Large body surface area (BSA) could be a pitfall in long-term peritoneal dialysis. We analyzed the viability of the peritoneum in terms of adequacy and technique survival in patients of varying BSA.

We grouped our PD patients into three categories (BSA $\leq$ 1.59 m², BSA 1.60 – 1.79 m², and BSA $\geq$ 1.80 m²) and used the Student t-test to compare the mean weekly Kt/V urea between the groups (significance set at $p < 0.05$). We also measured and used Kaplan–Meier analysis to compare technique survival overall and in anuric patients from the onset of PD to the endpoints of transfer to hemodialysis or death linked to dialysis technique (log-rank test, $p < 0.05$).

Group A consisted of 24 patients [2 men, 22 women; age: 41.9 ± 12 years; BSA: 1.49 ± 0.07 m²; total treatment duration: 1703.4 patient–months (mean: 71 ± 50.6 months); diabetic: 8.33%; anuric: 62%; weekly Kt/V urea: 2.36 ± 0.45; technique survival: 100%, 89%, 89%, 53%, and 53% at 1, 3, 5, 8, and 15 years]. Group B consisted of 35 patients [12 men, 23 women; age: 57.19 ± 18 years; BSA: 1.69 ± 0.05 m²; total treatment duration: 1870 patient–months (mean: 53.4 ± 46.2 months); diabetic: 17.14%; anuric: 37.14%; weekly Kt/V urea: 2.28 ± 0.41; technique survival: 97%, 93%, 87%, 78%, and 19% at 1, 3, 5, 8, and 14 years]. Group C consisted of 34 patients [24 men, 10 women; age: 56.2 ± 13 years; BSA: 1.90 ± 0.09 m²; total treatment duration: 1557.5 patient–months (mean: 45.8 ± 34.4 months); diabetic: 20.6%; anuric: 41%; weekly Kt/V urea: 1.98 ± 0.38; technique survival: 97%, 79%, 67.6%, 56%, and 28% at 1, 3, 5, 8, and 12 years]. Using the log-rank test, comparisons of technique survival overall and in anuric patients showed for A vs. B, $p = 0.49$ and $p = 0.58$ respectively; for A vs. C, $p = 0.45$ and $p = 0.06$; for B vs. C, $p = 0.56$ and $p = 0.10$. No significant differences in weekly Kt/V urea were observed between the groups (all $p > 0.05$).

Peritoneal dialysis is viable for patients with a high BSA. There is a tendency toward worse technique survival in anuric patients with a high BSA.

Keywords
Adequacy, technique failure, body surface area

Introduction
In terms of dialysis adequacy, the effectiveness of the peritoneum as a dialysis membrane has been discussed (1). Apparently, there are no doubts about the feasibility of short-term treatment with peritoneal dialysis (PD) in patients with a high body surface area (BSA) and a high body mass index (BMI) (2,3). Among other factors, residual renal function contributes to achieving adequacy targets; however, given that diuresis declines during the course of treatment, the dialysis prescription must be modified to maintain the adequacy level, especially for patients with a high body weight (4,5).

The impossibility of reaching adequacy and ultrafiltration (UF) targets leads to technique failure and an increased risk of morbidity and death. Taking into account those considerations, we studied the viability of the peritoneum in terms of adequacy and technique survival in very long-term PD therapy in patients of varying BSA.

Patients and methods
This retrospective study included all incident PD patients who were admitted to our PD program from August 4, 1993, to July 31, 2009, and who were undergoing various types of continuous ambulatory PD (CAPD) or automated PD (APD). We established three groups of patients: group A, BSA $\leq$ 1.59 m²; group B, BSA 1.60 – 1.79 m²; and group C, BSA $\geq$ 1.80 m².

From patient charts, we obtained the final kinetic transport parameters for the peritoneal membrane [from
a standardized PET (6)]. Using the last recorded value of weekly Kt/V urea for the patients, we calculated the mean weekly Kt/V urea per group, and we used the Student *t*-test to compare those values between the groups (significance set at \( p < 0.05 \)).

We calculated total body water (TBW) according to the Watson formulas (7):

Women: \[ \text{TBW} = -2.097 + (0.1069 \times \text{Height}) + (0.2466 \times \text{Weight}) \]

Men: \[ \text{TBW} = 2.447 - (0.09156 \times \text{Age}) + (0.1074 \times \text{Height}) + (0.3362 \times \text{Weight}) \]

We calculated BSA according to Du Bois and Du Bois (8):

\[ \text{BSA (m}^2) = 0.007184 \times \text{Height (cm)}^{0.725} \times \text{Weight (kg)}^{0.425} \]

We defined “anuria” as a lack of residual renal function, with a urine output of less than 100 mL daily.

We used the Kaplan–Meier product–limit estimation method to calculate global technique survival and technique survival in anuric patients from the onset of PD to the endpoints of transfer to hemodialysis or death related to PD therapy. Patients who were transplanted or lost to follow-up or who achieved partial recovery of renal function were censored. Comparisons of technique survival between the patients groups were made using the log-rank method (significance set at \( p < 0.05 \)).

**Results**

The study enrolled 93 PD patients who had been on treatment for at least 3 months. The patients were divided in three groups according to BSA. Table I summarizes patient characteristics.

Group A (BSA \( \leq 1.59 \text{ m}^2 \)) consisted of 24 patients with technique survival of 100%, 89%, 89%, 53%, and 53% at 1, 3, 5, 8, and 15 years respectively. Of the 24 patients, 12 underwent CAPD and APD successively. The peritonitis rate was 0.24 episodes in 12 months. The rate of drop-out for peritonitis was 20.8% (5 patients).

Group B (BSA 1.60 – 1.79 m²) consisted of 35 patients with technique survival of 97%, 93%, 87%, 78%, and 19% at 1, 3, 5, 8, and 14 years respectively. Of 35 patients, 15 underwent CAPD and APD successively. The peritonitis rate was 0.37 episodes in 12 months. The rate of drop-out for peritonitis was 25.7% (9 patients).

Group C (BSA \( \geq 1.80 \text{ m}^2 \)) consisted of 34 patients with technique survival of 97%, 93%, 87%, 87%, 78%, and 19% at 1, 3, 5, 8, and 14 years respectively. Of 34 patients, 14 underwent CAPD and APD successively. The peritonitis rate was 0.47 episodes in 12 months. The rate of drop-out for peritonitis was 25.7% (9 patients).

**Table I** Patient characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group A (BSA( \leq 1.59 \text{ m}^2 ))</th>
<th>Group B (BSA 1.60–1.79 m²)</th>
<th>Group C (BSA ( \geq 1.80 \text{ m}^2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>41.9±12</td>
<td>57.19±18</td>
<td>56.2±13</td>
</tr>
<tr>
<td>Sex (men/women)</td>
<td>2/22</td>
<td>12/23</td>
<td>24/10</td>
</tr>
<tr>
<td>PD treatment (patient–months)</td>
<td>1703.4</td>
<td>1870</td>
<td>1557.5</td>
</tr>
<tr>
<td>Mean time on PD (months)</td>
<td>71±50.6</td>
<td>53.4±46.2</td>
<td>45.8±34.4</td>
</tr>
<tr>
<td>Previous HD [ n (%)]</td>
<td>16 (66)</td>
<td>24 (68.6)</td>
<td>19 (55.8)</td>
</tr>
<tr>
<td>Mean time on HD (months)</td>
<td>64±52.7</td>
<td>39.6±29.10</td>
<td>36.6±35.4</td>
</tr>
<tr>
<td>Anuria (%)</td>
<td>62</td>
<td>37.14</td>
<td>41</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>8.33</td>
<td>17.14</td>
<td>20.6</td>
</tr>
<tr>
<td>Mean BSA (m²)</td>
<td>1.49±0.07</td>
<td>1.69±0.05</td>
<td>1.90±0.09</td>
</tr>
<tr>
<td>Weekly Kt/V urea</td>
<td>2.36±0.45</td>
<td>2.28±0.41</td>
<td>1.98±0.38</td>
</tr>
<tr>
<td>D/P creatinine (at 4 h)</td>
<td>0.71±0.11</td>
<td>0.68±0.14</td>
<td>0.69±0.11</td>
</tr>
</tbody>
</table>

PD = peritoneal dialysis; HD = hemodialysis; D/P = dialysate-to-plasma ratio.

Ultrafiltration failure was defined as a net UF of less than 400 mL during a 4-hour 3.86% glucose exchange (9). Definitive UF failure was considered when 24-hour UF did not satisfy the individual negative daily balance requirement of the patient. The data were analyzed retrospectively, and continuous variables are expressed as mean ± standard deviation.
Using the log-rank test, comparisons of overall technique survival between the groups showed, for A vs. B, $p = 0.49$ (Figure 1); for A vs. C, $p = 0.45$ (Figure 2); and for B vs. C, $p = 0.56$ (Figure 3). No statistical differences in weekly Kt/V urea were observed between the groups ($p > 0.05$).

Using the log-rank test, comparisons of technique survival in anuric patients between the groups showed, for A vs. B, $p = 0.58$ (Figure 4); for A vs. C, $p = 0.06$ (Figure 5); and for B vs. C, $p = 0.10$ (Figure 6). No significant differences in weekly Kt/V urea were observed between the groups ($p > 0.05$).

No patient in any group dropped out from PD for inadequate dialysis, and only 1 patient was transferred to hemodialysis because of UF failure.

**Discussion**

Technique failure is one of the most important indexes in the assessment of chronic PD therapy. Several situations such as catheter complications, refractory peritonitis, patient choice, and so on, can lead to discontinuation of PD, but UF failure and an inability to achieve effective solute clearances are the true causes. They are the situations in which peritoneal function is involved.

Acceptable evidence has been developed about patient and technique survival during short-term PD treatment for patients with larger BSAs and BMIs; however, experience with and the impact of very long-term PD treatment in these patients have yet to be reported (2,3).

Our study analyzed the permanence of PD treatment, taking into account the influence of BSA and the effects of an absence of residual renal function in very long-term treatment.

We observed an interesting survival expectancy for the PD method in our three groups of patients: none of the survival curves were statistically different, even in the higher BSA group, which (it is important to emphasize) contained more diabetic patients.
Likewise, we found no statistical differences in the technique survival of anuric patients across groups. On the other hand, a tendency of lower technique survival was observed in the higher BSA patients, but the causes of dropout related to technique survival in this group of patients were peritonitis (57%) and patient choice (43%).

In our program, CAPD and APD patients both receive gradual and adaptive modifications to their dialysis prescription according to the progressive decline of urine output and changes in peritoneal membrane transport characteristics (4). There are doubts about the efficacy of CAPD for treatment lasting more than 80 months in patients that have lost residual renal function. In their study of CAPD technique survival, Twardowski et al. considered a transfer to APD to be CAPD technique failure (10).

In our study, adequacy indicators were satisfactory, with no statistical differences between the three groups. Many patients who started CAPD were transferred to APD to improve adequacy levels to meet target recommendations through optimization of the transport characteristics of peritoneal membrane or to increase the UF volume (11). However, the reasons for transfer to APD were often linked to social situations—job or study possibilities, the needs of a partner, lifestyle, back pain, and so on—but not to membrane failure. Thus, under certain conditions, it is difficult to determine technique failure. A long-term prospective study should be therefore implemented with an elaborated definition of “endpoint” in the survival measurement.

**Conclusions**

Our experience shows that a large BSA is no obstacle to a patient in continuing chronic PD as a long-term renal replacement therapy. Anuria was not associated with lower technique survival in 3 BSA groups a follow-up of more than 10 years. Like Fried and co-workers, we are convinced that size alone should not preclude patients from starting PD (2).
References


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