We evaluated the usefulness of periodic abdominal irrigation through the peritoneal catheter preserved after termination of peritoneal dialysis (PD) to prevent encapsulating peritoneal sclerosis (EPS). The study group included 8 patients in whom PD had been terminated (mean age: 53.1 ± 7.1 years; mean PD duration: 119.6 ± 37.8 months).

The abdominal cavity was periodically irrigated through the peritoneal catheter preserved after PD discontinuation. The appearance rate of cancer antigen 125 (CA125-AR), corrected by body surface area, was obtained every 3 months from 4-hour dwells. Based on the creatinine levels in 4-hour dwells and plasma, the dialysate-to-plasma creatinine (D/P Cr) was also obtained. Following abdominal irrigation for more than 12 months, the peritoneal catheter was removed and a biopsy specimen was taken from the peritoneum.

The CA125-AR increased 3 months after PD discontinuation, but decreased thereafter. Encapsulating peritoneal sclerosis developed in 3 of 4 patients who lacked parietal mesothelial cells (PMCs) in a peritoneal specimen. In contrast, a good prognosis was obtained in 4 patients who had PMCs. The maximum value of the change in CA125-AR (ΔCA125-AR, as compared with the value at PD discontinuation) was significantly greater in the PMC+ group than in the PMC− group (8.0 ± 2.7 vs. 3.4 ± 3.1, p < 0.001). The D/P Cr at catheter removal was lower in the PMC+ group than in the PMC− group (0.45 ± 0.21 vs. 0.85 ± 0.18, p < 0.05).

Our findings suggest that periodic abdominal irrigation through the peritoneal catheter preserved after PD enhances the recovery of peritoneal damage. The CA125-AR value is a useful marker of viability and proliferation of PMCs.

Key words
Mesothelial cells, cancer antigen 125 (CA125), encapsulating peritoneal sclerosis (EPS)

Introduction
Encapsulating peritoneal sclerosis (EPS) is a serious complication of peritoneal dialysis (PD). In most cases, EPS occurs after removal of the peritoneal catheter. Dialysate is a bioincompatible fluid that may cause inflammatory reactions in the peritoneum. During PD, inflammatory substances are eliminated from the abdominal cavity with the dialysate, maintaining a well-balanced internal environment. However, after PD discontinuation, inflammatory reactions persist, resulting in the development of EPS.

We thought that EPS might be prevented if the abdominal cavity were to be periodically irrigated through the catheter to wash out inflammatory substances and to avoid peritoneal adhesion until peritoneal mesothelial cells are fully recovered. The present study was conducted to evaluate the usefulness of periodic abdominal irrigation through the peritoneal catheter preserved after PD discontinuation to prevent EPS.

Patients and methods
The subjects consisted of 8 long-term PD patients who were transferred to hemodialysis: 4 men and 4 women with a mean age of 53.1 ± 7.1 years (range: 40.3—61.8 years) and a mean PD duration of 119.6 ± 37.8 months (range: 61.5—173.1 months).

In all cases, the abdominal cavity was irrigated with 1.36% glucose dialysate twice weekly through the peritoneal catheter preserved after discontinuation of PD. The effluent of a 4-hour dwell (after abdominal irrigation twice with 1.36% glucose dialysate) was taken every 3 months. Cancer antigen 125 (CA125) in the effluent was measured. The appearance rate of CA125 (CA125-AR) was calculated using the method.
of Pannekeet et al and corrected by body surface area. Creatinine (Cr) levels in the effluent and plasma were measured at the end of irrigation to obtain the dialysate-to-plasma ratio of Cr (D/P Cr). The peritoneal catheter was removed and a biopsy specimen was taken from the peritoneum after abdominal irrigation for more than 12 months. Measurement of CA125 was performed using the radioimmunoassay (RIA) of Centocor Diagnostics, Inc. (Malvern, PA, U.S.A.).

**Results**

At the time of PD discontinuation, CA125-AR was 140.7 ± 84.3 U/min/1.73 m² and D/P Cr was 0.72 ± 0.21. The period between PD discontinuation and catheter removal was 15.5 ± 3.8 months on average (range: 12.1 — 21.3 months). Measurements of effluent were not performed during abdominal irrigation in 1 of 8 patients, although a biopsy specimen was taken from the peritoneum.

The CA125-AR markedly increased 3 months after PD discontinuation. It gradually decreased thereafter, but stayed at a level higher than after PD discontinuation. In 1 patient, however, CA125-AR markedly decreased after the initial increase and finally reached a value lower than the value at PD discontinuation (Figure 1). The change in the CA125-AR as compared with the value at PD discontinuation (ΔCA125-AR) reached its maximum value (5.4 ± 2.5) at 3 — 9 months after PD discontinuation. It then decreased to 3.0 ± 2.4 at the time of catheter removal.

Parietal mesothelial cells (PMCs) were observed in the peritoneal specimens taken at catheter removal in 4 of 8 patients. Omental mesothelial cells were observed in 5 of 6 patients whose omentum was successfully taken. A good prognosis was obtained in 4 patients that showed PMCs on examination of the peritoneal specimen. In contrast, EPS developed in 3 patients and prednisolone therapy was required in 1 of 4 patients who lacked PMCs in their specimens.

The ΔCA125-AR and D/P Cr were studied with respect to the presence or absence of PMCs in peritoneal specimens. In PMC+ patients, ΔCA125-AR rapidly increased after PD discontinuation, reached a maximum value 3 — 6 months after PD discontinuation, and then decreased (Figure 2). In the PMC— patients, ΔCA125-AR increased slowly, reached a maximum value 6 — 9 months after PD termination and then decreased (Figure 2). The maximum value of ΔCA125-AR was significantly higher in the PMC+ group than in the PMC— group (8.0 ± 0.5 vs. 3.4 ± 0.6, p < 0.001). The ΔCA125-AR at the time of catheter removal was slightly higher in the PMC+ group than in the PMC— group (4.6 ± 2.1 vs. 1.6 ± 1.7, p < 0.08). The D/P Cr at the time of catheter removal was significantly lower in the PMC+ group than in the PMC— group (0.45 ± 0.21 vs. 0.85 ± 0.18, p < 0.05; Table 1).

The histology findings in the parietal peritoneum in the PMC+ cases showed, in the upper layer of the peritoneum, a mixture of areas without mesothelial cells and areas with a single layer of mesothelial cells. Mesothelial cells were stratified in some parts. The basal membrane was not found. Similar findings were observed in each specimen.

**Discussion**

Encapsulating peritoneal sclerosis is a serious complication of PD. The condition has been reported to develop after PD termination following catheter removal in 75% of cases. Intestinal adhesion progresses owing to the absence of dialysate (a buffer solution for the intestine) after PD discontinuation. Various inflammatory substances released from the injured peritoneum cause progressive fibrosis and sclerosis of the peritoneum resulting in the development of EPS.

We considered that periodic abdominal irrigation through the peritoneal catheter preserved after PD...
would be effective for the prevention of EPS. Injury to the peritoneum would be repaired by the procedure, which might prevent intestinal adhesion and enhance elimination of inflammatory substances from the abdominal cavity. The present study was conducted to evaluate the usefulness of abdominal irrigation for prevention of EPS. We looked at CA125-AR in effluent and D/P’Cr (representing endothelial cell function), and at peritoneal biopsy specimens after catheter removal.

Cancer antigen 125, which is produced by mesothelial cells, is considered to be a marker of the mesothelial cell mass. A study reported that CA125 decreased with PD duration and reached an extremely

PD = peritoneal dialysis; ΔCA125-AR = change in appearance rate of cancer antigen 125; EPS = encapsulating peritoneal sclerosis.

FIGURE 2 Progression of change in appearance rate of cancer antigen 125 (ΔCA125-AR) and dialysate-to-plasma ratio of creatinine (D/P’Cr) with respect to the presence or absence of parietal mesothelial cells (PMCs). The maximum value of ΔCA125-AR was significantly higher in the PMC+ group than in the PMC— group (8.0±2.7 vs. 3.4±3.1, p<0.001). The D/P’Cr at the time of catheter removal was significantly lower in the PMC+ group than in the PMC— group (0.45±0.21 vs. 0.85±0.18, p<0.05). EPS = encapsulating peritoneal sclerosis.

TABLE 1 Mesothelial cells, dialysate-to-plasma creatinine (D/P’Cr), appearance rate of cancer antigen 125 (CA125-AR), and outcome

<table>
<thead>
<tr>
<th>Case</th>
<th>Parietal</th>
<th>Omental</th>
<th>Time on PD (months)</th>
<th>Peritonitis (patient—year)</th>
<th>D/P’Cr</th>
<th>CA125-AR (U/mL/1.73m²)</th>
<th>∆CA125-AR</th>
<th>∆CA125</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT</td>
<td>+</td>
<td>/</td>
<td>110.2</td>
<td>0.22</td>
<td>1.02</td>
<td>0.34</td>
<td>99.6</td>
<td>8.07</td>
<td>2.4</td>
</tr>
<tr>
<td>UM</td>
<td>+</td>
<td>+</td>
<td>105.6</td>
<td>0.11</td>
<td>0.72</td>
<td>/</td>
<td>109.4</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>UE</td>
<td>+</td>
<td>+</td>
<td>85.2</td>
<td>0</td>
<td>0.64</td>
<td>0.35</td>
<td>85.4</td>
<td>8.45</td>
<td>5.5</td>
</tr>
<tr>
<td>MT</td>
<td>+</td>
<td>+</td>
<td>135.4</td>
<td>0.44</td>
<td>0.56</td>
<td>0.70</td>
<td>81.6</td>
<td>7.42</td>
<td>6.4</td>
</tr>
<tr>
<td>HN</td>
<td>—</td>
<td>/</td>
<td>164.7</td>
<td>0.07</td>
<td>1.10</td>
<td>0.94</td>
<td>191.3</td>
<td>4.14</td>
<td>0.61</td>
</tr>
<tr>
<td>KH</td>
<td>—</td>
<td>+</td>
<td>173.1</td>
<td>0.28</td>
<td>0.58</td>
<td>0.88</td>
<td>213</td>
<td>3.46</td>
<td>2.67</td>
</tr>
<tr>
<td>WT</td>
<td>—</td>
<td>+</td>
<td>121.1</td>
<td>0.1</td>
<td>0.62</td>
<td>0.98</td>
<td>296.6</td>
<td>2.89</td>
<td>1.41</td>
</tr>
<tr>
<td>FY</td>
<td>—</td>
<td>—</td>
<td>61.5</td>
<td>0</td>
<td>0.53</td>
<td>0.58</td>
<td>48.6</td>
<td>3.06</td>
<td>3.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>130±51</td>
<td>0.11±0.12</td>
<td>0.71±0.26</td>
<td>0.85±0.18</td>
<td>187±103</td>
<td>3.9±0.6</td>
<td>1.6±1.7</td>
</tr>
</tbody>
</table>

PD˚= peritoneal dialysis; ΔCA125-AR˚= change in appearance rate of cancer antigen 125; EPS˚= encapsulating peritoneal sclerosis.
low value in patients with EPS (1). However, other studies reported that CA125 level was not related to the duration of PD (2). No relationship was seen between CA125 and PD duration in the present study either (3). In some studies, CA125 was very low early after the start of PD (1). It is still controversial whether CA125 can be used as a marker of the mesothelial cell mass. Long-term studies on many PD patients should be performed to resolve that question.

It was reported that CA125 increases 1˚week after acidic dialysate is replaced by neutral dialysate, and that it remains at high levels (4). Conversely, CA125 was reported to decrease after neutral dialysate was replaced by acidic dialysate (5). Increased production of CA125 appeared mainly in the G1 phase in ovarian cancer cells (6). The same procedure is presumed to take place in the mesothelial cells of the peritoneum. Based on that presumption, CA125 should be an index of viability of mesothelial cells.

In the present study, CA125-AR increased 3˚—6˚months after PD discontinuation and then decreased gradually during abdominal irrigation. The initial increase in CA125 indicates increased viability of mesothelial cells. It suggests that mesothelial cells proliferated into a stable condition corresponding to the gradual decrease in CA125 thereafter.

In 4˚patients with positive PMCs in peritoneal specimens, the maximum ΔCA125-AR showed, on average, a 8-fold increase 3˚—6˚months after abdominal irrigation. The ΔCA125-AR remained 5-fold increased at the time of catheter removal. In contrast, in PMC—patients, the maximumΔCA125-AR showed a 4-fold increase on average, and the ΔCA125-AR declined to a 1.5-fold increase at the time of catheter removal. Those findings also suggest that CA125 represents viability and proliferation of mesothelial cells in the peritoneum.

The D/P˚Cr changed in a fashion similar to the CA125-AR. In the PMC+ group, the D/P˚Cr decreased; it increased to 0.7 or higher in the PMC—group. However, changes in D/P˚Cr occurred stepwise, without the early change noted with CA125-AR. The D/P˚Cr is considered to represent endothelial cell function. It has been speculated that endothelial cells are also repaired after PD discontinuation, although the repair process might be different from that for mesothelial cells.

The CA125-AR increased and D/P˚Cr decreased in 4˚patients after abdominal irrigation through the peritoneal catheter preserved after PD discontinuation. In those patients, PMCs were found in peritoneal specimens taken at catheter removal. Those findings suggest the usefulness of abdominal irrigation. The 4˚patients were in good condition after catheter removal with no evidence of EPS.

In contrast, CA125-AR increased minimally, D/P˚Cr did not improve, and PMCs were not found on pathology examination in 4˚patients. In 3 of those 4˚patients, EPS developed 1˚—6˚months after catheter removal. No differences were noted in PD duration or in incidence of peritonitis between the two groups. The difference in peritoneal cell recovery between the groups remains unknown. Further studies should be performed in a larger number of patients.

**Conclusion**

Periodic abdominal irrigation through the peritoneal catheter preserved after the discontinuation of long-term PD was effective for repair of peritoneal damage in 4 of 8˚patients. In those patients, the ΔCA125-AR showed a 8-fold increase during therapy and PMCs were found in peritoneal biopsy specimens taken at the time of catheter removal, 14˚months after PD termination. The D/P˚Cr decreased in those patients.

Our findings suggest that peritoneal injury could be repaired by periodical abdominal irrigation through the preserved PD catheter. Appearance rate of CA125 appeared to be a good marker of viability and proliferation of mesothelial cells. However, in some cases, peritoneal injury did not improve and EPS developed. A new therapeutic method to repair peritoneal damage should be established for such intractable cases.

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Rapid Diagnosis of *Mycobacterium* Tuberculous Peritonitis in Two Continuous Ambulatory Peritoneal Dialysis Patients, Using DNA Amplification by Polymerase Chain Reaction

Wai-Choong Lye

Introduction

In countries where tuberculosis is endemic, tuberculosis is not an unusual infection. A recent study found a prevalence rate of 4.8% for tuberculosis among continuous ambulatory peritoneal dialysis (CAPD) patients, and tuberculous peritonitis accounted for 40% of the total cases of tuberculosis (1). Past experience has shown that *Mycobacterium tuberculosis* is responsible for 1.6% of CAPD peritonitis in our chronic peritoneal dialysis population (2).

The diagnosis of tuberculous peritonitis is usually delayed because conventional techniques for the early diagnosis of tuberculosis are insensitive and time-consuming. The microscopic examination for acid-fast bacilli (AFB) in peritoneal dialysate carries a low yield because of inadequate concentrations of bacteria and because the time required to obtain a positive culture of *M. tuberculosis* is many weeks. The duration between the onset of symptoms and the diagnosis of tuberculous peritonitis therefore ranged between 4 and 8 weeks (1, 3).

Recently, the DNA sequences of the *M. tuberculosis* genome have been characterized. That characterization has allowed polymerase chain reaction to be used to detect *M. tuberculosis* DNA by nucleic acid amplification. Nucleic acid amplification assays have been shown to be rapid and specific for the detection of *M. tuberculosis* complex in respiratory and non respiratory specimens (4—6). The present paper reports two cases of tuberculous peritonitis that were diagnosed using the commercial Amplicor *M. tuberculosis* nucleic acid amplification test (Roche Diagnostic Systems, Branchburg, NJ, U.S.A.).

Patients and methods

Case 1

A 18-year-old man with end-stage renal disease secondary to chronic glomerulonephritis was started on CAPD. He had no episodes of peritonitis until 2 years later, when he presented with low-grade fever, abdomi-
nal pain, nausea, and mildly cloudy dialysate. He did not have a past history of tuberculosis. His chest X-ray was clear. His peritoneal fluid cell count showed 12,500 white blood cells per milliliter fluid, with 65% lymphocytes. The peritoneal fluid culture was sterile. He was treated empirically with intraperitoneal vancomycin and gentamicin without any clinical response. Six days later, gentamicin was stopped, and he was started on intraperitoneal ceftazidime. Multiple peritoneal fluid smears for AFB were negative. Over the next 10 days, his fever persisted, the abdominal pain worsened, and he became severely anorexic. His peritoneal catheter was removed, and he was converted to hemodialysis. Analysis of a peritoneal fluid specimen for M. tuberculosis complex by polymerase chain reaction using nucleic acid amplification was positive. The assay was performed using the Amplicor test. M. tuberculosis was isolated from his peritoneal fluid 6 weeks later.

Case 2

A 50-year-old man with end-stage renal disease secondary to diabetes mellitus was started on CAPD. He gave a past history of possible tuberculosis 20 years earlier, at which time he had received a complete course of empirical anti-tuberculous therapy. His chest X-ray showed an old fibrous scar at the right lung apex. He had two past episodes of peritonitis secondary to coagulase-negative Staphylococcus. Five years after starting CAPD, he presented with fever, abdominal pain, diarrhea, and cloudy peritoneal dialysate. Peritoneal fluid cell count showed 5500 white blood cells per milliliter fluid with 70% lymphocytes. He was treated empirically with intraperitoneal vancomycin and gentamicin. Peritoneal fluid culture isolated coagulase-negative Staphylococcus, and gentamicin was stopped. His abdominal symptoms improved, and his peritoneal fluid cleared. Two weeks later, the abdominal pain recurred, and the dialysate became cloudy. The peritoneal fluid cell count was 8700 cells per milliliter with 90% lymphocytes. Peritoneal fluid culture was sterile, and smears for AFB were negative. Peritoneal fluid specimen analysis using the Amplicor test for M. tuberculosis complex was positive. He was started on anti-tuberculous therapy consisting of rifampicin, isoniazid, pyrazinamide, and ethambutol. He developed jaundice secondary to isoniazid-induced hepatitis and isoniazid was stopped. He was started on ciprofloxacin. His symptoms improved slightly but his peritoneal dialysate remained cloudy. Two weeks later, the patient requested to convert to hemodialysis, and his Tenckhoff catheter was removed. M. tuberculosis was isolated from his peritoneal fluid 6 weeks later.

Discussion and conclusions

Tuberculosis is not an uncommon infection in hemodialysis and chronic peritoneal dialysis patients (1,7—9). In a recent report, a prevalence rate of 4.8% was reported among Chinese CAPD patients (1). Tuberculous peritonitis occurs commonly in countries where tuberculosis is endemic (10). Tuberculous peritonitis is the second most common form of presentation of tuberculosis in CAPD patients from Hong Kong, accounting for 40% of the total cases of tuberculosis among those patients (1).

Abdominal pain and turbid peritoneal dialysate are the main presenting features of tuberculous peritonitis. Fever occurs in 70%—80% of patients with tuberculous peritonitis. A past history of tuberculosis is not usual in patients with tuberculous peritonitis and concomitant extraperitoneal tuberculous infections are rare (1,11—13). Peritoneal dialysate leukocytosis with a predominance of lymphocytes is the classic finding in tuberculous peritonitis, although neutrophils can predominate in the dialysate in up to 50% of cases (1). Hypercalcemia has been reported in a patient with tuberculous peritonitis (14).

The diagnosis of tuberculous peritonitis is difficult and the interval between the onset of symptoms and the diagnosis ranges from 4 to 8 weeks (1—3). The detection of AFB requires relatively large concentrations of bacteria (15). Lui et al (1) reported that only 2 of 14 cases of patients with tuberculous peritonitis had a positive smear for AFB. The culture for M. tuberculosis remains the gold standard for diagnosis of tuberculous peritonitis, and cultures are positive in up to 80% of cases, but the time required for a positive culture is at least 6—8 weeks. Occasionally detection of caseating granulomas in a peritoneal membrane biopsy may reveal a diagnosis of tuberculous peritonitis. Early diagnosis and treatment of tuberculous peritonitis is important to prevent technique failure and peritoneal scarring, and to preserve peritoneal membrane ultrafiltration and solute clearance.

Recent technologic developments have introduced a number of molecular techniques in mycobacterial detection. In 1999, the United States Food and Drug
Administration approved the use of two commercial nucleic acid amplification tests for direct detection of \textit{M. tuberculosis} in respiratory specimens (16). The two approved nucleic acid amplification tests are the amplified \textit{M. tuberculosis} Direct Test (MTD: Gen-Probe, San Diego, CA, U.S.A.) and the Amplicor \textit{M. tuberculosis} test (Roche Diagnostic Systems). The performance of both tests was excellent and showed a sensitivity of $\geq 95\%$ and a specificity of 100$\%$ when testing respiratory specimens that were AFB smear—positive. The sensitivity of the MTD test in AFB smear—negative patients ranged from 83$\%$ to 85$\%$ and had a specificity of 99$\%$ (3).

In a multicenter study using the Amplicor test for the diagnosis of tuberculosis in more than 2000 respiratory and non respiratory specimens, the Amplicor test showed high sensitivity and specificity. For specimens of all types, the sensitivity of the Amplicor test was 86$\%$ for AFB smear—positive specimens and 83$\%$ for AFB smear—negative specimens. For non respiratory specimens, the sensitivity of the Amplicor test was 94$\%$ for AFB smear—positive specimens and 74$\%$ for AFB smear—negative specimens. The sensitivity of direct microscopy for AFB in comparison with that for culture was just 58$\%$. In culture-proven tuberculosis, the Amplicor test was positive in 95$\%$ of cases (17).

The diagnosis of tuberculous peritonitis using molecular technique was first reported in 1996 (18). Since then, there have been no reports on the use of nucleic acid amplification techniques for the diagnosis of tuberculous peritonitis. We used the commercial Amplicor assay for the rapid detection of \textit{M. tuberculosis} complex in our two patients with culture-positive tuberculous peritonitis. In the first patient, the diagnosis was made only after the peritoneal catheter was removed. In the second patient, the diagnosis of tuberculous peritonitis was made earlier, and anti-tuberculous therapy was initiated. However, clinical improvement was slow, and the patient requested removal of the peritoneal catheter and conversion to hemodialysis. The Amplicor nucleic acid amplification test can be rapidly performed, and results are available within 24$^\text{th}$—48$^\text{th}$ hours. In patients with tuberculous peritonitis who are smear-negative for AFB, the test could provide rapid diagnosis and earlier initiation of therapy, eliminate the need for invasive diagnostic procedures such as peritoneal biopsy, avoid unnecessary use of antimicrobial agents, and prevent peritoneal membrane damage and technique failure. Further studies are needed to determine the sensitivity and specificity of the new molecular techniques in the diagnosis of tuberculous peritonitis.

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Keeping the Catheter Exit Site Clean by Sealing with a Dressing Film in Patients Under Continuous Ambulatory Peritoneal Dialysis

Shigeru Tanaka, Kazutake Yosizawa,1 Masao Sakuma1

In patients on continuous ambulatory peritoneal dialysis (CAPD), exit-site care is troublesome. We developed a new method for exit-site care, using a dressing film. We investigated the possibility of keeping the exit site clean for up to 6 weeks, using seven protocols: Control group (n=24) the exit site was cleaned with a povidone iodine solution daily and a gauze dressing was applied. Group A (n=120) the exit site was cleaned with a povidone iodine solution once weekly, was covered with a small piece of gauze, and was completely sealed using a dressing film. Group B (n=181) as with Group A, except once every 2 weeks. Group C (n=64) as with Group A, except once every 3 weeks. And so on: Group D (n=45) once every 4 weeks. Group E (n=8) once every 5 weeks. Group F (n=2) once every 6 weeks.

At each session, we examined the small gauze bacteriologically. In groups A—F, the patients were asked to bathe every day and not to do anything about the exit site for 1—6 weeks, as applicable. In the control group, the rate of positive bacterial culture was 87.5%. In the other groups, the rates were as follows: Group A, 15%; Group B, 6.6%; Group C, 6.3%; Group D, 2.2%; and Groups E and F, 0%. In the film-method groups, the rates of positive bacterial culture were significantly low. We thought that the film method kept the exit site clean.

Key words
Exit-site care, cleanliness of exit site, dressing film

Introduction
In patients on continuous ambulatory peritoneal dialysis (CAPD), exit-site care is troublesome. Strategies for optimizing exit-site care include cleaning the exit site and keeping it clean. We developed a new method for exit-site care that employs a dressing film.

We think that sealing the catheter exit site with a dressing film is the best method. We bacteriologically examined the possibility of keeping the exit site clean for up to 6 weeks.

Patients and methods
We usually manage exit sites by completely sealing them with a dressing film (film method). The film is Cathereep (180×200 cm), a polyurethane film made by Nichiban Co., Tokyo, Japan. Figure 1 illustrates the sealing technique.

We studied 28 patients on CAPD between 1 June 1999 and 31 May 2000 [12 men, 16 women; mean age: 68.6±6.8 years; 14 with diabetes mellitus (DM), 14 without DM; mean time on PD: 23.0±17.3 months]. None of the patients had exit-site infection. We managed the exit site using one of these seven protocols:

- Control group (n=24): The exit site was cleaned with a povidone iodine solution daily and a gauze dressing was applied.
- Group A(n=120): The exit site was cleaned with a povidone iodine solution once weekly, was covered with a small piece of gauze, and was completely sealed using a dressing film.

Figure 1 In this sealing technique, the exit site is completely sealed.
ered with a small piece of gauze, and was completely sealed using a dressing film.

- Group B ($n = 181$): As with Group A, except once every 2 weeks.
- Group C ($n = 64$): As with Group A, except once every 3 weeks.
- Group D ($n = 45$): As with Group A, except once every 4 weeks.
- Group E ($n = 8$): As with Group A, except once every 5 weeks.
- Group F ($n = 2$): As with Group A, except once every 6 weeks.

At each session, we examined the small gauze bacteriologically in thioglycolate broth. In all groups except for the control group, the patients were asked to bathe (Japanese style) every day and not to do anything about the exit site for 1—6 weeks, as applicable.

**Results**

Figures 2—5 show the rates of positive bacterial culture and of flaking off of the film in the different groups. The DM and non DM patients are also shown. Table 1 gives the frequency of positive bacterial culture.

**Discussion**

Exit-site care is very important for optimizing CAPD. Many reports have described cleaning of the exit site (medicine and technique), but only a few reports mention maintaining the cleanliness after cleaning (1—4).

In our department, we used a dressing film to manage wounds, and even without care for a week,
wound healing was good. Some studies have shown the effectiveness of dressing films applied to the exit site. However, those authors simply covered the exit site with a dressing film, and therefore the exit site was not completely sealed. Consequently, the space between the catheter and the skin was not sealed. In our method, the catheter is completely wrapped, and the exit site is completely sealed (Figure 1). Thus, even if the patient takes a bath without special care for the exit site, the site is kept clean.

The rate of positive bacterial growth was significantly high in the control group (87.5%), indicating that the exit site failed to remain clean for 24 hours after it had been cleaned. In the film methods (groups A—F), the rates of positive bacterial growth were significantly lower. The rates of positive culture were high in the case of repeated flaking off of the film in any group. Our results suggest that the film protected the exit site from bacterial invasion after cleaning for up to 6 weeks.

The frequency of positive bacterial culture was very low in all of the film-method groups. In Group D, the frequency was 1 in 180 patient-weeks. The exit site was certainly kept clean when care was provided once per month.

**Conclusion**

The rate of positive bacterial growth was high in the control group, using daily care with a gauze dressing for the exit site. In the film-method groups, the rates of positive bacterial culture were significantly low. Although the patients took baths and did not take care of the exit site for 1—6 weeks (as applicable), the film protected the exit site against bacterial invasion.

We think that the film method kept the exit site clean. We believe that our film method will contribute to preventing exit-site infection, while eliminating daily care.

**References**


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The increased use of automated peritoneal dialysis (APD) has generated interest in potential differences in the incidence and causes of peritonitis between APD and continuous ambulatory peritoneal dialysis (CAPD). Several seldom-considered factors may influence peritonitis rates in those patient groups. Patient selection and sequence of therapies, reuse practices, effect of solutions on host defenses, and promptness of diagnosis may have an effect on peritonitis rates. Those factors are reviewed in light of recent literature and technologic advances.

Key words
Peritonitis, automated peritoneal dialysis (APD), continuous cycling peritoneal dialysis (CCPD)

Introduction
The use of automated peritoneal dialysis (APD) has increased worldwide during the past decade, with continuous cycling peritoneal dialysis (CCPD) accounting for most of the increase. In some mature markets, the use of APD has recently exceeded that of continuous ambulatory peritoneal dialysis (CAPD). Use of APD in the United States is estimated to be 52% (Figure 1). That fact alone has stimulated review of current recommendations for the treatment of peritonitis, still a common complication of all PD modalities. In addition, other concerns may justify different guidelines for the diagnosis and treatment of peritonitis in APD.

Discussion
Historically, the incidence of peritonitis among patients undergoing CCPD has been generally lower than that experienced by adult CAPD patients (1). However, generalized use of disconnect CAPD systems, improved connectology, fewer exposures of the peritoneal catheter lumen to the environment, and attention to patient training have all markedly reduced the incidence of CAPD peritonitis to rates similar to those seen in CCPD. Several seldom-considered factors may influence the rate of peritonitis in those two modalities.

Let us first consider the effect of patient selection and sequence of therapies on the rate of peritonitis (2). Some programs start all patients on CAPD and reserve APD for patients with ultrafiltration failure, insufficient clearance, and inability to perform self-dialysis, or for those who are at high risk of peritonitis. Such selection obviously penalizes the cohort on APD. Only two randomized studies have so far been designed to shed light on that issue. In a prospective, randomized study of patients on CAPD with a Y-connector or on CCPD, de Fijter et al (3) confirmed their previous findings of a significantly lower rate of peritonitis among APD patients. They observed peritonitis rates of 0.94 and 0.52 episodes per patient—year for CAPD and CCPD respectively ($p=0.03$). In another randomized study, Bro et al (4) reported peritonitis rates of 0.31 and 0.17 episodes per patient—year for CAPD and APD respectively. However, the sample size in that study was small and did not allow for statistical analysis. An additional cause of peritonitis unique to APD is the inappropriate reuse of cycler...
tubing and cassettes with the intention of reducing cost (5).

The use of conventional solutions may impair host defenses owing to acidic pH (6, 7), high concentrations of glucose degradation products (8, 9), and (to a lesser extent) lactate (10). The deleterious effects of bioincompatible solutions could potentially be worse in CCPD than in CAPD owing to the cumulative effect of larger volumes of solution. The capacity of peritoneal macrophages to kill bacteria and produce acute-phase cytokines is very much affected by the cytoplasmic pH of the cells. Douvdevani et al (6) studied the effect of several solutions with pHs ranging from 5.3 to 7.0 values that represent the pHs existing in conventional dialysate during the first 30 minutes of dwell time to attain various degrees of cytoplasmic pH. Bringing the intracellular pH to values below 6.5 led to markedly reduced tumor necrosis factor α production and phagocytosis. At pH values above 6.5, those functions returned to normal. The researchers concluded that exposure of peritoneal macrophages to commercial solutions causes a profound drop in intracellular pH owing to the accumulation of lactic acid, resulting in significant cytotoxicity. Liberek et al (7) exposed polymorphonuclear cells (PMNs) to fluids with various lactate concentrations, and adjusted the pH to 5.2 and 7.3. Phagocytosis was reduced by the higher lactate concentrations, but exposure of PMNs to fluids at pH 5.2 further reduced phagocytosis, suggesting that exposure of PMNs to acidic fluid results in a lactate-concentration-dependent reduction of phagocytosis. Topley et al (10) demonstrated better in vitro biocompatibility for pure bicarbonate solutions as compared with lactate solutions. The viability of neutrophils (measured by ATP level) was preserved only with bicarbonate solution. Reduction or elimination of glucose degradation products has been shown to improve cellular function and survival, regardless of glucose concentration in the solution (8, 9). Solutions that are more physiologic, recently introduced in Europe and Asia Pacific, should improve host defenses based on preliminary in vitro data.

Some observations suggest that, while the incidence of peritonitis is lower among CCPD patients, the causative micro-organisms may differ (11—13). Others have observed no significant difference in the types of organisms (3, 14). If indeed CCPD patients were to experience a higher rate of infections owing to gram-negative organisms, the recommendations for empiric therapy of peritonitis would require revision. However, further studies are necessary to clarify the issue.

The diagnosis of peritonitis theoretically may be influenced by the CCPD schedule. Contamination is most likely to occur at the time of connection and disconnection. If external occlusion is used for disconnection, the likelihood of contamination is diminished. Aside from intraluminal contamination, it is possible that catheter manipulation during the procedure may also increase the probability of contamination. If contamination is to occur in CCPD, it is most likely to take place at night, just before retiring. Three sources of potential contamination occur at that time: connection of the bags to the cycler, connection of the cycler tubing to the catheter or adapter, and manipulation of the catheter.

The diagnosis of peritonitis may be delayed in CCPD for several reasons. The repeated lavage associated with frequent cycling may reduce symptoms and deplete the resident macrophage population and opsonic concentrations, thus reducing host defenses. Several studies have shown repopulation of the intraperitoneal macrophages during the exchange-free period of CCPD or of nocturnal intermittent peritoneal dialysis (NIPD), and significant reduction in cell counts during the frequent exchange intervals (15, 16). Frequent lavage may also result in clearer effluent and prevent the observation of cloudy fluid in the morning. That aspect is particularly important for patients undergoing treatment with cyclers equipped with pump-to-drain devices that drain the effluent directly into the sewage without a collection bag to allow visual inspection of the effluent before disposal. The absence of a collecting bag may prevent the observation of cloudy fluid and a prompt diagnosis of peritonitis (17). All patients trained on APD cyclers with long drain lines but no drain bags could be taught to collect a small amount of dialysate from the initial drain at the start of night therapy. That sample will enable them to visually check the clarity of the fluid.

Peritonitis in APD patients often presents with systemic symptoms rather than with a cloudy bag, suggesting a delayed diagnosis. Held et al (18) reported an incidence of 73% abdominal pain and 35% systemic symptoms at the time of initial diagnosis among their APD patients with peritonitis, but only 48% with cloudy bags.
Another possible alternative to assure early diagnosis of peritonitis in APD could be the use of chemical detectors for PMNs by measuring leukocyte esterase or markers for the presence of endotoxin, such as the Limulus amoebocyte lysate (LAL) assay in the collecting bag (19—21). A change in color of the drained solution could alert the asymptomatic patient to the possibility of peritonitis and would prompt a sample collection for culture.

Specific recommendations for the treatment of peritonitis in CCPD have recently been made based on pharmacokinetic evidence (1). Intermittent regimens are being favored over continuous administration of antibiotics intraperitoneally. The new guidelines are intended both to improve the efficacy of the therapy and to reduce the undesirable side effects of the drugs.

**Conclusion**

Progress has been made in identifying subtle but important differences in the diagnosis and management of peritonitis between CAPD and CCPD. Application of that knowledge, use of solutions that are more physiologic, and use of better therapeutic protocols for the treatment of peritonitis should reduce the incidence and duration of peritonitis and prolong peritoneal membrane function.

**References**

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