PART FIVE  Catheters and Connectors
Many studies have examined the survival of the first peritoneal dialysis (PD) catheter. However, data are scarce about the factors that influence the function and survival time of a second PD catheter. The purpose of the present study was to calculate the survival time of the second PD catheter and to examine factors that predict removal of that catheter.

We conducted a retrospective study of second PD catheters inserted at our institution over a 10-year period from May 1992 to April 2002. The endpoint consisted of removal of the second catheter. Voluntary change to hemodialysis, kidney transplantation, transfer to another center, and death with a functioning catheter were censored observations. Catheter survival was analyzed by the Kaplan–Meier method.

During the study period, 106 patients (59 men, 47 women) received a second catheter. The mean age of the patients was 55 ± 14.9 years. One third of the patients had diabetes. The reasons for removal of the first catheter and insertion of the second one were peritonitis (n = 50), catheter malfunction (n = 20), catheter leak (n = 11), exit site or tunnel infection (n = 21), and failed kidney transplantation with resumption of PD (n = 4). The median survival of the second catheter was 48 months (95% confidence interval: 38 months to 59 months). On univariate analysis, increasing patient age and peritonitis as cause for removal of the first catheter were associated with an increased risk of removal of the second catheter. However, on multivariate analysis, only increasing patient age was associated with a greater risk to survival of the second catheter.

Key words
Peritoneal dialysis catheter, technique survival, catheter removal

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demographics, diabetic status, primary renal disease, catheter leak or malfunction, exit-site and tunnel infection, peritonitis, failed renal transplant, use of beta-blockers or intraperitoneal insulin, duration of PD with the first catheter, and interval between removal of the first catheter and insertion of the second one. Voluntary change to hemodialysis, kidney transplantation, transfer to another center, and death with a functioning catheter were also recorded. Those latter observations were censored.

Statistical analysis
Statistical analyses were performed using the SAS software program for Windows (SAS Institute, Inc., Cary, NC, U.S.A.). All data are expressed as mean ± standard deviation unless otherwise specified. Univariate and multivariate analyses by logistic regression were performed to predict factors important for second catheter removal. All baseline demographic and other factors recorded were included in the model. A p value of 0.05 was considered significant. Catheter survival was analyzed by the Kaplan–Meier method.

Results
During the study period, 106 patients (59 men, 47 women) received a second catheter. The mean age of the patients was 55 ± 14.9 years. One third of the patients had diabetes. The reasons for removal of the first catheter and insertion of the second catheter were peritonitis [n = 50 (47.2%)], exit-site or tunnel infection [n = 21 (19.8%)], catheter malfunction [n = 20 (18.9%)], catheter leak [n = 11 (10.4%)], and failed kidney transplant with resumption of PD [n = 4 (3.7%)].

Of the 106 patients who received a second catheter, 65 patients (61.3%) continued with PD; 41 patients (38.7%) subsequently had the second catheter removed. Of the 65 patients who continued with PD, 23 (21.7%) died with a functioning catheter, 14 (13.2%) received a kidney transplant, 6 (5.7%) voluntarily switched to hemodialysis, and 6 (5.7%) were transferred to other centers. The remaining 16 patients (15.1%) were continuing PD at our center at the end of study period. Among the 41 patients who had the second catheter removed, peritonitis was again the leading cause [n = 25 (61%)], followed by catheter malfunction [n = 9 (22%)], ultrafiltration failure [n = 4 (9.8%)], exit-site and tunnel infection [n = 2 (4.8%)], and catheter leak [n = 1 (2.4%)].

The median survival of the second catheter was 48 months (95% confidence interval: 38 months to 59 months). The 1-year, 2-year, and 3-year survivals of the second catheter were 79.9%, 63.2%, and 61.3% respectively (Figure 1). On univariate analysis, increasing patient age and peritonitis as the cause of first catheter removal were associated with an increased risk of removal of the second catheter. However, on multivariate analysis, only increasing patient age was associated with a greater risk to survival of the second catheter (hazard ratio: 1.02).

Discussion
The median survival of the second catheter was excellent at 48 months. In our study, the 1-year, 2-year, and 3-year survivals were 79.9%, 63.2%, and 61.3% respectively. In comparison, the 1-year, 2-year, and 3-year survivals for surgically inserted, double-cuff Tenckhoff catheters (first catheter) from a prospective study were 62.5%, 41.5%, and 36% respectively (1). In another large series, the 1-year and 3-year survivals for a first catheter were 75% and 37% respectively (3).

The high proportion of censored patients may, in part, explain our good outcome. However, one would not necessarily expect the censored patients to bias the result, because many patients were censored for reasons unrelated to the catheter. Szeto et al. found an overall technique survival of only 30.8% for a second PD catheter at 2 years (4). However, the patient population in that study was significantly different from ours: only patients who had had their first catheter removed because of severe peritonitis were in-
cluded. In contrast, only 47.2% of our patient population had severe peritonitis as the cause for first catheter removal.

On analyzing the factors predicting survival of a second catheter, we found that patient age was the single most important factor associated with reduced survival. Each year was associated with a 2% increase in risk of catheter removal (hazard ratio: 1.02). It is interesting to note that duration of PD with the first catheter was not associated with survival time of the second catheter.

On univariate analysis, peritonitis as the cause of removal of the first catheter was another factor found to be associated with decreased survival of a second catheter. Peritonitis is a risk not only for the contemporary catheter but also for future catheters. Peritonitis is the major cause of technique failure in PD patients, accounting for 30%–80% of permanent transfers (6,7). Peritonitis is well known to alter the nature of the peritoneal membrane and to cause fibrosis and adhesions (8). Adhesions are likely to ultimately jeopardize the functioning of subsequent catheters. Szeto et al. (4) examined patients whose catheters were removed because of peritonitis and found that peritonitis predicted failure of PD catheter reinsertion.

Other causes of removal of the first catheter—such as catheter leak or malfunction, and exit-site and tunnel infection—were not associated with the survival of a second catheter. Similarly, sex of the patient, primary renal disease, history of failed renal transplant, and use of beta-blockers or intraperitoneal insulin were not important factors. Unexpectedly, the diabetic status of patient did not turn out to be important. Again, the interval between removal of the first catheter and insertion of the second catheter was not important for survival of the second catheter.

Conclusion
This retrospective study shows that survival of a second PD catheter is excellent. Increasing patient age and peritonitis as cause of removal of the first catheter are associated with an increased risk of removal of a second catheter. Other factors such as sex, primary renal disease, diabetic status, duration of PD with first catheter, catheter malfunction or leak, exit-site or tunnel infection, use of beta-blockers or intraperitoneal insulin, transport status of the peritoneal membrane, and interval between removal of the first catheter and placement of the second catheter do not affect survival of the second PD catheter.

References

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Since the introduction of Y-connector technology and the subsequent reduction in the frequency of peritonitis, catheter-related infections have become the primary infectious complication in patients on peritoneal dialysis (PD). Such infections may lead to prolonged morbidity, recurrent peritonitis, and catheter failure. Despite appropriate treatment of catheter-related infections, removal of the catheter is sometimes necessary. The timing of catheter removal and replacement has been the focus of significant discussion. The International Society for Peritoneal Dialysis recommends a 3-week interval, but also allows for individualized timing. Long staging periods present problems that simultaneous removal and replacement (SRR) of the catheter may obviate. Here, we review a body of literature on SRR and present guidelines as to when SRR of an infected PD catheter may be considered a safe alternative to a staged procedure.

Key words
Peritonitis, exit-site infection, tunnel infection, PD catheter removal and replacement

Introduction
Since the introduction of Y-connector technology and the subsequent reduction in the frequency of peritonitis, catheter-related infections have become the primary infectious complication in patients on peritoneal dialysis (PD). Such infections may lead to prolonged morbidity, recurrent peritonitis, and catheter failure (1). Piraino et al. (2) reported that 22% of transfers from continuous ambulatory peritoneal dialysis (CAPD) to hemodialysis were attributable to catheter infections alone, and an additional 15% were attributable to peritonitis associated with catheter infection. Gram-positive cocci, mostly *Staphylococcus* species, account for between 60% and 70% of all catheter-related infections. Gram-negative rods account for between 15% and 25% of cases, and fungi for between 2% and 3% of cases.

Despite appropriate treatment of catheter-related infections, removal of the catheter is sometimes necessary. Infectious indications for catheter removal include persistent exit-site infection (ESI), chronic tunnel infection (CTI), relapsing peritonitis, refractory peritonitis, fungal peritonitis, mycobacterial peritonitis, and enteric peritonitis (Table I). “Relapsing” peritonitis is defined as recurrence of peritonitis with the same organism within 4 weeks of completion of therapy. “Refractory” or “persistent” peritonitis is defined as persistence of cloudy dialysate for more than 5 days despite appropriate antibiotic therapy.

The timing of catheter removal and replacement has been the focus of significant discussion. The International Society for Peritoneal Dialysis (ISPD) stated in 2000 that “the optimal period of time between catheter removal for infection and reinsertion...
of a new catheter is not known. Empirically, a minimum of 3 weeks between catheter removal and reinsertion of a new catheter is recommended.” They added that the timing of catheter reinsertion should be individualized, because shorter periods between catheter removal and insertion have been successfully tried (3).

The potential problems with staging catheter removal and replacement (using an interval delay of several days to several weeks) include disruption of PD, risk of fibrosis or adhesion formation, need for a hemodialysis catheter with its attendant cost, need to find a temporary hemodialysis unit for the patient, and potential for permanent loss of the patient to hemodialysis. Simultaneous removal and replacement (SRR) of the catheter may obviate those problems.

We identified 20 published reports that address the issue of catheter SRR (4–23). We reviewed that body of literature in an effort to develop guidelines regarding when SRR of an infected PD catheter may be considered a safe alternative to a staged procedure.

Patients and methods

Literature review
In one of the earlier reports on this subject, Grefberg et al. (4) noted that 3 of 13 patients with recurrent or persistent peritonitis treated with SRR had recurrence of peritonitis. In contrast, no recurrences were seen in 10 patients whose catheters had been replaced after 2 days. He therefore recommended against SRR, suggesting instead that, after an infected catheter was removed, at least 2 days should pass before a new one was placed.

Swartz et al. (5) reported very different results. They found the success rate of SRR to be 30 of 36 procedures (83%) in patients with refractory or persistent peritonitis or chronic tunnel infection. When the results were stratified by the nature of the offending organism, staphylococcal species were seen to cause the majority of infections, and SRR was observed to fail in only 2 of 23 staphylococcal infections. The authors therefore suggested that SRR is an appropriate procedure in patients with difficult infections not associated with *Pseudomonas*, fungi, or surgical complications.

Cancarini et al. (6) reported on 68 infectious complications of PD (26 tunnel infections, 22 peritonitis complicating tunnel infection, 12 refractory peritonitis, and 8 recurrent peritonitis). Only 1 failure occurred in a patient who had peritonitis associated with ESI/CTI, and no failures occurred in patients with recurrent peritonitis or isolated ESI/CTI. In contrast, 10 failures occurred among the 12 patients with refractory peritonitis. Among those 10 failures, the following microorganisms were cultured: fungus (*n* = 3), mycobacterium (*n* = 2), *Pseudomonas* (*n* = 2). *Acinetobacter* (*n* = 1), *Acinetobacter* and *Pseudomonas* (*n* = 1), and *Enterobacter* (*n* = 1). The authors concluded that SRR is a viable technique, but that it should not be used in patients with active inflammation [white blood cell count (WBC) > 100/mL], such as in patients with refractory peritonitis. [That conclusion was supported by the analysis of Singhal et al. (1), who compiled data from several studies demonstrating that the failure rate for SRR in the treatment of refractory peritonitis is 42%] Cancarini et al. (6) also concluded that infections attributable to mycobacteria, fungi, and some gram-negative organisms should not be treated with SRR.

Posthuma et al. (7) subsequently reported on the results of SRR in 39 patients: 15 who had bacterial peritonitis combined with ESI, 22 with isolated ESI, and 2 with chronically colonized catheters. Patients with refractory peritonitis and those whose infections were attributable to fungi or other nonbacterial organisms were excluded from the study. The SRR was performed after the dialysate leukocyte count had fallen to below 100/mL. Only 2 of the 39 procedures were complicated by peritonitis within 30 days (1 case of *Escherichia coli* and 1 case of *Pseudomonas*).

Similarly, Majkowski and Mendley (8) reported good results with SRR. They compared the outcomes of 34 patients treated with SRR to those of 18 patients treated with staged procedures (6–65 days between catheter removal and replacement; mean: 34 ± 17 days). Most of the cases documented a normal peritoneal WBC at the time that the catheter exchange was performed. Only 5 of 34 SRR procedures failed within the first 45 days (2 due to *Staphylococcus aureus*, and 1 each due to *Pseudomonas*, *Candida*, and *E. coli*). Those results compared favorably with the staged procedures, in which 1 of 18 failed (*S. aureus*).

Schroeder et al. (9) reported on 23 cases of SRR in 17 children. Complications necessitating catheter removal included 21 CTIs and 2 episodes of recurrent peritonitis. Nineteen procedures resulted in an infec-
tion-free period of at least 6 months. In 4 cases, a relapse of the CTI with the same micro-organism was observed within 3 months. The infecting micro-organisms were *S. aureus* (*n* = 2), *P. aeruginosa* (*n* = 1), and *Streptococcus viridans* (*n* = 1). The authors concluded that SRR is a safe procedure in the pediatric population.

Goldraich *et al.* (10) likewise obtained favorable results in 9 pediatric patients who underwent 15 SRR procedures. The reasons for catheter replacement were tunnel complications (*n* = 10), relapsing bacterial peritonitis (*n* = 3), and fungal peritonitis (*n* = 2). Relapse of tunnel infection after SRR occurred in 1 instance in the first month. (The organism responsible for the recurrence was not identified in the paper.) No episodes of recurrent peritonitis were seen. Interestingly, there was no recurrence of fungal peritonitis in the 2 cases of fungal peritonitis treated with SRR.

Williams *et al.* (11) treated 20 episodes of recurrent peritonitis with SRR. Only 1 patient developed peritonitis within the first month, and 15 of the 20 patients treated with SRR were peritonitis-free in the same time period.

Hadjiyannakis *et al.* (12) reported on their experience with SRR in 7 patients with refractory (*n* = 3) or recurrent (*n* = 4) peritonitis. Resolution of peritonitis was achieved in all patients, and the peritoneal cultures became negative. The follow-up period was between 3 months and 31 months, and no episodes of peritonitis were seen in the first 3 months. Three episodes of peritonitis occurred at 6, 16, and 27 months. It is unclear whether the original offending organism caused the recurrent peritonitis.

Ludlam *et al.* (13) used SRR to treat 8 cases of recurrent peritonitis and 4 cases of persistent peritonitis. No recurrence of peritonitis was seen in the follow-up period (mean: 16 months; range: 4 – 24 months). Similarly, Morton *et al.* (14) reported on the use of SRR for the treatment of 12 cases of “unresponsive bacterial peritonitis.” Their report is unclear about whether the patients had refractory or recurrent peritonitis. Nevertheless, no instances of recurrent infection were seen (follow-up time not reported).

Fredensborg *et al.* (15) retrospectively compared two groups of patients: 32 treated with SRR (group 1) and 26 who underwent staged catheter removal and reinsertion with an intervening period of 1 – 30 days (group 2). The groups were similar in regard to spectrum of micro-organisms and number of days of antibiotic treatment before catheter removal. In group 1, 3 patients (9%) had an infection within the first month after catheter replacement; in group 2, 7 patients (27%) had such an infection. However, no statistical difference was seen between the two groups when comparing either time to first infection after catheter replacement or rate of loss of reinserted catheters owing to infection. The authors concluded, therefore, that the interval between removal of an infected PD catheter and reinsertion of a new one has no influence on the ultimate outcome.

**Discussion**

We reviewed 20 studies that address the efficacy and safety of SRR for the treatment of catheter-related infection. Of those 20, 19 are small retrospective reports whose results may therefore reflect selection bias. The sole prospective study (11) did not compare SRR to a staged procedure. A prospective randomized controlled trial would be most useful in determining if SRR is equivalent to staged catheter placement. However, given the rarity of catheter-related peritonitis in individual centers, it would be difficult to obtain a high-powered prospective study in this field. We therefore compiled data from the various studies and, after analysis, we believe that several conclusions may be drawn.

Of all 420 cases of SRR reported in the literature, 370 (88%) have had a successful outcome. For cases of ESI or CTI alone, the success rate is 93%. In cases of peritonitis, with or without the presence of ESI/CTI, 240 of 278 cases (86%) were successful (Figure 1). Figure 2 illustrates the success rates of SRR for treatment of peritonitis (with or without the presence of ESI/CTI) by organism type (when the offending organism was listed in the original paper). Staphylococcal infection accounted for 58% of all cases of SRR; of those, 9% had an infection within the first month after peritonitis treatment before catheter removal. In group 1, 3 patients (9%) had an infection within the first month after catheter replacement; in group 2, 7 patients (27%) had such an infection. However, no statistical difference was seen between the two groups when comparing either time to first infection after catheter replacement or rate of loss of reinserted catheters owing to infection. The authors concluded, therefore, that the interval between removal of an infected PD catheter and reinsertion of a new one has no influence on the ultimate outcome.

**Pseudomonas** species have not been as well studied, but only 14 of 20 (70%) SRR attempts in the setting of *Pseudomonas* peritonitis have had a successful outcome (Figure 4). In contrast, upon analyzing the
data for ESI not associated with peritonitis, it appears that SRR may be successfully used in nearly 90% of cases (Figure 4).

Many fewer cases of other organisms were reported. Only 2 cases of SRR in mycobacterial infections were reported, and both failed. In addition, 2 of 5 fungal cases were failures.

Until a prospective study is performed, we believe that the available literature supports these recommendations regarding SRR:

- SRR is an acceptable and safe procedure for recurrent peritonitis or peritonitis associated with ESI/CTI when staphylococcal species are the causative organism.
- Data to support the use of SRR in peritonitis associated with *Pseudomonas* or other gram-negative organisms are inadequate. However, attempts at SRR may be justified for patients in whom vascular access cannot be obtained or who are otherwise poor candidates for hemodialysis.
- SRR should not be attempted in patients with fungal, mycobacterial, or enteric peritonitis.
- SRR should not be attempted in patients with active or refractory peritonitis (persistent cloudy effluent with WBCs > 100/mL).
References


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Recurrent and persistent peritonitis episodes are exhausting problems in children on chronic peritoneal dialysis (PD) and can lead to discontinuation of treatment. In the present report, we describe our clinical experience with endoluminal brushing (EB) in 3 pediatric patients with refractory peritonitis episodes maintained on chronic PD. The EB was performed on 4 occasions in 3 patients. Peritonitis resolved in 2 of the patients. The remaining patient required removal of the PD catheter. No adverse events have since been observed.

Endoluminal brushing should be considered an option for the management of persistent peritonitis before catheter removal.

Key words
Persistent peritonitis, endoluminal brushing, children

Introduction
Chronic peritoneal dialysis (PD) is the preferred renal replacement modality in children with end-stage renal failure (1). Unfortunately, persistent or recurring peritonitis episodes are the most common causes of peritoneal dialysis catheter removal and termination of therapy (2).

The endoluminal brushing (EB) technique has been used in various therapeutic modalities such as management of blocked hemodialysis (HD) or PD indwelling catheters, in situ diagnosis and treatment of catheter-related infections, and procurement of cytology samples (3–5). To our knowledge, the present report describes the first application of EB in the treatment of recurring or persistent peritonitis episodes in pediatric PD patients.

Patients and methods
Catheter brushing technique
Our endoluminal brush kit (FAS Medical International, Sunbury, Middlesex, U.K.) is an in situ sampling brush for indwelling catheters of 1.8 – 2.8 mm internal diameter. Catheter brushing was performed aseptically in the treatment room on the ward. The titanium adapter was carefully cleaned with Betadine and held with the left hand. An external plastic sheath and an adapter for the Luer-lock connection maintained a closed system, avoiding external contamination. Using the right hand, the brush was inserted into the catheter and advanced slowly toward the peritoneal end. The brush was then withdrawn from the catheter, and the bristles of the brush were cleansed with sterile saline. The procedure was repeated until discoloration of the bristles ceased. Following the procedure, the catheter lumen was rapidly flushed with 50 mL normal saline mixed with 1000 U heparin. Any fibrin or clots were removed from the brush. Prophylactic antibiotics were not used for the procedure. The brush technique was always performed by the same physician.

Case 1
In July 2001, a 10-year-old boy whose primary renal disease was obstructive uropathy (posterior urethral valve) and who had been treated with chronic PD for 32 months, presented with abdominal pain, vomiting, fever, and cloudy peritoneal fluid. He had had 2 peritonitis episodes within the preceding 2 months, both of which had been treated successfully with intraperitoneal antibiotics. On admission, analysis of a 10-mL sample of dialysate showed 900 white blood cells (WBCs) with 90% polymorphonuclear leukocytes. Pseudomonas aeruginosa was cultured from the PD
fluid. Antibiotic treatment was started with ceftazidime at an initial dose of 250 mg/L, followed by 125 mg/L thereafter, and tobramycin at an initial dose of 8 mg/L for the first 6-hour exchange, followed by 4 mg/L thereafter.

By the 15th day of treatment, the boy’s clinical condition had improved, but a high leukocyte count persisted. Therapy was extended empirically with vancomycin (15 mg/L), ampicillin (50 mg/L), and oral fluconazole (5 mg/kg daily). The patient could not be transferred to HD owing to socioeconomic difficulties. We were forced to maintain a chronic PD regime because a donor for a renal allograft had not been found. On the 30th day after onset, a high leukocyte count was still present. We then performed EB with no complications. Four days after the EB procedure, the effluent became clear, and leukocytes disappeared (Figure 1). No peritonitis episode has been observed in the subsequent 10 months.

Case 2
A 13-year-old boy maintained on chronic PD for 3 years as a result of amyloidosis presented with nausea, vomiting, abdominal pain, and cloudy effluent. He had had 3 episodes of peritonitis (the latest 2 episodes within the preceding 2 months), which had resolved uneventfully with intraperitoneal antibiotics. Microscopic examination of dialysate revealed “too numerous to count” WBCs, with 100% neutrophils. *Enterococcus* was isolated from the dialysate culture. This patient was placed on therapy with intraperitoneal ceftazidime at an initial dose of 250 mg/L, followed by 125 mg/L thereafter, and tobramycin at an initial dose of 8 mg/L, followed by 4 mg/L thereafter.

On the 15th treatment day, cloudy effluent and a high dialysate WBC count continued. We therefore offered the parents of the patient a choice of removing the indwelling PD catheter and transferring the patient to HD. The patient could not be transferred owing to rejection of that choice by his family (because they lived in a distant rural area). Therapy was extended with additional intraperitoneal vancomycin (15 mg/L) and oral fluconazole (5 mg/kg daily).

Because of persistence of a high dialysate WBC count on day 28, EB was performed. Despite an initial improvement, the EB attempt did not establish remission. On the 37th day, a second attempt to achieve remission was also unsuccessful (Figure 1).

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**FIGURE 1** Time course of effluent leukocyte count before and after endoluminal brushing (EB) in 3 patients. Notice the disappearance of effluent leukocytes after EB in 2 of 3 patients.
The PD catheter was removed. The boy was transferred to HD 2.5 months after onset of the peritonitis; 5 months after onset, the boy underwent cadaveric renal transplantation.

**Case 3**
An 8-year-old girl with end-stage renal disease secondary to focal glomerulosclerosis had 2 episodes of bacterial peritonitis within a 53-month period. The first episode (attributable to *Enterococcus*) resolved successfully with intraperitoneal antibiotics. For the second episode, from which *Pseudomonas* was isolated, we administered intraperitoneal cefazolin at an initial dose of 250 mg/L, followed by 125 mg/L thereafter, and ceftazidime at an initial dose of 250 mg/L, followed by 125 mg/L thereafter. After identification of the bacteria, cefazolin was withdrawn and intraperitoneal amikacin 25 mg/L initially, 12 mg/L thereafter, was started. On the 22nd treatment day, a high leukocyte count and cloudy effluent were still present. We therefore performed an EB procedure with no complications. The patient’s condition improved, and, 5 days later, the dialysate WBC count decreased to 100/mL without the need for catheter removal (Figure 1). No peritonitis episode has been observed in the subsequent 9 months.

**Discussion**
Recurrent and persistent peritonitis episodes are the most common cause of PD catheter removal and discontinuation of therapy in PD patients (2). The causes of recurrent and persistent peritonitis are often regarded as being catheter-related—that is, the catheter constitutes a focus for the infection (6). Biofilm is believed to play a key role. It has been suggested that the catheter surface biofilm is associated with reduced effectiveness of antibiotics or development of antibiotic resistance.

Endoluminal brushing is being used with increasing frequency in various therapeutic modalities, such as management of blocked HD or PD indwelling catheters, *in situ* diagnosis and treatment of catheter-related infections, and procurement of cytology samples (3–5,7). Kumwenda et al. (8) reported effective application of a channel-cleaning brush to treat malfunctioning Tenckhoff catheters in PD patients. Figueiredo et al. (4) performed EB in a 2-month-old child who had an acute episode of peritonitis and who consecutively developed peritoneal catheter occlusion owing to fibrin clot. The child remained clinically well, and the peritonitis slowly resolved.

In the present report, we describe an alternative approach in the treatment of recurrent or persistent peritonitis episodes in PD patients. To our knowledge, ours is the first application of EB technique in pediatric PD patients with persistent peritonitis. We performed EB on 4 occasions in 3 children with persistent peritonitis. The lack of prompt transplantation and the unwillingness on the part of the parents to transfer their children to HD forced us to perform EB in those particular patients. We thought that the persistent peritonitis episodes might be caused by the presence on the catheter internal surface of a biofilm sheath. We therefore postulated that the use of a channel-cleaning brush could be an option in the management of the infection and could eliminate the need for catheter removal by sweeping the biofilm sheath. Indeed, remission was achieved in 2 of the 3 patients. Using the brush technique, removal of 2 catheters was prevented. The patients experienced no adverse effects such as abdominal bleeding or irritation.

**Conclusion**
Endoluminal brushing can be considered in patients with recurrent or persistent peritonitis episodes attributed to endoluminal colonization or biofilm sheath, and the technique should be performed in selected cases before catheter removal. However, the procedure requires further evaluation in a larger study.

**References**
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