The number of elderly patients requiring dialysis therapy has been increasing in developed countries. Among elderly patients on dialysis, the incidence of death from cardiovascular complications has increased. Our objective was to study whether the presence of abnormal cardiac function at the initiation of peritoneal dialysis (PD) affects the prognosis of patients over the age of 75 years on PD therapy.

A retrospective analysis of 46 patients more than 75 years of age who started PD therapy (average age: 79.4 ± 3.5 years; 26 women, 20 men) collected demographic and comorbidity data. Survival was defined as time from the initiation of PD therapy.

In 12 patients, ejection fraction measured by echocardiography was less than 50% (“abnormal EF” group); in 34 patients, ejection fraction was more than 50% (“normal EF” group). In the abnormal EF group, 9 patients (75%) survived 12 months; in the normal EF group, 26 patients (76%) survived that long. However, at 24 months, only 2 patients (16%) in the abnormal EF group and 18 patients (52%) in the normal EF group were still alive. Survival was significantly longer in the normal EF group (p < 0.0019). With the exception of serum albumin, other parameters such as age, serum creatinine, and hemoglobin were not significantly different between the two groups at the initiation of dialysis therapy.

Our study demonstrated that cardiac performance at the initiation of PD therapy predicts prognosis in PD patients more than 75 years of age.

**Key words**

Continuous ambulatory peritoneal dialysis, CAPD, elderly, cardiovascular disease, ejection fraction, albumin, prognosis

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From: Department of Nephrology, Saitama Medical School, Saitama, Japan.
and were observed for a period of 5 years. All patients provided informed consent. The protocol was approved by the Human Research Ethics Committee of Saitama Medical University. Patients were divided into two groups: one with an abnormal ejection fraction (less than 50%, “abnormal EF” group) and the other with a normal ejection fraction (more than 50%, “normal EF” group). Patients were allocated to these groups according to echocardiography findings obtained at the start of CAPD.

Patients were seen at the outpatient clinic every 2 – 4 weeks for blood work, radiography of chest and abdomen, and an electrocardiogram. Routine laboratory blood tests included determination of levels of serum total and low-density lipoprotein cholesterol, liver enzymes, alkaline phosphatase, and intact parathyroid hormone. Peritonitis was diagnosed in the presence of at least two of abdominal pain, cloudy effluent with more than 100 white blood cells per milliliter, or a positive dialysate culture. Exit-site infection was diagnosed in the presence of serous or purulent discharge accompanied by a positive swab. Rates of peritonitis are expressed as episodes per patient–year. Hospitalization for any reason was recorded. Information about cause of death was obtained when available.

The CAPD treatment consisted of 1 – 4 1.5-L exchanges daily using dialysate containing lactate and 1.5 g/dL or 2.5 g/dL of dextrose. All patients were treated using a disconnect system. The schedule for bag exchanges was adjusted according to patient data. Mean daily dietary intake was determined from individual 24-hour food records that were tabulated during a 3-day period at the beginning of the study. The patients’ dietary protein intake averaged approximately 0.7 g/kg daily and their energy intake exceeded 25 kcal/kg daily. Their salt intake was restricted to 9 g daily.

Residual renal function was estimated from the daily renal creatinine and urea clearances determined from a 24-hour urine collection. Weekly peritoneal creatinine clearance was calculated using a 24-hour collection of spent dialysate and serum and peritoneal concentrations of creatinine. The PD Adequest computer program for Windows (version 2.0: Baxter Healthcare, Tokyo, Japan) was used for the calculations.

Recombinant human erythropoietin was administered once or twice weekly by the subcutaneous route at doses that were adjusted monthly to achieve a target hemoglobin level of 10.5 g/dL.

Patients with parathyroid hormone levels above 200 pg/mL were treated with 1,25(OH)2D3 and CaCO3 supplements; patients with levels below 70 pg/mL were treated with CaCO3 to reduce their degree of hyperphosphatemia. Doses were adjusted based on serum calcium and phosphate levels. Lipid-lowering drugs, primarily statin derivatives, were administered if serum cholesterol levels exceeded 240 mg/dL. If systolic blood pressure in a subject exceeded 140 mmHg or if diastolic blood pressure exceeded 90 mmHg, antihypertensive therapy was initiated.

Evaluation of echocardiography
Echocardiography with a 3.3-mHz multiphase array probe was used to obtain two-dimensional echocardiograms in subjects lying in the left decubitus position. Two-dimensional assessment of the aortic valve and mitral valve was performed, together with continuous-wave Doppler ultrasound on the basis of the parasternal long-axis and short-axis views. All echocardiography exams were performed according to the recommendations of the American Society of Echocardiography (6).

Statistical analysis
Results are expressed as mean ± standard error of the mean. Statistical analyses used the Student t-test for unpaired samples and the Mann–Whitney test for comparison of means. Cumulative event-free curves were determined using Kaplan–Meier analysis, and the differences between those curves were analyzed using the log-rank test. Statistical significance was set at p < 0.05. All calculations were performed using the StatView statistical software package (version 5.0: SAS Institute, Cary, NC, U.S.A.).

Results
Patient characteristics at the start of CAPD
We observed no differences in the extent of underlying renal disease (hypertension, diabetes, and so on) between patients with and without cardiac dysfunction (Table I). In addition, no significant differences were noted in laboratory tests between the two groups except for the level of serum albumin.

Echocardiographic findings
We observed significant differences in ejection fraction (p < 0.005) and in diameter during diastolic
phase \((p < 0.04)\) between patients with and without cardiac dysfunction (Table II).

**Survival rate**
The overall survival rate was 70% at 12 months, 40% at 24 months, 20% at 36 months, and 10% at 60 months as shown in Figure 1(A). The impact of cardiac function on survival rate was analyzed using Cox regression, and Figure 1(B) shows the survival curves for the abnormal EF and normal EF patients. In the abnormal EF group, 9 patients (75%) survived 12 months; in the normal EF group, 26 patients (76%) survived 12 months. However, at 24 months, only 2 patients (16%) in the abnormal EF group and 18 patients (52%) in the normal EF group were still alive. The difference between the two groups was significant (log-rank test: \(p < 0.0019\)).

**Causes of death**
Table III shows causes of death. In both groups, most patients died of infection. The percentage of deaths from cardiovascular diseases was 15% in both groups, and we observed no significant differences in cause of death between the two groups.

**Occurrence of peritonitis**
During the study period, we observed no difference in the incidence of peritonitis between the two groups (normal EF group: 2 episodes in 2 patients; abnormal EF group: 1 episode in 1 patient). These 3 episodes in

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**TABLE I** Patient demographic data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall</th>
<th>Abnormal EF</th>
<th>Normal EF</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (males/females)</td>
<td>20/26</td>
<td>6/6</td>
<td>14/20</td>
<td>NS</td>
</tr>
<tr>
<td>Age (years)</td>
<td>79.4±3.5</td>
<td>78.6±1.5</td>
<td>80.1±4.2</td>
<td>NS</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>5.42±1.46</td>
<td>5.75±1.87</td>
<td>5.31±1.33</td>
<td>NS</td>
</tr>
<tr>
<td>Underlying renal disease (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>30</td>
<td>8</td>
<td>22</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetes</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>NS</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Interstitial nephritis</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Renovascular hypertension</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>145.3±19.6</td>
<td>151.6±21.2</td>
<td>147.3±18.2</td>
<td>NS</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>99.1±16.7</td>
<td>83.7±23.3</td>
<td>75.5±13.4</td>
<td>NS</td>
</tr>
<tr>
<td>eGFR (mL/min/1.73 m(^2))</td>
<td>8.0±23.4</td>
<td>8.5±2.3</td>
<td>7.9±3.7</td>
<td>NS</td>
</tr>
<tr>
<td>Blood urea nitrogen (mg/dL)</td>
<td>64.8±24.9</td>
<td>70.3±30.3</td>
<td>62.7±23.2</td>
<td>NS</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>10.7±5.9</td>
<td>9.8±1.3</td>
<td>9.3±1.7</td>
<td>NS</td>
</tr>
<tr>
<td>Ca (mg/dL)</td>
<td>7.9±1.3</td>
<td>7.8±0.7(^*)</td>
<td>8.0±1.4</td>
<td>NS</td>
</tr>
<tr>
<td>P (mg/dL)</td>
<td>4.7±1.3</td>
<td>4.7±0.8</td>
<td>4.8±1.4</td>
<td>NS</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.8±0.5</td>
<td>2.7±0.6</td>
<td>3.7±0.7</td>
<td>0.05</td>
</tr>
</tbody>
</table>

\(EF = \text{ejection fraction}; \ BP = \text{blood pressure}; \ eGFR = \text{estimated glomerular filtration rate.}\)

**TABLE II** Echocardiographic data

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall</th>
<th>Abnormal EF</th>
<th>Normal EF</th>
<th>(p) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF (%)</td>
<td>611±18.8</td>
<td>33.9±10.6</td>
<td>69.6±9.6</td>
<td>0.005</td>
</tr>
<tr>
<td>PWT (mm)</td>
<td>11.9±1.5</td>
<td>13.1±1.6</td>
<td>11.3±1.5</td>
<td>NS</td>
</tr>
<tr>
<td>IVT (mm)</td>
<td>12.0±1.3</td>
<td>13.1±1.6</td>
<td>11.7±1.1</td>
<td>NS</td>
</tr>
<tr>
<td>Ds (mm)</td>
<td>40.8±7.2</td>
<td>42.8±11.6</td>
<td>40.1±5.1</td>
<td>NS</td>
</tr>
<tr>
<td>Dd (mm)</td>
<td>25.5±7.8</td>
<td>31.5±12.9</td>
<td>23.7±4.2</td>
<td>0.04</td>
</tr>
</tbody>
</table>

\(EF = \text{ejection fraction}; \ PWT = \text{posterior wall thickness}; \ IVT = \text{isovolumic time}; \ Ds = \text{systolic distention}; \ Dd = \text{diastolic distention.}\)
3 patients over 18 months translates into a peritonitis rate of 0.05 episodes/patient–year. The organism most frequently found in the peritonitis episodes was \textit{Staphylococcus epidermidis} [2 cases (66%); in the third case, no organisms were recovered].

**Discussion**

As a method for ultrafiltration, CAPD has unique advantages. Fluid can be removed continuously in hemodynamically unstable patients, thus avoiding the sudden reduction in blood pressure incurred by rapid fluid removal during intermittent hemofiltration (7,8). In a retrospective analysis, Hebert \textit{et al.} (9) reported that quality of life in patients with severe left ventricular systolic dysfunction and renal failure can be substantially improved by CAPD. In their study, the left ventricular ejection fraction had a significant influence on the survival rate. In the present study, by
the end of the first year after the start of CAPD, survival was similar between the groups with and without cardiac dysfunction. However, 18 months after the start of CAPD, the survival rate of the patients in the abnormal EF group abruptly declined.

Previously, our group reported that the introduction of CAPD in patients with symptoms of congestive heart failure is associated with a significant improvement in ejection fraction at 1 year. However, no follow-up data after year 1 are available.

Elderly patients are at increased risk of infection because they are generally immunodeficient and malnourished, and they have a high rate of bowel disease. In our study, infection was the cause of all deaths in our patients from both groups, pointing to the need for rapid detection and treatment of infection in elderly patients on CAPD. The occurrence of peritonitis was not higher in our study than in studies reported by other authors (10,11).

In Japan, infection is the major cause of death in the elderly population with or without dialysis therapy. Pneumonia is regarded as the number one cause of the death in people over 80 years of age. This situation is probably a result of malnutrition and inadequate food intake leading to lower serum albumin (12). We observed no significant difference in infection as the cause of death between the two study groups, but a greater proportion of the deaths occurred in the abnormal EF group. Several risk factors for infection in dialysis patients (low serum albumin, diabetes, and poor residual renal function, among others) have been proposed. A relatively large investigation revealed that degree of malnutrition consistently correlated with serum albumin (11). That finding agrees with data from Mignon et al. (13), who showed that a low initial albumin level is a risk factor for mortality in elderly patients on CAPD. Given those findings, it is likely that reduced cardiac output over a long time may produce malnutrition and, together with lower serum albumin, will eventually increase susceptibility to infection.

Previously, we reported that valsartan, an angiotensin II receptor blocker (ARB), slowed the decline in residual renal function that is a major factor contributing to the mortality and morbidity of CAPD patients (14,15). In the present study, all patients with lower cardiac output were being treated either with angiotensin converting–enzyme inhibitors or with ARBs, resulting in a favorable effect on cardiac function and preservation of renal residual function. In spite of those treatments, the prognosis of those patients was found to be poor.

Conclusions

The present study demonstrated that cardiac performance at the initiation of PD therapy, in conjunction with lower levels of serum albumin, predicts prognosis in PD patients more than 75 years of age.

References


Corresponding author: Hiromichi Suzuki, MD, PhD, Department of Nephrology, Saitama Medical University, 38 Morohonngo, Moroyama machi, Iruma gun, Saitama 350-0495 Japan. E-mail: iromanichi@saitama-med.ac.jp