SHORT REPORTS

HomeChoice Automated Peritoneal Dialysis Machines: the Impact of Reuse of Tubing and Cassettes

The increased availability of sophisticated automated peritoneal dialysis (APD) machines has made the choice of APD much more attractive to many patients and nephrologists. However, the cost of APD consumables still generally makes this option more expensive than many existing continuous ambulatory peritoneal dialysis (CAPD) systems. Reusing the tubing and cassette for APD machines (APD with reuse) could significantly reduce the cost and thus make this therapy available to a greater proportion of the CAPD population. The major concern, however, is the possible microbiological risk of APD with reuse.

MATERIALS AND METHODS

The aim of this study was to assess the bacteriological risks of reusing lines and cassette, over two nights, for HomeChoice (Baxter, Deerfield, IL, U.S.A.) APD patients. Four patients were studied on APD with reuse until their first episode of peritonitis. These were stable patients who had successfully performed CAPD and then APD without reuse. In general, patients are put on APD if they require the help of a caregiver or have a medical problem or social need to perform dialysis supine overnight. Four patients were selected as representative of the whole group and, while on APD, enrolled in this study after careful training in the reuse protocol and sampling technique. All four patients gave informed consent. Prior Ethics Committee approval was received. The Microbiology Department and Infection Control Unit of the Liverpool Hospital assisted in the design of the sampling protocol. The patients’ age, sex, time on the different therapies, and days to first peritonitis are summarized in Table 1.

The “Day 0” sample of peritoneal residual fluid was taken (after the second use of the previous set) immediately prior to the initiation of dialysis with a new set of lines and cassette in place. This specimen was aspirated from the effluent sampling site 5 minutes after outflow was initiated (approximately 200 mL flush), after having been retained all day in the peritoneal space following the use of the previous disposable set.

Following conclusion of the first overnight use of lines and cassettes, all clamps on the disposable set were closed; a blue clamp was placed on the drain (waste) line and the machine–patient line was capped. The disposable set containing clean dialysate was left loaded in the machine throughout the day, prior to its second use.

The “Day 1” samples of peritoneal residual fluid were taken immediately prior to the second overnight use (i.e., reuse) of lines and cassette after the lines and cassette had stood unused for approximately 12 hours. This specimen was aspirated from the effluent sampling site 5 minutes after outflow was initiated (approximately 200 mL flush) after having been retained in the peritoneal space during the first full day of the cycle. To arrive at the sampling port, this effluent traveled through lines that had stood all day. Both Day 0 and Day 1 peritoneal residual fluid samples were kept refrigerated overnight prior to submission to the laboratory.

The blue clamp on the drain line was released and fluid was collected immediately prior to the second use of lines and cassette, after priming of the lines and a 10 – 50 mL flush. After the second night (reuse), cassette and lines were submitted whole and the cassette subsequently accessed by sterile needling through the valve ports. A swab from the PD catheter exit site was collected weekly. Patients were monitored for clinical peritonitis and PD fluid was submitted for culture when peritonitis was suspected.

Each PD fluid sample was examined by both quantitative and qualitative culture techniques using lysed horse blood agar containing saponin (to release any micro-organisms that may have been sequestered in white blood cells) (1). Cultures were incubated in 10% CO₂ for 5 days at 35°C. In addition, 10 mL of sample was inoculated into Vital blood culture bottles (bioMerieux-Vitek, Baulkham Hills, NSW, Australia). All isolates were identified to species level using conventional techniques and sensitivity patterns were determined. The study was performed over approximately 7 months, with a total of 438 patient-days on HomeChoice APD with reuse.

RESULTS

Patients underwent intensive microbiological surveillance only in the early part of their course. Or-
ganisms found were frequently relatively uncommon, gram-negative, often water-borne species, such as Proteus, Serratia, and Klebsiella species. Often there were multiple isolates from a single fluid specimen. Patients developed peritonitis, with uncommon gram-negative and antibiotic-resistant organisms at 17 days, 33 days, 142 days, and 164 days after the initiation of APD with reuse (Klebsiella pneumoniae, Kleb. oxytoca, Serratia marcescens, Aeromonas hydrophila, and Citrobacter freundii).

Bacterial counts ranged from $3 \times 10^3$ colony forming units per liter (cfu/L) to more than $100 \times 10^3$ cfu/L. Three of the 4 patients showed counts of greater than $100 \times 10^3$ cfu/L within 48 hours of commencing the reuse protocol. These numbers remained consistent for the remainder of the trial for each patient. It is of interest to note the polymicrobial nature of the colonization. Five different organisms were isolated from 2 patients, while in 1 patient, up to 12 different bacteria were isolated over the trial period. These isolates included repeated isolations of Staphylococcus aureus and Streptococcus pyogenes; however, neither of these recognized pathogens were responsible for the eventual episode of peritonitis.

The Day 0 residual fluid specimens rarely demonstrated any microbial growth. The Day 1 residual fluid samples were frequently contaminated and often grew multiple organisms. The waste line dialysate culture was also frequently positive with multiple organisms. This could be expected as this open port was in direct contact with the air and in physical contact with a drain throughout the night. Cultures of the cassette were usually sterile.

Cultures of dialysate directly from the cassette were rarely positive, suggesting that contamination of the lines did not ascend as high as the cassette, or did not remain following rapid washout with fresh dialysate. The weekly exit-site swab usually showed no specific growth, suggesting that the peritonitis that ultimately transpired did not infect the peritoneum by traveling along the catheter tunnel from the exit site.

An infection-free technique survival analysis (Figure 1, upper panel) showed that the same 4 patients did better on CAPD and APD without reuse than on APD with reuse (not statistically significant due to small APD-with-reuse patient numbers). When the APD-with-reuse experience was compared to the concurrent population of patients receiving APD without reuse and the general CAPD population, there was a highly statistically significant reduced infection-free technique survival in APD-with-reuse patients compared to both CAPD and APD without reuse (Figure 1, lower panel). The peritonitis rate was calculated as 1 episode in 27 patient-months for CAPD.

### TABLE 1
Clinical Profile of APD-with-Reuse Study Patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/sex</th>
<th>APD by</th>
<th>CAPD Days on therapy</th>
<th>Days to first peritonitis</th>
<th>APD without reuse Days on therapy</th>
<th>Days to first peritonitis</th>
<th>APD with reuse Days on therapy</th>
<th>Days to first peritonitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>37/F</td>
<td>Self</td>
<td>1909</td>
<td>1028</td>
<td>218</td>
<td>Nil</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>67/F</td>
<td>Caregiver</td>
<td>89</td>
<td>Nil</td>
<td>653</td>
<td>485</td>
<td>142</td>
<td>142</td>
</tr>
<tr>
<td>3</td>
<td>78/F</td>
<td>Caregiver</td>
<td>54</td>
<td>Nil</td>
<td>776</td>
<td>279</td>
<td>164</td>
<td>164</td>
</tr>
<tr>
<td>4</td>
<td>55/F</td>
<td>Self</td>
<td>385</td>
<td>52</td>
<td>213</td>
<td>97</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

Figure 1 — The upper panel compares the infection-free technique survival of the 4 study patients who sequentially underwent the different modalities of peritoneal dialysis (PD). The poorest infection-free technique survival occurred while on automated peritoneal dialysis (APD) with reuse. The lower panel compares the 4 study patients on APD with reuse with all other concurrent patients on APD without reuse (n = 12) or CAPD (n = 110, mostly Freeline solo). This analysis showed statistically highly significant reduction of infection-free technique survival on APD with reuse compared to both APD without reuse and CAPD ($p < 0.0001$, log rank, Mantel-Cox).
1/11 pt-mths for APD without reuse, and 1/3 pt-mths for APD with reuse.

DISCUSSION

Reuse of lines and cassettes has the potential to significantly reduce the cost of APD therapy in the home, making it available to a wider population of patients. Previously published experience demonstrated successful reuse of lines in some of the older APD machines, such as Pac-X and Pac-Xtra (Baxter) (2,3). Studies addressing reuse of HomeChoice lines (Baxter) (4,5) suggest that multiple use of tubing sets could be safe and economical for hospital inpatients undergoing APD. However, there has been only one cohort study that addressed the microbiological risks of APD with reuse in the home, and it similarly found a cluster of gram-negative peritonitis episodes (6).

This study aimed to assess the microbiological risks of APD with reuse in the home setting. Multiple positive cultures were obtained from the lines during the course of APD with reuse, even early in the course of reuse, before any peritonitis transpired. Automated PD with reuse was associated with eventual peritonitis in all 4 patients studied, generally with a rapid time course.

Examination of the quantitative cultures showed that 3 of the 4 patients developed heavy colonization of waste and residual fluid immediately upon starting the reuse protocol. As these levels remained consistent for the remainder of the trial, monitoring of the bacterial counts provided no predictive value as to the timing of an episode of peritonitis.

From the results of this study, it is possible to conclude that microbiological contamination of dialysate most likely occurred first in the lines, which were found to be increasingly contaminated distally. It is quite likely that micro-organisms spread upward from the waste port during the period of standing. Alternatively, contamination might have occurred due to spiking or other connections.

Automated PD with reuse performed in this way risks an increased incidence of subclinical and clinical infection. This is likely to impact on patient morbidity and mortality. Long-term complications and patient survival on PD can be directly related to the frequency and severity of peritonitis. Thus, if APD with reuse is to be considered, it is essential to first establish and verify regimens effective in minimizing the risk of infection ascending the lines from the waste port.

Far from saving money, analysis of costs in this study demonstrated that the costs of hospital admission and antibiotic therapy for severe peritonitis readily outweighed any short-term cost savings achieved by APD with reuse.

ACKNOWLEDGMENT

The authors acknowledge the grant supported by the Nurses Research Grant of the South Western Sydney Area Health Service, Sydney, Australia.

Josephine Chow1
Colleen Munro1
Mary Wong1
Noemir Gonzalez1
Maggie Ku1
Stephen Neville2
Rosemary Munro2
Bruce Hall1
Bruce Cleland1
Ken Howlin1
Michael G Suranyi1

Renal Unit1
Liverpool Hospital
Department of Microbiology & Infectious Diseases2
South Western Area Pathology Service
South Western Sydney Area Health Service
Sydney, New South Wales, Australia
Josephine.Chow@swsahs.nsw.gov.au
Michael.Suranyi@swsahs.nsw.gov.au

REFERENCES


The Rate, Risk Factors, and Outcome of Fungal Peritonitis in CAPD Patients: Experience in Turkey

Continuous ambulatory peritoneal dialysis (CAPD) is an increasingly popular replacement therapy for patients with end-stage renal disease (ESRD). How-
ever, peritonitis continues to be a frequent complication of CAPD (1,2). Pathogenic bacteria and a small number of fungi cause the majority of cases of peritonitis. In most series, about 2% – 10% of CAPD-related peritonitis episodes have a fungal etiology. About 80% – 90% of fungal peritonitis (FP) episodes are caused by yeasts of the Candida species, less frequently by a variety of other yeasts and filamentous fungi. Fungal peritonitis is often a major cause of treatment failure in patients on CAPD and carries high risk of morbidity and mortality. The risk factors that predispose to the development of FP and regimens for FP treatment are not clear (1–6).

In an attempt to identify the rate and risk factors for FP, and to examine outcome in relation to treatment strategies, we reviewed our experience with FP in this multicenter study.

PATIENTS AND METHODS

This retrospective study was conducted on 34 cases of FP among 1030 patients. Inpatient and outpatient medical records were reviewed retrospectively for demographic and clinical details. The records were specifically examined for evidence of peritonitis, exit-site infections, and the use of antibiotics prior to FP episodes. Our diagnostic criteria for FP included a CAPD effluent cell count of 100 or more white blood cells (WBC) per microliter, a dialysate differential cell count with more than 50% polymorphonuclear cells, and isolation of fungi.

RESULTS

We treated 1030 patients with CAPD (26 138 months of treatment) between September 1986 and December 1998. There were 1375 episodes of peritonitis during the study period (1 case of peritonitis for every 18.9 months of treatment). Thirty-four cases (2.5%) of peritonitis had a fungal etiology. The mean age of the patients (9 female, 25 male) was 48.4 ± 17.8 years (range 22 – 82 years). The cause of ESRD was diabetic nephropathy in 8 patients (23.5%), glomerulonephritis in 5 (14.7%), nephrosclerosis in 2 (5.9%), polycystic disease in 2 (5.9%), and unknown in 17 (50%). The mean duration of CAPD before FP was 19.4 ± 13.2 months (range 1 – 50 months). Candida species caused 97% of the episodes of FP. Twenty-two patients (64.7%) had an episode of bacterial peritonitis during the month preceding their FP. Twenty-four (70.6%) patients had received multiple antibiotics in the preceding month because of either bacterial peritonitis or exit-site infection. The most common manifestations of peritonitis were abdominal pain, tenderness, cloudy dialysate, and fever. Antifungal drugs were initiated in all episodes as soon as the diagnosis of FP was made. Agents used included amphotericin and fluconazole. The agents used and route of administration varied, but all patients received antifungal therapy for at least 3 weeks or until death. In 32 patients (94.1%), removal of the peritoneal catheter was required because the symptoms persisted. No attempt was made to re-establish peritoneal dialysis in these patients. Two (5.9%) patients recovered without removal of the catheter. Twenty-three patients (67.6%) were transferred to hemodialysis. Nine patients (26.5%) died during an episode of FP.

DISCUSSION

The events leading to FP are not clear, but a variety of anatomic, metabolic, chemical, and immunologic factors are known to predispose to the infection. Patients with a recent history of bacterial peritonitis and a prolonged course of multiple antibiotics are more at risk for FP (5–7). Inflammation due to bacterial peritonitis may enhance susceptibility of the peritoneum to fungal invasion. Antibiotics, administered either systemically or intraperitoneally (IP), may allow for fungal proliferation and overgrowth on the skin and among bowel flora, thus producing an environment conducive to fungal colonization and infection. The fungi enter through contamination by touch, or perhaps by aerial contamination, or by direct extension of infection of the catheter exit site through the subcutaneous tunnel into the peritoneal cavity, or by tubal uterine (7–9). In our patients 2.5% of all CAPD-associated peritonitis episodes were due to fungal infection; 97% of the cases were caused by Candida albicans or other Candida species. In 24 fungal episodes (70.6%), the patient had received broad spectrum antibiotics within the preceding month. We found that the preceding bacterial peritonitis and recent exposure to antibiotics were associated with the development of FP. Of our 34 patients, 9 were women, none of whom had documented preceding or coexistent vulvovaginal candidiasis.

There are no generally accepted therapeutic regimens for the treatment of FP in patients on CAPD. Management strategies have included early peritoneal catheter removal with or without antifungal therapy, or antifungal therapy with subsequent catheter removal if symptoms persisted (3,5–11). Most investigators agree that catheter removal is an important part of the treatment for FP because the peritoneal catheter provides a site conductive to microbial colonization. Electron microscopy of removed peritoneal catheters shows organisms embedded in an amorphous matrix on the surface of the catheter. This renders antimicrobial therapy less effective (3,12). The current recommendation for treating FP caused by candida or other yeast-like organisms is fluconazole plus oral or...
IP 5-flucytosine (13,14). Amphotericin B is mainly used for cases refractory to fluconazole therapy and for filamentous fungal infection because amphotericin B given intravenously has variable penetration into intraperitoneal fluid, and when given IP, often results in severe pain and chemical peritonitis (3). The catheter should be removed if clinical improvement with antifungal drugs does not occur after 5 – 7 days of therapy; antifungal therapy should be continued for at least 10 days after removal of the catheter, or for 4 – 6 weeks without catheter removal (13,14).

In our cases, antifungal therapy including fluconazole alone, amphotericin alone, or a combination of these two drugs was initiated with close monitoring of the patient. Catheters were removed in 4 – 7 days if symptoms persisted. In our series, of 34 FP, 2 were managed without catheter removal. However, despite antifungal medications, 32 of our patients required removal of the Tenckhoff catheter during their course of therapy. The patients whose catheters were removed did not go back to peritoneal dialysis in our cases. The death rate was 26.47%.

After an episode of FP, no more than 35% of patients are able to continue CAPD or have the technique re-established because of peritoneal adhesions, abscess formation, or progressive sclerosing peritonitis (2,5–8). In our cases, re-establishment of the catheters was not preferred for these reasons.

Fungal peritonitis is a dreaded complication of CAPD; death from FP has been reported to be 12% – 44% in some series, in contrast to a rate of 0.6% – 3% for patients with bacterial peritonitis (1,2,7,15). In our cases the death rate was high. This high mortality may have been due to delay in diagnosis and removal of catheters. Since fungi are often slow growing, the fungemia may be present initially in culture-negative patients.

In conclusion, patients suffering from bacterial peritonitis and receiving antibiotics are at great risk of suffering from FP. Because of the high mortality rate, excessive hospital stay, and potential for multiorgan complication, focus on awareness of the problem and development of measures for its prevention are very important. Once the diagnosis of FP is established, intensive antifungal therapy must be given and the catheter must be removed as soon as possible, thus removing the main locus of occult colonization and allowing the normal defense mechanisms of the peritoneum to clear the remaining infection.

ACKNOWLEDGMENT

This study was supported by Eczacibasi/Baxter.

The Turkish Multicenter Peritoneal Dialysis Study Group1 (TULIP)

REFERENCES


1 The following persons and Nephrology Departments of Universities participated in TULIP: Hülya Tas¸kapan, Erçiyes; Çetin Özener, Marmara; Kenan Ates¸, Ankara; Fehmi Akçiçek, Ege; Mahmut Yavuz, Uluda¸g; M. Emin Akpolat, Ondokuz Mayis; Cengiz Uta¸s, Erçiyes (utas@kaynet.net.tr).
Sclerosing Encapsulating Peritonitis After Renal Transplantation. Does It Make Sense?

Sclerosing encapsulating peritonitis (SEP) is a rare but serious complication of continuous ambulatory peritoneal dialysis (CAPD). It was first described in association with peritoneal dialysis in 1978 by Gandhi as a markedly thickened peritoneal membrane, with the loops of bowel bound together in a fibrous exudate that looks like “icing on a cake” (1).

Scleorosis of the peritoneum with encapsulation of the small bowel presents initially as impaired ultrafiltration (2), or later as gastrointestinal obstruction (3), in patients on long-term CAPD with recurrent peritoneal infection who are frequent beta-blocker users (3). The diagnosis is usually made at laparotomy, but it can be suggested by clinical findings and highly supported by ultrasonography and computed tomography (CT) scan (4,5).

Until 1993, SEP was managed by CAPD interruption, long-term parenteral hyperalimentation, and surgery, with operative mortality rates as high as 66% (3). Then Junor and McMillan reported on the benefits of immunosuppression for this condition (6).

We report one case of SEP diagnosed after renal transplantation, despite using triple immunosuppression therapy.

CASE REPORT

In 1990, a Caucasian male patient, aged 32 years, presented with chronic renal failure secondary to chronic glomerulonephritis and commenced on CAPD. Since then, two episodes of peritonitis occurred and he was temporarily transferred to hemodialysis. He used the Y-set and had four exchanges per day (1 of 4.25% and 3 of 1.5% glucose dialysate). During the last year of CAPD, he complained of recurrent edema and started alternating exchanges of 4.25% and 1.5% glucose dialysate. He did not use beta-blockers. In December 1997, he underwent a cadaveric donor renal transplantation and commenced on prednisone, azathioprine, and cyclosporine A. He was evaluated for delayed graft function due to a biopsy-proven acute tubular necrosis and remained on hemodialysis until the 22nd postoperative day. A week later the Tenckhoff catheter was removed and he was discharged home.

Three months later he began to experience back pain, abdominal distension and constipation, hypogastric colicky pain, nausea, and vomiting. He was dehydrated and had a palpable lower left abdominal quadrant mass. Plain abdominal radiographs showed dilated small bowel loops lying in the left flank. Ultrasoundography revealed a mass of tightly bound small bowel loops with fibrous adhesions and ascites, and CT showed dilated small bowel loops encased by a thickened peritoneal membrane, loculated ascites, and small bowel and mesenteric torsion (Figure 1). Previous plain abdominal radiographs and ultrasonography were normal in April 1996. Abdominal paracentesis produced 1 L of yellow-colored fluid that was a transudate with 90 cells/mm³ and negative for bacteria and fungi on culture. Routine serum laboratory values were within normal limits. A nasogastric tube for drainage was used and he was discharged asymptomatic 4 days later.

The patient was readmitted 6 days later with the same complaints. Computed tomography revealed contrast stopping in the small bowel, which was encased by the thickened membrane. He underwent laparotomy. At operation, the small bowel was distended and encased in a dense white fibrous tissue with intervening ascites. Dissection of the encapsulated small bowel and resections of fibrous tissue were carried out successfully. Histological examination revealed chronic peritonitis with dense collagenous tissue, fibrin patches, and small abscesses. He left hospital on an oral diet a week later and he has been doing well since then.
DISCUSSION

We have described a typical patient with SEP secondary to CAPD after renal transplantation, who developed progressive loss of ultrafiltration before the allograft surgery, and bowel obstruction after transplantation, in spite of using azathioprine, cyclosporine, and prednisone. His diagnosis was suspected on clinical findings and supported by characteristic radiological images previously described by us (5). Surgery was postponed for a trial of nonoperative therapy with immunosuppression and gastric drainage.

Junker and McMillan reported 17 cases of laparotomy-proven SEP for symptoms of small bowel disease and prolonged survival of patients given immunosuppressive therapy with or without a functioning transplant (12 deaths without immunosuppression vs 5 long-term survivors with immunosuppression). Four patients underwent renal transplantation and were given prednisolone and azathioprine or cyclosporine A. Furthermore, when immunosuppression was stopped because of chronic rejection in 1 patient, symptoms of bowel obstruction occurred but resolved as treatment was restarted (6).

Bhandari et al. also reported laparotomy-proven SEP in a CAPD patient who was given corticosteroids and azathioprine for 6 weeks and showed marked improvement in the degree of adhesions, allowing its separation and division in a subsequent surgery (7). Hawley et al. reported a patient with SEP refractory to low-dose prednisolone for 9 months who did well after renal transplantation and triple immunosuppression (8). Selgas et al. also noted the beneficial effect of renal transplantation and/or immunosuppression in the subsequent appearance of SEP (including intraperitoneal steroid treatment) (9).

Contrary to previous reports, Bowers et al. described 3 patients with SEP that developed after renal transplantation. In 2 of the patients, the symptoms came on months after transplantation, and in the other, at least 1 year posttransplantation. They eventually improved symptomatically but they needed surgery (10). One patient received triple immunosuppression but it was not mentioned in the others. Holland described a female patient who complained of indigestion, diarrhea, and vomiting that continued following renal transplantation (4). In Australia, Rigby and Mawley reported treatment with immunosuppressraction in 5 patients with a favorable outcome in 3: 2 were renal transplant recipients; 1 was a 52-year-old female who presented with small bowel obstruction, 2 weeks posttransplant, and had SEP diagnosed at laparotomy (11), just as in our patient.

Considering the possible pathophysiological link between interleukin-1 release by activated peritoneal macrophages and fibroblast proliferation, collagen deposition, and SEP (12), immunosuppression by blocking the inflammatory cascade would be a logical choice of therapy.

Further studies should consider the use of immunosuppression prior to surgery to reduce adhesions, although the best outcome could probably be achieved in the early phase of ultrafiltration loss. It is interesting that minimizing or avoiding the use of cyclosporine might be important, due to its ability to upregulate transforming growth factor-β mRNA expression and increase the production of extracellular matrix (13).

We must emphasize the high risk of immunosuppression, but must also keep in mind the natural history of SEP, with its high mortality rates, when weighing the risk/benefit ratio of this therapy in an individual patient (9).

Avoidance of risk factors and early diagnosis of SEP remain the most important steps in ensuring long-term CAPD success and absence of abdominal complications posttransplantation.

David J.B. Machado
C.S. Cocuzza
W.C. Nahas
L.E. Ianhez
Renal Transplant Unit
Hospital das Clínicas
University of São Paulo, Brazil

REFERENCES

Iatrogenic Peritonitis: the Need for Prophylaxis

The need for antibiotic prophylaxis to prevent peritonitis prior to invasive procedures or dental work in patients on peritoneal dialysis (PD) is controversial. In a recent editorial in Peritoneal Dialysis International, Vas stated that the event was rare and proposed a registry of clinical cases (1). It has been our impression that peritonitis postprocedure is uncommon but not rare. Our policy is to provide prophylactic antibiotics. We have reviewed our experience and the literature to determine the frequency of iatrogenic peritonitis.

METHODS

Data on peritonitis have been prospectively gathered and maintained in a database from 1982 to 1 July 1999. Episodes that occurred within a few days of a procedure were considered secondary (dental, endoscopic, gynecologic procedure, biopsy, cholecystectomy).

MEDLINE was searched for reports of peritonitis after dental, endoscopic, or other procedures, using the key words and index terms peritonitis, peritoneal dialysis, iatrogenic, colonoscopy, endoscopy, and dental.References of articles were searched for additional cases.

RESULTS

During the study period, there were 787 patients on PD, with a total time of 1270.8 years on PD. There were 971 episodes of peritonitis, for an overall rate of 0.76/year. Nine (1% of total) were subsequent to a procedure (4 colonoscopy, 1 laparoscopic cholecystectomy, 1 uterine biopsy, 1 dental work, 1 liver biopsy, 1 barium enema that led to a perforation). The data on the cases are summarized in Table 1. In all but one case, the patients did not receive prophylactic antibiotics. In that case the patient received vancomycin and gentamicin before colonoscopy and polypectomy, but subsequently developed peritonitis with several species of Bacteroides. This case has been reported previously (2).

The literature review found an additional 14 cases (Table 1) (3–12). In only one case was antibiotic prophylaxis given prior to the procedure (7). In that case the patient grew Enterococcus, which was not covered by the cephalothin administered. In addition, Tzamaloukas et al. reported two cases of peritonitis after sigmoidoscopy resulting in bowel perforation (13).

DISCUSSION

This review of our experience and that in the literature demonstrates that lower gastrointestinal endoscopy, gynecologic procedures, and dental work performed without prophylaxis can lead to peritonitis. These procedures can produce transient bacteremia that could seed the peritoneum. Endoscopy is associated with bacteremia in 0% – 5% and barium enemas in 10% of cases, while the incidence of bacteremia with dental work can be as high as 80% (14). Lower endoscopic procedures, other abdominal procedures, and uterine biopsies could also produce peritonitis through transmural migration of bacteria across the bowel wall or via the gynecologic tract.

At our facility, the rate of iatrogenic peritonitis is low, which may be related to our policy of using prophylaxis. We follow the American Heart Association guidelines (15). In addition, we drain the abdomen of dialysate prior to the procedure. The policy of draining the abdomen is based on data showing that current dialysis solutions impair phagocytic function and that leukocyte function might improve during a dry period (16). However, this has not been directly tested as a method of decreasing peritonitis. In all episodes reported here except one, the patient forgot our instructions or the doctor performing the procedure was unaware of the policy. What is not known, however, is what proportion of procedures done without prophylaxis lead to peritonitis, and to what degree antibiotics lower the incidence of peritonitis. That is, we do not know the denominator. We agree with Vas that this information will be difficult to obtain and we support the idea of a registry (1).
Lower gastrointestinal procedures lead to peritonitis with gut flora, which is usually gram-negative. Gram-negative peritonitis is associated with significant morbidity and mortality (17–19). Given this, we recommend the use of antibiotic prophylaxis prior to all intra-abdominal endoscopic procedures, as well as prior to any invasion of the uterus.

Linda Fried1,2
Judy Bernardini2
Beth Piraino2

VA Pittsburgh Healthcare System1
Renal-Electrolyte Division2
University of Pittsburgh School of Medicine
Pittsburgh, Pennsylvania, U.S.A.
LFPP94@pitt.edu

REFERENCES

Impact of Total Solute Clearance on Clinical Outcomes in Korean CAPD Patients

Recently, the CANUSA study showed a strong association between dialysis delivery and patient outcome (1); the National Kidney Foundation-Dialysis Outcomes Quality Initiative (NKF-DOQI) recommendations suggested that the target delivered solute clearance should be a Kt/Vurea of 2.0/week, and a standardized creatinine clearance (SCCr) of 60 L/week/1.73m², for optimal dialysis outcomes (2). However, these were based on Western patients, and whether the currently recommended levels are equally applicable to Asians, including Korean continuous ambulatory peritoneal dialysis (CAPD) patients, has not yet been determined.

The specific aim of the present study was to evaluate the predictive value of total solute clearance and other clinical and biochemical parameters for mortality in Korean CAPD patients.

PATIENTS AND METHODS

A retrospective analysis was performed in 128 consecutive patients commencing CAPD during the 6-year period from May 1991 to May 1997. Patients that had been treated previously with either hemodialysis or transplantation were excluded. Urea kinetic data were measured within 6 months of beginning CAPD, and at 6-month intervals thereafter, in the usual way. Blood chemistries, including blood urea nitrogen (BUN), serum creatinine (Cr), and total protein were measured by standard techniques. Serum albumin was determined by the bromcresol green method. Monthly biochemical data and biannual urea kinetic variables were averaged for outcome analysis.

RESULTS

Patients were divided into two groups based on Kt/Vurea: Kt/Vurea ≤ 2.1 (n = 65) and > 2.1 (n = 63). Only the male-to-female ratio was significantly different, as shown in Table 1. BUN and Cr levels were significantly lower in the higher Kt/Vurea group; small solute clearances, including both peritoneal and renal, were significantly higher compared to the lower Kt/Vurea group. However, total protein and albumin levels were not different in the two groups (Table 2).

During the follow-up period, there were 11 deaths and 21 technique failures. Patient survival rate was superior in the higher Kt/Vurea group, with a marginal significance (p = 0.0534); whereas technique survival rates were similar between the two groups (90.1% vs 92.5% at 2 years and 57.2% vs 77.7% at 5 years in the lower and higher Kt/Vurea groups, respectively).

The 5-year survival rate for the patients that had Kt/Vurea > 2.1 was 97.9%; whereas, for those patients with Kt/Vurea ≤ 2.1, the 5-year survival rate was 66.8%. When the patients were grouped according to weekly CCr (WCCr) at the level of 60 L/week/1.73m², the clinical outcomes were not statistically different (data not shown).

Univariate analysis was performed to determine the prognostic factors for patient survival. Variables tested were age, sex, body weight, diabetic status, presence of cardiovascular disease, serum albumin, and solute clearances. Among these factors, age, sex, and diabetic status had a significant association with patient survival. Kt/Vurea had a marginal significance with a p value of 0.0534 (Figure 1). In order to esti-
mate the effect of each variable after adjustment for the others, we applied a Cox proportional hazards model. Diabetes mellitus (DM) was the first variable to enter the model and it gave a relative risk of 25.31. Age had a relative risk of 1.21. Kt/Vurea was the last variable to enter the analysis, and its degree of significance was 0.0445. A decrease of 0.1 unit Kt/Vurea per week was associated with a 39% increase in the risk of death.

As indicated in Table 3, those patients who remained alive at the end of the study were significantly younger, and there were more diabetic patients in the deceased group. Their total Kt/Vurea and WCCr were significantly higher compared to deceased patients. Mean renal Kt/Vurea during the follow-up period (median 0.19 vs 0.06) and residual renal Kt/Vurea at start of CAPD (median 0.41 vs 0.28) tended to be higher in survivors. When we calculated the change of total and renal Kt/Vurea over time, using the values from the start of CAPD and the last observations prior to last event, the proportion of patients with increasing, not changing, and decreasing Kt/Vurea was not different between survivors and nonsurvivors (data not shown).

### DISCUSSION

This study investigated the association of small solute clearance with clinical outcomes in Korean CAPD patients. During the follow-up period of 34 months, the patients who remained alive had a significantly higher mean Kt/Vurea, and Kt/Vurea of > 2.1 was associated with a favorable outcome. Although there was no statistical significance, the difference between survivors and nonsurvivors was actually in residual renal Kt/Vurea. A decrease of 0.1 unit Kt/Vurea per week was associated with a 39% increase in the relative risk of death. This is similar to the findings of a French study (3) that reported the relative risk of death for lower Kt/Vurea was 1.69. In the CANUSA study, for a 0.1 unit lower Kt/Vurea per week, there was a 6% increase in the relative risk of death (1).

In order to approach the optimal dialysis level in Korean CAPD patients, we compared the clinical outcomes after subdividing at the level of Kt/Vurea 1.7 (data not shown). However, patients whose Kt/Vurea ranged between 1.7 and 2.1 (n = 51) had a death prob-

### TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>Kt/Vurea ≤ 2.1 (n=65)</th>
<th>Kt/Vurea &gt; 2.1 (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.8±11.9</td>
<td>47.4±12.3</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>48:17 (2.8:1)</td>
<td>13:50 (0.3:1)</td>
</tr>
<tr>
<td>Cause of renal failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic glomerulonephritis</td>
<td>17 (26.2%)</td>
<td>22 (34.9%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>10 (15.4%)</td>
<td>8 (12.7%)</td>
</tr>
<tr>
<td>Diabetic nephropathy</td>
<td>6 (9.2%)</td>
<td>6 (9.5%)</td>
</tr>
<tr>
<td>Other</td>
<td>32 (49.2%)</td>
<td>27 (42.9%)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>6 (9.2%)</td>
<td>8 (12.7%)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>5 (7.7%)</td>
<td>6 (9.5%)</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>62.0±8.3</td>
<td>54.2±8.1</td>
</tr>
<tr>
<td>Follow-up duration (months)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ±SD</td>
<td>34.7±18.7</td>
<td>33.9±17.6</td>
</tr>
<tr>
<td>Range</td>
<td>7.4–74.1</td>
<td>8.5–70.9</td>
</tr>
</tbody>
</table>

a p < 0.05 versus Kt/Vurea ≤ 2.1 group.

<table>
<thead>
<tr>
<th></th>
<th>Kt/Vurea ≤ 2.1 (n=65)</th>
<th>Kt/Vurea &gt; 2.1 (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemical data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUN (mg/dL)</td>
<td>57.5±14.6</td>
<td>50.0±8.5</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>12.3±3.3</td>
<td>9.1±1.7</td>
</tr>
<tr>
<td>Protein (g/dL)</td>
<td>6.7±0.5</td>
<td>6.8±0.5</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.9±0.4</td>
<td>3.9±0.4</td>
</tr>
<tr>
<td>Weekly Kt/Vurea</td>
<td>1.9±0.2</td>
<td>2.4±0.2</td>
</tr>
<tr>
<td>Peritoneal</td>
<td>1.7±0.2</td>
<td>1.9±0.3</td>
</tr>
<tr>
<td>Renal</td>
<td>0.08 (0–0.91)</td>
<td>0.29 (0–1.62)</td>
</tr>
<tr>
<td>Weekly CCr (L/wk/1.73m²)</td>
<td>62.5±11.2</td>
<td>78.3±16.4</td>
</tr>
<tr>
<td>Peritoneal</td>
<td>53.6±12.8</td>
<td>59.4±15.2</td>
</tr>
<tr>
<td>Renal</td>
<td>5.7 (0–28.4)</td>
<td>14.8 (2.2–68.4)</td>
</tr>
</tbody>
</table>

CCr = creatinine clearance.
Values are mean ±SD or median with range.
a p < 0.05 versus Kt/Vurea ≤ 2.1 group.

Figure 1 — Observed patient survivals according to total Kt/Vurea are plotted. Patients with Kt/Vurea > 2.1 had better long-term survival compared to those who had Kt/Vurea ≤ 2.1, with a marginal significance.
ability that did not differ significantly from those patients with Kt/Vurea < 1.7 (n = 14). In this study, the proportion of patients with decreasing, not changing, and increasing Kt/Vurea was not different between survivors and nonsurvivors. The explanation for this finding is probably that there is a tendency for longer-term survivors to have lower Kt/Vurea values.

The discordance between a Hong Kong study (4) and ours is possibly due to methodological differences. In the Hong Kong study, the influence of dialysis dose on patient survival was analyzed by single measurements of urea kinetic variables. However, indices of dialysis adequacy measured once cannot accurately reflect the dialysis doses over the entire clinical course. In addition, the fact that only patients who remained alive entered the cross-sectional urea kinetic study should be noted. It is possible that these study designs have obscured real effects.

The presence of DM and advanced age were other independent predictors of mortality; this finding is in agreement with other previous studies (1,3,5). However, in contrast to other reports (1,5), serum albumin failed to predict survival in our study. A possible explanation is that serum albumin was negatively correlated with age (r = -0.41, p < 0.0001) and DM (r = -0.19, p = 0.023), a fact that contributed to the statistical model most importantly. Furthermore, serum albumin levels in our population were distributed in a relatively higher range, with a mean value of 3.9 ± 0.4 g/dL (range 3.0 – 5.0 g/dL). These findings may have reduced the impact of the predictive role of low serum albumin on mortality, and supported the hypothesis that the association between serum albumin and clinical outcomes may reflect a common predisposing comorbidity rather than malnutrition itself (6,7).

Gender was associated with patient survival in univariate analysis in our study. However, after adjustment to other factors, it lost its statistical significance. The fact that there were more female patients in the higher Kt/Vurea group may be attributed to this association. The prevalence of females in the higher Kt/Vurea group could be due to their lower body weight (53.8 ± 7.9 kg vs 63.0 ± 7.8 kg, p = 0.000).

In this study, the patient long-term survival rate was substantially higher compared to Western centers (1,8). It is possible that the improved survival rate in our patient population was related to patient selection: the mean age of our patients was 48.7 ± 12.1 years, and the proportion of diabetic patients was 10.9%, substantially younger and lower compared to Western studies (1,8). The residual renal Kt/Vurea (median 0.39) at the start of CAPD was not different compared to the CANUSA study (1). The potential problem of our method of averaging 6-monthly clearance values is that patients who survive longer have more measurements to average and, as measurements will tend to decrease with time in most studies, there will be a tendency for longer-term survivors to have lower average clearance values. Paradoxically, this does not seem to be the case in this study. Survivors appear to have higher not lower Kt/Vurea compared to nonsurvivors. This strengthens the notion that Kt/Vurea is important.

In conclusion, small solute clearance seems to determine long-term patient survival, and a value of 2.1 can be recommended as a target Kt/Vurea in Korean CAPD patients. However, survival of patients

---

### TABLE 3
Comparison of Surviving and Deceased Patients

<table>
<thead>
<tr>
<th></th>
<th>Surviving</th>
<th>Deceased</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>117</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>47.5±11.8</td>
<td>60.9±9.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>6.8%</td>
<td>54.5%</td>
<td>0.001</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>8.5%</td>
<td>9.1%</td>
<td></td>
</tr>
<tr>
<td>Mean follow-up duration (months)</td>
<td>32.0±18.3</td>
<td>39.0±18.3</td>
<td>NS</td>
</tr>
<tr>
<td>Biochemical parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUN (mg/dL)</td>
<td>54.1±12.5</td>
<td>50.4±12.9</td>
<td>NS</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>10.8±3.1</td>
<td>10.1±2.1</td>
<td>NS</td>
</tr>
<tr>
<td>Albumin (g/dL)</td>
<td>3.9±0.4</td>
<td>3.7±0.4</td>
<td>NS</td>
</tr>
<tr>
<td>Weekly Kt/Vurea</td>
<td>2.14±0.35</td>
<td>1.90±0.19</td>
<td>0.025</td>
</tr>
<tr>
<td>Peritoneal</td>
<td>1.80±0.28</td>
<td>1.87±0.23</td>
<td>NS</td>
</tr>
<tr>
<td>Renal</td>
<td>0.19 (0-1.62)</td>
<td>0.06 (0-0.77)</td>
<td>NS</td>
</tr>
<tr>
<td>Weekly total Ccr (L/week/1.73 m²)</td>
<td>71.3±16.3</td>
<td>60.6±8.6</td>
<td>0.042</td>
</tr>
</tbody>
</table>

Ccr = creatinine clearance.
appears to be influenced predominantly by other clinical factors, such as DM and age.

ACKNOWLEDGMENT

Presented as an abstract at the VIIIth Congress of the International Society for Peritoneal Dialysis in 1998.

Hyunjin Noh
Hyun Yong Song
Shin Wook Kang
Kyu Hun Choi
Ho Yung Lee
Dae Suk Han

Division of Nephrology
Department of Internal Medicine
Institute of Kidney Disease
Yonsei University College of Medicine
Seoul, Korea

REFERENCES


