Comparison of Continuous Ambulatory Peritoneal Dialysis-Related Infections With Different “Y-Tubing” Exchange Systems

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ABSTRACT
Despite several modifications of the continuous ambulatory peritoneal dialysis (CAPD) technique over the last decade, peritonitis remains a major source of morbidity and is the leading cause of dropout for patients maintained on CAPD therapy. Recently, Baxter Healthcare introduced the Ultra Twin bag system, which uses drainage and infusion bags both secured to Y connecting tubing. Previous nonrandomized studies comparing the Ultra Twin bag system with other systems have indicated an improvement in the peritonitis rate with the Ultra Twin bag system. In this study, 82 patients were randomized to use the Ultra Twin bag system or the Ultra Y-set system, which uses only the drainage bag already attached to the Y connecting tubing. Peritonitis rates were significantly lower with the Ultra Twin bag system, one episode per 33.9 patient months, compared with the Ultra Y-set system, one episode per 11.7 patient months (P < 0.05). Furthermore, the 1-yr infection-free survival rates with the Ultra Twin bag system and the Ultra Y-set system were 71 and 40%, respectively. Exit-site infections were lower with the Ultra Twin bag system, one episode per 12.5 patient months, compared with the Ultra Y-set system, one episode per 28.3 patient months, although this difference was not statistically significant (P = 0.084). The effect of the reduction in the infection rate on patient dropout with the Ultra Twin bag system remains to be addressed.

Key Words: Peritonitis, exit site infection, continuous ambulatory peritoneal dialysis, Ultra Twin bag, Ultra Y-set

Continuous ambulatory peritoneal dialysis (CAPD) is a generally accepted therapy for patients with ESRD, with over 75,000 patients receiving this therapy worldwide. Peritonitis remains a major source of morbidity for patients treated with CAPD and is the leading cause of patient dropout from CAPD and transfer to hemodialysis (1). The technology of CAPD therapy has been modified over the past several years in an attempt to reduce peritonitis rates. Recently, Baxter Healthcare introduced a new technique, the Ultra Twin Bag system (Integrated Disconnect System), which has been reported to reduce peritonitis rates in uncontrolled, nonrandomized patient studies (2-7). This study was designed to prospectively examine, in a controlled fashion, the infection rates in CAPD patients randomly assigned to treatment with Ultra Y-set or Ultra Twin bag systems (Baxter Healthcare, Round Lake, IL).

METHODS
Between June 1993 and January 1994, 185 patients were cared for in the CAPD unit in New Haven, CT, and 35 new patients were trained for CAPD. All CAPD training took place in an outpatient setting as previously described (8; see Ref. 12). All patients had a double-cuff silastic Tenckhoff catheter inserted by standard surgical techniques (8).

Eighty-two CAPD patients were asked to participate in this study. All of the 35 new patients agreed to participate, and 37 of the 47 established patients agreed to participate. The established patients were all using the Ultra Y-set system. After informed consent was obtained, each patient was stratified by race and then randomly assigned to the Ultra Y-set system (Group I, N = 41) or the Ultra Twin Bag system (Group II, N = 41). Stratification by race was done because differences in peritonitis rates have been reported between African-Americans and whites (9). After assignment to a particular group, the patient, the primary nurse, and the physician were made aware of the decision, with appropriate training undertaken in the outpatient CAPD unit.

The original design of the study was to enroll 50 patients in Group I and 50 patients in Group II (25 patients in each group being new patients and 25 being established CAPD patients) and to complete 12 months of follow-up for each patient enrolled in the study. We felt that preliminary results should be examined after the completion of a total of 300 patient months of CAPD therapy. If the difference in infection rates between Groups I and II was statistically significant at this time, the study would be terminated. This indeed occurred, and this article presents the analysis of our data.

The technique for using the Ultra Y-set system has been previously described (10,11). Briefly, the patient makes a luer lock connection between the catheter and the Y-set and spikes a new bag of dialysate. The patient first flushes the system, opens the dialysate effluent to drain, and then fills
the peritoneal cavity with the dialysis solution. The Ultra Twin Bag system is an entirely closed system that has been described previously (2). The patient makes a luer lock connection between the Tenckhoff catheter and the Ultra Twin Bag system. The new bag of dialysis solution is already attached to the Y-set, eliminating the spiking procedure. The patient flushes the system after breaking color-coded frangible seals, drains the dialysate effluent, and then fills the peritoneal cavity with the dialysis solution.

Parameters examined during the study period included basic demographic data (race, gender, age, primary renal diagnosis, the presence of diabetes mellitus, HIV seropositivity) and various outcome measures (inpatient hospital days, episodes of peritonitis and exit-site infection, and the mean serum albumin concentration). The mean serum albumin concentration was calculated by averaging three random serum albumin concentrations obtained during the study period. The records of the established patients were reviewed retrospectively for the number of episodes of peritonitis and exit-site infections occurring in the 6 months before enrollment in the study.

Peritonitis was defined by the presence of a cloudy dialysate with more than 100 white blood cells/mm³ and a white blood cell differential count of more than 50% polymorphonuclear cells as previously described (12). An exit-site infection was defined as pericatheter erythema, tenderness, and drainage (purulent or nonpurulent) (12).

Peritonitis and exit-site infection rates were calculated by dividing the total number of infections in all patients by the total months of patient CAPD therapy. Hospital days were not included in the total months of patient CAPD therapy.

Peritonitis and exit-site infection rates were compared with a mixed-effects Poisson model for peritonitis and a fixed-effects Poisson model for exit-site infections (13,14). In terms of peritonitis, the mixed-effects model assumes that the rate of peritonitis varies from patient to patient. Under the mixed-effects Poisson model, the average rate of peritonitis among patients is computed and compared between both groups. The fixed-effects model was applied to the exit-site infection data, assuming that the infection rates between patients within the same group are similar, an assumption that is not unreasonable for a single-center study.

RESULTS

Eighty-two patients were enrolled in the study between June 1993 and January 1994. Of the patients enrolled, 37 were white and 45 were African-Americans. There were 39 men and 43 women. The mean age ± SD was 54.7 ± 14.5 yr, with a range of 23 to 80 yr.

Table 1 compares the demographic data of the two groups of patients. Mean age, race, and cause of ESRD were similar between the two groups. There were 10 diabetics in Group I and 15 diabetics in Group II; 4 patients were positive for HIV in both groups. The mean ± SD serum albumin was 3.3 ± 0.4 and 3.4 ± 0.4 in Groups I and II, respectively (P = not significant).

Of the 82 patients enrolled in the study, 15 did not complete the study: 11 patients in Group I and 4 in Group II. The reasons for failure to complete the study in Group I included transfer to hemodialysis in five patients, renal transplant in three, transfer to a CAPD unit in another state in one, transfer to continuous cycling peritoneal dialysis (CCPD) in one, and death in one. The patients who transferred to hemodialysis did so because of loss of the peritoneal membrane in one patient after an episode of peritonitis and psychosocial reasons in four. The patient who died electively terminated CAPD therapy. The reasons for failure to complete the study in Group II included renal transplant in one, problems with drainage in two, and recovery of renal function in one.

There was a statistically significant difference observed in the peritonitis rates between Groups I and II. Group I had a peritonitis rate of one episode per 11.7 patient months, whereas Group II had a rate of one episode per 33.9 patient months (P < 0.05).

Figure 1 shows the estimated infection-free survival curves for the two groups. The 1-yr infection-free survival rate is estimated to be 40% for Group I and 71% for Group II.

The organisms involved in the episodes of peritonitis occurring in the two groups of patients were noted. Group I patients had 15 episodes of peritonitis, and Group II had 5 episodes. Group I had peritonitis caused by Staphylococcus aureus in four, Staphylococcus epidermidis in three, Streptococcus species in two, Pseudomonas species in one, and Serratia species in 1; there was no growth in four episodes. Group II patients had peritonitis caused by S. aureus in two, and Escherichia coli in one; there was no growth in two.

There were 20 exit-site infections during the study
period—14 in Group I and 6 in Group II. Exit-site infection rates were one in 12.5 patient months in Group I and one in 28.3 patient months in Group II. These differences did not reach statistical significance ($P = 0.084$). The organisms causing the 14 episodes of exit-site infection in Group I were *S. aureus* in five, *Pseudomonas* species in four, *Streptococcus* species in one, Enterobacter species in one, *Serratia* species in one, *Proteus* species in one, and *Klebsiella* species in one (some patients had polymicrobial exit-site infections). The organisms involved in the six exit-site infections in Group II were *S. aureus* in five and *Pseudomonas* species in one. Of the 14 exit-site infections in Group I, 3 were followed by an episode of peritonitis involving the same organism (*Serratia* species in 1, *S. aureus* in 2). In Group II, two exit-site infections were followed by an episode of peritonitis involving the same organism (*S. aureus* in two).

In the retrospective review of the records of the established patients, peritonitis and exit-site rates were compared in the 12 months before patient enrollment in the study. The rates of peritonitis and exit-site infection were similar in the two groups before randomization. The rate of peritonitis in the Group I patients was one episode per 14.6 patient months, and the exit-site rate was one episode per 24 patient months. The rate of peritonitis in the Group II patients was one episode per 18.3 patient months, and the exit-site rate was one episode per 22 patient months.

**DISCUSSION**

Peritonitis remains a major cause of morbidity for CAPD patients. Considerable attention has been devoted to the modification of CAPD techniques to reduce peritonitis rates. For example, the concepts of the "Y-set" designed by Buocristiani et al., as well as the "double bag" and "flush before fill" techniques designed by Bazzato et al., have all been reported to decrease peritonitis rates (10,11,15).

Recently, Baxter Healthcare has introduced the Ultra Twin Bag system (Integrated Disconnect System) (2). This system is similar in all aspects to the Ultra Y-set, with the exception of the elimination of the spiking procedure. Uncontrolled, nonrandomized studies with this system have claimed that peritonitis rates have been reduced to between one episode per 27.3 patient months and one episode per 67.3 patient months (3,7). Honkanen et al., comparing a single-bag system with the Ultra Twin bag system, noted a reduction in their peritonitis rate from one episode per 11.3 patient months to one episode per 27.3 patient months, respectively (3). Similarly, Dratwa et al. noted a reduction in their peritonitis rates from one episode per 10.4 patient months with the Ultra Y-set system to one episode per 29.4 patient months with the Ultra Twin bag system (6).

This study is the first prospective, controlled study in which patients were randomly assigned to the Ultra Y-set or the Ultra Twin bag systems. The results indicate a significant reduction in the peritonitis rate with the Ultra Twin bag system while peritonitis rates of one episode per 33.9 patient months with the Ultra Twin bag and one episode per 11.7 patient months with the Ultra Y-set ($P < 0.05$). Furthermore, the 1-yr probability of remaining infection free was 70% with the Ultra Twin bag system and 30% with the Ultra Y-set system. It is noteworthy that the mean observation period was only 4 months in each group of patients. Preliminary analysis after 300 patient months of CAPD therapy indicated a significantly decreased peritonitis rate in patients using the Ultra Twin bag system. Therefore, the study was terminated and the patients using the Ultra Y-set system were converted to the Ultra Twin bag system.

The cause of the improved peritonitis rate with the Ultra Twin bag system remains uncertain. It is noteworthy that the patient profiles in both groups were similar with regard to age, race, presence of diabetes, HIV seropositivity, and mean serum albumin concentration. This suggests that the patient demographics did not influence the outcome of the peritonitis rates noted in this study. A reduction in the number of episodes of peritonitis may well reflect the lack of touch contamination that occurs during the spiking procedure required with the Ultra Y-set system. In fact, there were four episodes of peritonitis with *S. aureus* and three episodes with *S. epidermidis* in patients using the Ultra Y-set system and two episodes with *S. aureus* and none with *S. epidermidis* in the patients using the Ultra Twin bag system. The necessity of spiking a new bag of dialysate with the Ultra Y-set system may predispose patients to exit-site infections. There were twice as many exit-site infections noted in patients using the Ultra Y-set system compared with the Ultra Twin bag system, although this difference was not statistically significant. Perhaps the greater number of exit-site infection in the Ultra Y-set group of patients increased the risk for development of peritonitis. In fact, five of the episodes of peritonitis were preceded by an exit-site infection involving the same offending organism.

We conclude that CAPD therapy with the Ultra Twin bag system results in a significantly lower incidence of peritonitis than with the Ultra Y-set system. The effect of the reduced peritonitis rates on patient dropout remains to be determined.

**REFERENCES**

4. Dasgupta MK, Fox S, Gagnon D, Bettcher K, Ulan RA: Significant reduction of peritonitis rate by the use of