The relationship between dialysis vintage (length of time on dialysis), body composition, and survival has been reported in hemodialysis patients. In the present study, we examined the association of dialysis vintage with body composition and survival in peritoneal dialysis (PD) patients.

At enrollment, body composition in 65 PD patients was determined by bioelectrical impedance analysis. Patients (mean age at enrollment: 54 years) were followed for up to 11 years maximum. At enrollment, the mean, median, and maximum dialysis vintages were 51, 34, and 261 months respectively. After adjusting for age, race, sex, and diabetes status, dialysis vintage was indirectly correlated (partial correlation coefficients) with body weight ($r = -0.40$, $p = 0.001$), body mass index ($r = -0.40$, $p = 0.002$), body surface area ($r = -0.39$, $p = 0.002$), body cell mass ($r = -0.39$, $p = 0.002$), total body fat weight ($r = -0.30$, $p = 0.02$), and fat percentage of body weight ($r = -0.31$, $p = 0.018$), and directly correlated with extracellular mass to body cell mass ratio ($r = 0.27$, $p = 0.039$). The observed cumulative survival was significantly higher ($p = 0.007$) in patients with a dialysis vintage at enrollment of 35 months or less, than in patients with dialysis vintage at enrollment of more than 35 months. In the multivariate Cox regression analysis, adjusting for age, race, sex, and diabetes, dialysis vintage at enrollment remained an independent predictor of mortality (relative risk: 1.010; $p = 0.002$). Increase in relative risk of death with increasing dialysis vintage may be partly explained by the association of vintage with unfavorable changes in body composition and the nutrition status of patients over time.

Key words
Dialysis vintage, bioelectrical impedance analysis, BIA, survival, nutrition

Introduction
The term “dialysis vintage” means the length of time in months or years that end-stage renal disease patients spend on dialysis. We and other authors have reported that the characteristics of patients with a long dialysis vintage are different from those of patients with a short vintage. In peritoneal dialysis (PD) patients, younger age and nondiabetic status have been associated with prolonged survival (1–3). Abraham et al. reported that nondiabetic patients, those with average transport, those who are nonsmoking with a reasonable nutrition status, and those with a low peritonitis rate, among others, survive for 3 years or longer (4).

Nutrition status is an important predictor of outcomes in PD patients. Lower values for serum markers of nutrition are associated with higher mortality in PD patients (1,5–7). Enrollment values for markers such as albumin and creatinine were significantly higher in PD patients on dialysis for more than 10 years than in those on dialysis for less than 5 years (1). Compared with patients who survived less than 3 years on PD, those who survived 3 years or longer had higher serum albumin (4).

Body composition is closely related to nutrition indicators and chronic illnesses in dialysis patients (8). Bioelectrical impedance analysis (BIA) has been recognized as a simple, noninvasive technique for the determination of body composition and fluid status in PD patients (9). We and other authors have investigated the relationship of BIA-derived body composition parameters with nutrition markers and morbidity and mortality in PD patients (10,11).

The relationship between dialysis vintage, body composition, and survival has been reported in patients
on hemodialysis. In hemodialysis patients, dialysis vintage is directly related to unfavorable changes in nutrition status, including body weight and body composition (12). That relationship remains to be studied in PD patients. In the present work, we examined the association of dialysis vintage at enrollment with body composition and survival in PD patients.

Methods
From November 2000 to May 2008, our study enrolled 65 PD patients, who were then followed until September 2011 (up to 11 years maximum). On enrollment, demographic, clinical, and biochemical data were recorded. The BIA measurements were performed using an impedance plethysmograph (800 mA, 50 kHz). The resulting electrical impedance, resistance, and reactance values were used in a computerized calculation of body composition parameters including extracellular mass (ECM) and body cell mass (BCM) using Cyprus (BIA-101, version 1.0: RJL/Akern Systems, Clinton Township, MI, U.S.A.). The Long Island College Hospital Institutional Review Board approved this study protocol, and informed consent was obtained from each patient.

Statistical analysis
Continuous variables are expressed as mean ± standard deviation. Correlations are reported as Spearman rank correlation coefficients and partial correlation coefficients. Observed survival was computed by the Kaplan–Meier method (13). A log-rank test was used to assess differences between the survival curves. Independent predictors of survival were determined by Cox regression analysis. Calculations were performed using SPSS for Windows (version 12.0.1: SPSS, Armonk, NY, U.S.A.).

Results
In our patient cohort [mean age: 54 years (range: 21 – 95 years); 56% women; 64% of African descent; 24% diabetic], the mean, median, and maximum dialysis vintages at enrollment were 51, 34, and 261 months respectively. Mean body mass index (BMI), total body fat, fat percentage (fat%), body weight, phase angle, and ECM/BCM ratio were 25.37 ± 5.45 lb./in.², 45.32 ± 21 lb., 26.86% ± 10.3%, 6.06 ± 1.6 degrees, and 1.21 ± 0.2 respectively.

Using Spearman rank correlation, dialysis vintage was negatively correlated with BMI ($r = -0.27$, $p = 0.03$), total fat weight ($r = -0.29$, $p = 0.02$), and fat% body weight ($r = -0.26$, $p = 0.04$). Table 1 shows correlations between enrollment dialysis vintage and body composition parameters adjusted for age, race, sex, and diabetes. Dialysis vintage was inversely correlated with body weight ($r = -0.40$, $p = 0.001$), BMI ($r = -0.40$, $p = 0.002$), body surface area ($r = -0.39$, $p = 0.002$), total body fat ($r = -0.30$, $p = 0.02$), fat% body weight ($r = -0.31$, $p = 0.018$), and BCM ($r = -0.39$, $p = 0.002$), and directly correlated with ECM/BCM ratio ($r = 0.27$, $p = 0.039$).

The patients were allocated to two equal groups based on median dialysis vintage at enrollment. At 11 years of observation, the cumulative observed survival (Kaplan–Meier) of patients with a dialysis vintage at enrollment of 35 months or less ($n = 33$) was significantly higher ($p = 0.007$) than that of patients with dialysis vintage of more than 35 months ($n = 32$).

By univariate unadjusted Cox regression analysis, increased dialysis vintage at enrollment was associated with increased risk of mortality (relative risk: 1.008; $p = 0.008$). In a multivariate Cox regression analysis with adjustment for age, sex, race, and diabetes status, dialysis vintage at enrollment as a continuous variable was a significant independent predictor of mortality (relative risk: 1.010; $p = 0.002$). For each month of increased dialysis vintage, the relative risk of death increased significantly by 1%. Analyses with log-transformed dialysis vintage yielded similar results. On multivariate Cox regression analysis, using

<table>
<thead>
<tr>
<th>Variable</th>
<th>Partial correlation coefficient a</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Body weight (lb.)</td>
<td>-0.40</td>
<td>0.001</td>
</tr>
<tr>
<td>Body mass index (lb./in.²)</td>
<td>-0.40</td>
<td>0.002</td>
</tr>
<tr>
<td>Body surface area (m²)</td>
<td>-0.39</td>
<td>0.002</td>
</tr>
<tr>
<td>Fat weight (lb.)</td>
<td>-0.30</td>
<td>0.02</td>
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<td>Fat% body weight</td>
<td>-0.31</td>
<td>0.018</td>
</tr>
<tr>
<td>Body cell mass [BCM (lb.)]</td>
<td>-0.39</td>
<td>0.002</td>
</tr>
<tr>
<td>ECM/BCM ratio</td>
<td>0.27</td>
<td>0.039</td>
</tr>
<tr>
<td>Phase angle (degrees)</td>
<td>-0.23</td>
<td>0.07</td>
</tr>
</tbody>
</table>

a Adjusted for age, sex, race, and diabetes.

ECM = extracellular mass.
dialysis vintage as a categorical variable and adjusting for age, sex, race, and diabetes, the mortality risk was more than doubled for patients with a dialysis vintage at enrollment of more than 35 months compared with patients with a dialysis vintage at enrollment of 35 months or less (relative risk: 2.37; \( p = 0.04 \)).

**Discussion**

In the present study, we show that greater dialysis vintage is associated with unfavorable changes in body composition parameters. After adjustment for age, race, sex, and diabetes status, an increase in dialysis vintage was associated with lower body weight, BMI, total fat weight, fat% body weight, and BCM, and with a higher ECM/BCM ratio. Our results accord with work by Chertow et al., who reported that, when adjusted for age, race, sex, and diabetes, body composition parameters such as body weight, total body water, BCM, and phase angle tended to be lower in hemodialysis patients after 2 years of dialysis vintage (12). In our study, the relationship between phase angle and dialysis vintage did not reach statistical significance. In contrast, in hemodialysis patients, the largest relative differences by vintage were obtained for phase angle (12).

Our finding that body fat declines with increase in dialysis vintage is interesting. Because we lack longitudinal data, we cannot report the percentage of our patients in whom body fat declined with increased dialysis vintage. It has been reported that, after 12 months of dialysis, 53% of PD patients had gained and 47% had lost body fat. Baseline BMI and hospitalizations during follow-up were the most important factors associated with variability in change of body fat (14). The ECM/BCM ratio has been reported to be a highly sensitive index of malnutrition and a marker for survival in PD patients (15). The higher the ECM/BCM ratio, the poorer the nutrition status. We observed an increase in ECM/BCM ratio with increasing dialysis vintage, which implies poorer nutrition status with increasing dialysis vintage in our patients.

Although dialysis vintage has been associated with survival in hemodialysis (12), little is known about the relationship between dialysis vintage and outcomes in PD patients. The relationship between dialysis vintage and survival is difficult to explain because of various confounding factors. Unfavorable changes in body composition parameters with increasing dialysis vintage may be one of the factors contributing to the increasing risk of death in PD patients.

**Conclusions**

End-stage renal disease is a wasting illness, as indicated by unfavorable changes in body composition over time with increasing dialysis vintage. Increase in relative risk of death with increasing vintage may be partly explained by the association of vintage with declining body weight and BMI, depletion of body fat and BCM, and increase in ECM/BCM ratio, implying deteriorating nutrition status in patients over time. Longitudinal studies with serial measurements of body composition parameters are needed to better understand the natural history of wasting in PD patients.

**Disclosures**

The authors have no financial conflicts of interest to declare.

**References**


Corresponding author: Morrell M. Avram, MD, Avram Division of Nephrology, SUNY Downstate Medical Center UHB at Long Island College Hospital, 339 Hicks Street, Brooklyn, New York 11201 U.S.A. E-mail: morrell.avram@Downstate.edu