A broad consensus has not been reached on the appropriate timing for cessation of peritoneal dialysis (PD). Decreasing urine volume, repeated and refractory peritonitis, and deterioration of the peritoneal membrane are major reasons to stop PD. Also, the link between length of time on PD and encapsulating peritoneal sclerosis (EPS) should be an additional concern. The aim of the present study was to investigate patients who had been on continuous ambulatory PD (CAPD) for a long time. 

All patients undergoing CAPD at our kidney center for more than a decade from January 1990 to September 2011 were included in the study. Among more than 436 CAPD patients, 11 met the inclusion criteria. Their mean PD duration was 12.3 ± 3.1 years. Mean age at CAPD introduction had been 46.0 ± 10.1 years. All patients had nondiabetic nephropathy as the underlying cause of their end-stage renal disease. At least 2 of the 11 had developed EPS, and 1 had subsequently died from EPS.

Patients on prolonged CAPD for more than a decade are still rare. The CAPD modality may be continued if it is efficiently maintained within an acceptable level, but EPS remains a serious complication of prolonged PD.

Key words
Prolonged peritoneal dialysis, encapsulating peritoneal sclerosis, end-stage renal disease

Introduction
To date, a broad consensus has not been reached on the appropriate timing for the cessation of peritoneal dialysis (PD) and a switch to hemodialysis (HD).

A successful dialysis modality, CAPD enables patients with end-stage kidney disease to have a home-based treatment with many advantages for their
quality of life. In general, outcomes with CAPD are equal to those with HD. Many patients are reluctant to transfer to HD, even when that modality is clinically indicated, because they perceive that the transfer will adversely affect their quality of life. In fact, according to a statement from the International Society for Peritoneal Dialysis (7), evidence to support a single rule about the optimal length of time on CAPD to avoid the risk of EPS is lacking. Each patient needs to be considered individually. That statement has shown no significant effect on long-term CAPD.

Here, we summarize 11 cases in which patients were maintained on CAPD for 10 or more years. Based on that experience, we discuss our thoughts about long-term CAPD therapy.

Methods
All patients undergoing CAPD at our kidney center from January 1990 to September 2011 were eligible for the study. All patients had received treatment at least once monthly in our outpatient clinic throughout the period for which they underwent CAPD. Daily dietary protein intake was approximately 1.0 g per kilogram body weight, and daily energy intake was 30 – 35 kcal or more per kilogram body weight. Daily salt intake was restricted to between 7 g and 9 g (15).

The CAPD dose (fluid quantity and frequency of bag exchanges) was adjusted to maintain a weekly creatinine clearance (CCr) of approximately 60 L. If the weekly CCr fell below 45 L despite a full dose of CAPD, once-weekly HD was introduced (15). Patients who required two or more HD sessions to meet the ideal solute-removal efficiency were excluded from the study.

The average weekly CCr at our kidney center is around 40 L/week, because a high priority is placed on quality of life before incurring laboratory abnormalities. Also, some patients require combination therapy to maintain euvoolemia. Those patients usually show anasarca, an increase of cardiothoracic ratio, and hypertension that is difficult to control.

Several situations call for cessation of CAPD. Those situations can be broadly classified into two categories: transfer to combination therapy with HD or PD catheter removal. Previously, our group reported that PD peritonitis was the main reason for PD catheter removal (1,2) at our center. Another major reason is urgent or elective surgery for disease of the gastrointestinal tract, including neoplasm or perforation, or both (3).

Peritonitis related to PD is diagnosed based on abdominal pain, together with cloudy PD effluent with or without fever; or on a peritoneal white blood cell count exceeding 100/mL, with more than 50% neutrophils (16). The decision to remove a PD catheter is made in cases of recurrent or relapsing peritonitis, or peritonitis resulting from infection with Pseudomonas, tuberculosis, or Candida (2). “Relapse” is defined as a peritonitis episode occurring within 4 weeks of completion of therapy for a prior peritonitis episode with the same organism, or an episode occurring after one sterile episode. “Recurrence” is defined as a peritonitis episode occurring within 4 weeks of completion of therapy for a prior peritonitis episode with a different organism (16). All patients who underwent catheter removal continued to receive HD at our kidney center or at other outpatient clinics using an arteriovenous fistula.

At the beginning of CAPD, our patients receive good information about EPS, including the fact that it is a fatal disease. We usually explain about EPS again after 4 – 5 years of CAPD. If patients prefer to continue on PD, they can do so, provided they demonstrate competence. Patients undergo plain computed tomography of the abdomen once annually, and, if at all possible, a peritoneal equilibration test is performed whenever necessary to evaluate calcification and adhesion of the intestine and deterioration of the peritoneal membrane.

All data on prognosis in the study group was collected October 1, 2011.

Results
Among more than 436 CAPD patients at our kidney center during the study period, 11 (2.5%) met the inclusion criteria (Table I). All 11 patients [5 men (45.5%), 6 women (54.5%)] had nondiabetic nephropathy as the underlying cause of their end-stage renal disease. Their mean duration of CAPD was 12.3 ± 3.1 years (range: 10.1 – 20.4 years) and of renal replacement therapy (RRT), 13.07 ± 3.0 years (range: 10.1 – 20.4 years). Their mean age at CAPD introduction was 46.0 ± 10.1 years (range: 23 – 60 years).

Of these 11 patients, 1 underwent HD in combination therapy once weekly for 17.2 months to make up for a decline in CAPD efficiency. At least 2 of the 11 patients (18.2%) developed EPS, and 1 subsequently died because of bowel obstruction and malnutrition. Another patient was taking oral prednisolone to
prevent EPS progression. Although some ascites had been detected, and computed tomography showed calcifications and slight adhesion of the intestine, no clinical symptoms had developed. Eventually, that patient died from gastrointestinal hemorrhage and ischemic heart disease.

The PD catheter had been removed in 2 patients. In one patient, the catheter was removed at the same time that living-donor renal transplantation was performed. Another patient preferred to have the PD catheter removed when she began HD, which was allowed. To date, neither of those patients has evidence of newly developed EPS since removal of the catheter.

Only 2 of the 11 patients have had an episode of PD-related peritonitis (1 episode each).

At the end of the study, 9 patients were still alive, 6 of whom still depend primarily on CAPD as their modality of RRT. Their average serum creatinine is $11.9 \pm 1.2$ mg/dL; blood urea nitrogen, $64.2 \pm 14.8$ mg/dL; daily urine volume, less than 100 mL; and weekly CCr, $38.6 \pm 8.4$ L. Another 2 patients have continued PD, but only as a “wash” procedure to eliminate obstructions and maintain the PD catheter. That procedure is also effective in preventing the occasional accumulation of ascitic fluid.

**Discussion**

Prolongation of PD, such as in the 11 patients who continued (or are continuing) on CAPD for more than a decade, are rare at our kidney center. Encapsulating peritoneal sclerosis is an important complication of prolonged CAPD. However, for patients whose CAPD efficiency and euvoletma are maintained at the proper level, continuing on CAPD for a decade does not seem inconceivable.

From our experience, the major obstacle to continuing CAPD is deterioration of the peritoneal membrane. All complications of CAPD appear to result from that deterioration—not only EPS, but also decline in CAPD efficiency. On the other hand, the pursuit of quality of life is always a significant consideration in a patient’s decision to continue CAPD. It should be noted that (for our 11 patients at least) no attention was paid to the recommendations of the nephrologists, and the patients all hope to continue CAPD. The nephrologists cooperate and do their best using their specialized experience to prevent any deleterious results from CAPD or end-stage renal disease in those patients.

There are several reasons to offer CAPD as the first-choice modality, including preservation of

### Table 1: Clinical characteristics of the patients

<table>
<thead>
<tr>
<th>Pt ID</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>PD duration (years)</th>
<th>RRT duration (years)</th>
<th>Age (years)</th>
<th>Combination therapy duration</th>
<th>Continued PD?</th>
<th>Reason for cessation of PD</th>
<th>Catheter removed</th>
<th>EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>Unknown</td>
<td>20.4</td>
<td>20.4</td>
<td>36.3</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>CGN</td>
<td>15.7</td>
<td>15.7</td>
<td>45.6</td>
<td>No</td>
<td>Death from EPS</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>Unknown</td>
<td>12.0</td>
<td>12.0</td>
<td>53.4</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Female</td>
<td>Unknown</td>
<td>12.0</td>
<td>14.0</td>
<td>23.3</td>
<td>No</td>
<td>Living-donor graft</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>CGN</td>
<td>11.3</td>
<td>13.2</td>
<td>49.6</td>
<td>No (wash)</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>Nephrosclerosis</td>
<td>11.0</td>
<td>11.0</td>
<td>39.2</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>Nephrosclerosis</td>
<td>11.0</td>
<td>12.5</td>
<td>53.0</td>
<td>No (wash)</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Female</td>
<td>CGN</td>
<td>11.0</td>
<td>13.8</td>
<td>60.8</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>Male</td>
<td>CGN</td>
<td>10.7</td>
<td>10.7</td>
<td>47.8</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>Female</td>
<td>Unknown</td>
<td>10.4</td>
<td>10.4</td>
<td>46.1</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Female</td>
<td>CGN</td>
<td>10.1</td>
<td>10.1</td>
<td>50.5</td>
<td>17.2 months</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

---

**Notes:**

- Total of any RRT involving PD, HD, combination of PD and HD, and transplantation.
- At the time of PD introduction.
- “Wash” is a one-time exchange of 500 mL dialysate daily, used to prevent catheter obstruction.
- Pt = patient; PD = peritoneal dialysis; RRT = renal replacement therapy; EPS = encapsulating peritoneal sclerosis; CGN = chronic glomerulonephritis; HD = hemodialysis.
remnant kidney function and, from the patient’s perspective, a flexible schedule and increased freedom. In other words, the modality offers the convenience of home therapy (17). At our hospital, in the 15 years since the kidney center was established, a high priority has been placed on preservation of remnant kidney function, recommending PD as the initial RRT modality (“PD First”). Even though home HD is rapidly becoming popular in Japan, PD remains the major home dialysis modality, and it plays an important role in RRT.

It is important to evaluate the medical appropriateness of prolonged CAPD. Declining CAPD efficiency can be resolved by introducing the concept of combination therapy with occasional HD. On the other hand, the EPS problem is far from being resolved. Several reports on the incidence of EPS are available. A U.K. series identified 27 EPS cases, for a rate of 3.3% over 7 years (12). An Australian study identified 54 cases in 14 years, yielding a rate of 0.7% (8). Japanese and Korean studies described rates of 0.8% – 2.5% (10,11,18). In 2001, Kawanishi et al. (10) published a 2-year follow-up for a PD cohort, suggesting an incidence of 0.8%. More recently, a national-scale cohort study (n = 1238) based on the Scottish Renal Registry was published (9). The 46 EPS cases identified yielded a rate of 1.5% and an incidence of 4.9 per 1000 person–years. The incidence increased with PD duration, with rates of 0%, 0.6%, 2.0%, 3.5%, 8.1%, 8.8%, and 5% at <1, 1 to 2, >2 to 3, >3 to 4, >4 to 5, >5 to 6, and >6 years of PD exposure respectively. The median PD duration in patients with EPS was 5.1 years. At diagnosis, 12 patients (26%) were on PD, and in 33 (72%), the diagnosis was made less than 2 years after PD ended.

In the present study, EPS was diagnosed using International Society for Peritoneal Dialysis criteria (7), including clinical features and radiologic confirmation, as in previous reports. Our EPS incidence rate, 18.2% in 12.3 years, was higher than expected. Previous studies have suggested that, to avoid EPS, the PD duration should not exceed 5 years. Our pathology studies have shown that obvious peritoneal alterations, subserous fibrosis, and fibrin deposition are present in approximately half of all CAPD patients (3). According to a recent report (7), by 5 years of PD, 22 of 46 patients (48%) had developed EPS. After 3.5 years from first exposure to PD, the incidence of EPS seems to increase linearly with the duration of PD (7). That finding suggests that the incidence rate per year remains constant after 3 – 4 years. It appears that “long-term PD” itself is a major risk factor for EPS.

Conclusions

We summarized data for 11 patients who underwent prolonged CAPD. It may be possible to continue CAPD for more than a decade (with or without HD as needed) if the technique is efficiently maintained within an acceptable level. However, EPS remains a serious concern because the risk increases with increased duration of PD and that risk should therefore be carefully considered, especially for patients receiving long-term PD.

Disclosures

The authors have no financial conflicts of interest to declare.

References


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