hemodialysis but not peritoneal dialysis patients. These results are consistent with a decrease in intracellular water content in hemodialysis patients.
Bioimpedance body composition analysis in dialysis

**DISCUSSION**

This study demonstrates that bioelectrical impedance analysis can be routinely used in the clinical setting for the surveillance of nutritional status in dialysis patients. The technique is simple, portable, reproducible, easy to use, and requires no more than ten minutes of patient and staff time. In our center the primary responsibility for measurements rests with the renal dietitians, and is considered an integral part of their clinical patient evaluation.

Our findings also indicate that bioelectrical impedance analysis may detect losses in fat free mass and body cell

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<th>Table 2. Morphometric and body composition parameters.</th>
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<td>Body mass index, kg/m²</td>
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BSA = body surface area

*p* = 0.0334.

†*p*= 0.0028.

‡*p*= 0.0036.
mass that may not be apparent by body weight monitoring. In hemodialysis patients body weight loss was identified as pertaining exclusively to the fat free and body cell mass compartments, while no changes were observed in fat mass (Table 3). In contrast, body weight gain in peritoneal dialysis patients was proportionally distributed among the three compartments studied (Table 3). The number of patients on peritoneal dialysis was smaller than those on hemodialysis. It is therefore possible that subtle differences in peritoneal dialysis during longitudinal follow up may have escaped statistical significance due to a type 2 error.

A few clinical studies have simultaneously evaluated body composition analysis by bioelectrical impedance and dual-energy x-ray absorptiometry (36-38). In general very good agreements were found by both methods in assessing fat mass and fat free mass. However, both methods are affected by the state of hydration (21,25, 30,32). It could be argued that the differences observed between hemodialysis and peritoneal dialysis patients in this study are related to a greater degree of overhydration in the latter when compared to the former. The relationship found between the bioimpedance parameters reactance and phase angle and serum albumin concentration reflects the combined effect of volume expansion and malnutrition. This potential confounding factor was evaluated by bioelectrical impedance vector analysis (30). This method allows definition of the state of hydration of a given individual or group in comparison to a reference group (31). The sex and race adjusted vector plots presented in Figure 1 indicate that both hemodialysis and peritoneal dialysis patients have a greater degree of overhydration (vector displaced to the right) when compared to the general population (NHANES III). However, no differences in vector parameters were noted between hemodialysis and peritoneal dialysis patients indicating a similar degree of overhydration.

Biochemical parameters related to dialytic clearance and divalent ion metabolism were similar in both groups (Table 1). As reported previously, peritoneal dialysis patients had lower serum albumin concentrations than their hemodialysis counterparts. This is of interest considering that fat free and body cell mass was better preserved in peritoneal dialysis patients, and is consistent with current views of factors including dialysis modality in addition to malnutrition impacting serum albumin concentrations (8-10,33-35).

In conclusion, bioelectrical impedance analysis is a practical clinical tool for evaluating body composition in dialysis patients.

REFERENCES
Bioimpedance body composition analysis in dialysis


