

## Clinical Outcomes in Peritoneal Dialysis: Impact of Continuous Quality Improvement Initiatives

Mohammad Qamar, Heena Sheth, Filitsa H. Bender, Beth Piraino

*The Kidney Disease Outcomes Quality Initiative guidelines for peritoneal dialysis (PD) emphasize the need for quality improvement interventions to improve outcomes in PD. Here, we report 17 years' experience of initiatives focused on lowering peritonitis rates in a single PD program. This institutional review board–approved retrospective analysis used a PD registry containing prospectively collected data on patient demographics, initial Charlson comorbidity index (CCI), peritonitis, and clinical outcomes, including reasons for transfer to hemodialysis. Periods were analyzed based on quality initiatives: 1990 – 1991, baseline; 1992 – 1995, randomized controlled trial of exit-site infection prophylaxis comparing mupirocin cream applied daily to the exit site with oral cyclical (every 12 weeks) rifampin; 1996 – 1999, compact assist device introduced for spiking on the cycler; 2000 – 2004, randomized controlled trial comparing daily gentamicin cream with mupirocin as exit-site prophylaxis; and 2005 – 2007, gentamicin prophylaxis implemented as routine care (2005) and retraining of all patients (2006). Infection rates and technique failure rates in each period were compared with baseline rates using incident rate ratio analysis. A total of 382 PD patients were evaluated [median age: 50 years (range: 18 – 90 years); 54% women; 19% African American; 36% with diabetes; median CCI: 5 (range: 2 – 14)]. The peritonitis rate declined from 0.5 episodes per year at risk in 1990 – 1991 to 0.25 episodes per year at risk in 2005 – 2007 ( $p < 0.004$ ). The exit-site infection rate declined from 0.72 episodes per year at risk to 0.1 episodes per year at risk over the same period ( $p < 0.0001$ ). The*

*percentage of patients transferring to hemodialysis did not change significantly over time (overall 14%, varying from 12% to 17% annually), nor did the mortality rate, which varied from 115 per 1000 years to 171 per 1000 years. We conclude that quality improvement initiatives can reduce infection rates in PD patients.*

### Key words

Quality improvement, peritonitis, exit-site infection, hemodialysis transfers, technique failure, mortality

### Introduction

Peritoneal dialysis (PD)–related infection continues to be a serious complication for PD patients and the leading cause of technique failure resulting in transfer to hemodialysis (HD). Since the end of the 1980s, there has been great interest in studying the causes of peritonitis and exit-site infection and the strategies that can help to reduce rates of infection. The latest recommendations of the International Society for Peritoneal Dialysis for the management of peritonitis and exit-site infection were published in 2005 (1). Protocols to reduce the infection risk in PD patients include, but are not limited to, periodic retraining of patients, antibiotic prophylaxis to prevent exit-site infection, and use of a compact assist device to prevent contamination at the time of bag–catheter connection (1–6). The PD guidelines from the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (KDOQI) emphasize quality improvement interventions to improve outcomes in PD.

Our center has had an institutional review board–approved PD registry with prospective data collection since 1982; it has also collected initial comorbidity and serum albumin information since 1990. This information has allowed for an evaluation of the impact of multiple evidence-based quality improvement initiatives instituted over time. The main aim of the

From: The Renal Electrolyte Division, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, U.S.A.

present study was to analyze the effect of various interventions on PD-related infections and technique failure over time.

### Patients and methods

The patients included in the study were cared for at a single not-for-profit dialysis center and were followed by physicians affiliated with the University of Pittsburgh Medical Center. The present report includes all PD patients between January 1, 1990, and June 2007 identified from the PD registry. At the start of dialysis, patients were asked to sign an institutional review board–approved consent to participate in the PD registry. More than 99% of patients agreed to participate. This study retrospectively analyzes the prospectively collected data on demographics, initial Charlson comorbidity index (CCI), exit-site infections, peritonitis episodes, clinical outcomes, and reasons for transferring to HD. The infection rates were tracked monthly by the PD team.

The quality improvement process in the program consists of monthly meetings of the administrator, nurse manager of the home program, social worker, dietician, home dialysis nurses, and generally, the two physicians who followed most of the PD patients. Our research nurse also participates. At each monthly meeting, episodes of peritonitis are reviewed, and root-cause analysis is performed. Rates of peritonitis and exit-site infection are reviewed. An action plan is developed by the team as needed.

We used the period from 1990 to 1991 as the baseline. During period II, from 1992 to 1996, a randomized controlled trial of prophylaxis comparing mupirocin cream applied to the exit-site daily with oral cyclical (every 12 weeks) rifampin was conducted (5). During period III, 1996 – 1999, the compact assist device for spiking on the cyclor was introduced. In period IV, 2000 – 2004, a randomized controlled trial comparing daily exit-site gentamicin cream with mupirocin was conducted (2). During period V, 2005 – 2007, gentamicin prophylaxis became the standard of care for all patients. In addition, in 2006, retraining of patients after prolonged hospitalization or peritonitis was implemented.

Demographic characteristics, initial CCI, and serum albumin are reported using descriptive statistics. For each period, the rate of infection is reported as the number of infections per dialysis years at risk. Technique failure is reported as the percentage of

patients transferring to HD during each period and also as the rate of transfer per years at risk within the period. We compared infections, transfers, and mortality for each period with the baseline data. Frequencies were compared using the chi-square test, and rates for exit-site infection, peritonitis, and transfer to HD are compared using incident rate ratio analysis (Stata: Cytel Software Corporation, Cambridge, MA, U.S.A.).

### Results

The study evaluated 382 PD patients. Table I shows the patient characteristics. Overall mortality was 134 per 1000 years. The technique failure rate, defined as the number of patients transferring to HD over the entire period of the study, was 14%.

Table II and Figure 1 show the peritonitis and exit-site infection rates. At baseline, the peritonitis rate was 0.50 episodes per year at risk, and the exit-site infection rate was 0.72 episodes per year at risk. Over time, both infection rates declined compared with baseline. The peritonitis rates in periods IV and V were significantly lower than those in the first three periods ( $p < 0.0004$ ). The exit-site infection rate in all periods was significantly less than it was at baseline in period I ( $p < 0.0001$ ).

Table III shows the percentage of patients transferring to HD and the HD transfer rate. These figures

TABLE I Patient characteristics

Patients ( <i>n</i> )	382
Median age [years (range)]	50 (18–90)
Women [ <i>n</i> (%)]	206 (54)
African American [ <i>n</i> (%)]	73 (19)
With diabetes [ <i>n</i> (%)]	138 (36)
Median CCI score (range)	5 (2–14)

CCI = Charlson comorbidity index.

TABLE II Infections per period

Period	Rate (episodes/year)	
	Peritonitis	ESI
I 1990–1991	0.505	0.72
II 1992–1995	0.43	0.56 <sup>b</sup>
III 1996–1999	0.45	0.37 <sup>b</sup>
IV 2000–2004	0.24 <sup>a</sup>	0.42 <sup>b</sup>
V 2005–2007	0.25 <sup>a</sup>	0.10 <sup>b</sup>

<sup>a</sup>  $p < 0.0004$  (periods IV and V compared with I, II, III).

<sup>b</sup>  $p < 0.0001$  (periods II, III, IV, and V compared with I).

ESI = exit-site infection.

did not vary significantly over time. Transfers to HD were 17% (0.26 transfers per year at risk) at baseline and 13% (0.20 transfers per year at risk) during the last study period, but this decline was not significant. The mortality rate was 168 per 1000 years at baseline and 122 per 1000 years in the last study period (range: 115 – 171 per 1000 years,  $p =$  nonsignificant).

## Discussion

Peritonitis and exit-site infections contribute greatly to overall morbidity and mortality in PD patients. Quality improvement initiatives in PD, using a multifaceted approach, are increasingly being recognized as the benchmark for success (7). Since the early 1990s, many clinical studies have focused on the impact of various antibiotic prophylaxis regimens in reducing PD infection rates (6,8,9). Over the years, our program

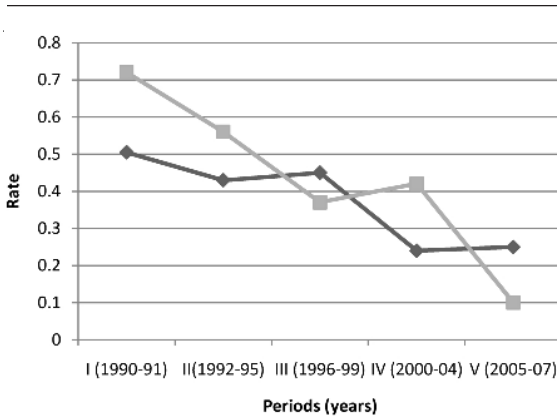


FIGURE 1 Rates of exit site infection (gray closed squares;  $p < 0.0001$ , periods II, III, IV, and V as compared with I) and peritonitis (black closed diamonds;  $p < 0.0004$ , periods IV and V as compared with I, II, III), as episodes per year at risk, for each quality improvement period.

TABLE III Transfer to hemodialysis as a percentage of all patients during the period

Period	Transfers to HD (%)			TOTAL [% (rate <sup>a</sup> )]
	Uremia	Infection	Other reasons	
I	2.2	1.5	13.3	17 (0.26)
II	3.5	2.7	6.9	12 (0.20)
III	4.8	2.6	9.6	17 (0.28)
IV	1.8	3.4	7.0	12.2 (0.18)
V	0.5	3.1	9.4	13 (0.20)

<sup>a</sup> Transfers per year at risk.

has refined the use of prophylactic antibiotic creams. Similarly, the spiking of dialysis bags is a procedure with a high risk for contamination of the system (10,11). We introduced the use of an automated spiking device into our program as part of an initiative in 1996, with favorable results. The final major initiative reported in the present study is patient retraining, which has been shown in a recent study to be an effective tool for reducing PD infections (12). All initiatives fall under the umbrella of continuous quality improvement (CQI) and have had a positive effect in reducing rates of peritonitis and exit-site infection, as shown here. The baseline peritonitis rate was reduced by about half ( $p < 0.0004$ ). The exit-site care protocol has had an even more pronounced effect on exit-site infection rates, which declined from 0.72 to 0.1 episodes per year at risk ( $p < 0.0001$ ).

The KDOQI emphasizes the need for CQI in PD and recommends the tracking of rates of peritonitis, exit-site infection, and technique failure (13). In many programs, peritonitis remains an important problem, leading to technique failure, mortality, hospitalization, and health care costs. In our single-center study, we did not find an effect of the decline in PD-related infections on technique failure or mortality, but this negative finding may be a result of the foregoing reasons being minor ones for transfer to HD in our program. This question needs to be further evaluated in a larger multicenter study.

## Conclusions

It is possible for a center to significantly lower PD-related infection rates with quality improvement initiatives. This work requires a process of data collection and repeated feedback to the PD team so that interventions can be implemented.

## Acknowledgments

The authors acknowledge the other members of the PD team, including James R. Johnston, MD; Carol Dacko, RN; Mary Bird, RN; Marge Miller, RN; Bonnie Carnes, RN (former Dialysis Unit Administrator); Iris Hayes, MSW; Heather Lash, RD; Sue Stark, RD; and Judith Bernardini, RN.

## References

- 1 Piraino B, Bailie GR, Bernardini J, *et al.* Peritoneal dialysis-related infections recommendations: 2005 update. *Perit Dial Int* 2005;25:107–31.

- 2 Bernardini J, Bender F, Florio T, *et al.* Randomized, double-blind trial of antibiotic exit site cream for prevention of exit site infection in peritoneal dialysis patients. *J Am Soc Nephrol* 2005;16:539–45.
- 3 Cavdar C, Saglam F, Sifil A, *et al.* Effect of once-a-week vs thrice-a-week application of mupirocin on methicillin and mupirocin resistance in peritoneal dialysis patients: three years of experience. *Ren Fail* 2008;30:417–22.
- 4 Russo R, Manili L, Tiraboschi G, *et al.* Patient re-training in peritoneal dialysis: why and when it is needed. *Kidney Int Suppl* 2006;(103):S127–32.
- 5 Bernardini J, Piraino B, Holley J, Johnston JR, Lutes R. A randomized trial of *Staphylococcus aureus* prophylaxis in peritoneal dialysis patients: mupirocin calcium ointment 2% applied to the exit site versus cyclic oral rifampin. *Am J Kidney Dis* 1996;27:695–700.
- 6 Tacconelli E, Carmeli Y, Aizer A, Ferreira G, Foreman MG, D'Agata EM. Mupirocin prophylaxis to prevent *Staphylococcus aureus* infection in patients undergoing dialysis: a meta-analysis. *Clin Infect Dis* 2003;37:1629–38.
- 7 Borg D, Shetty A, Williams D, Faber MD. Fivefold reduction in peritonitis using a multifaceted continuous quality initiative program. *Adv Perit Dial* 2003;19:202–5.
- 8 Zimmerman SW, Ahrens E, Johnson CA, *et al.* Randomized controlled trial of prophylactic rifampin for peritoneal dialysis-related infections. *Am J Kidney Dis* 1991;18:225–31.
- 9 Wong SSH, Chu KH, Cheuk A, *et al.* Prophylaxis against gram-positive organisms causing exit-site infection and peritonitis in continuous ambulatory peritoneal dialysis patients by applying mupirocin ointment at the catheter exit site. *Perit Dial Int* 2003;23(Suppl 2):S153–8.
- 10 Strauss FG, Holmes DL, Dennis RL, Nortman DF. Pre-spiking dialysate bags: improved peritonitis prevention in patients on CAPD. *Adv Perit Dial* 1991;7:193–5.
- 11 Piraino B. New insights on preventing and managing peritonitis. *Pediatr Nephrol* 2004;19:125–7.
- 12 Hall G, Bogan A, Dreis S, *et al.* New directions in peritoneal dialysis patient training. *Nephrol Nurs J* 2004;31:149–54,159–63.
- 13 National Kidney Foundation (NKF). The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF KDOQI) [Web resource]. New York: NKF; 2009. [Available at: [www.kidney.org/professionals/KDOQI/](http://www.kidney.org/professionals/KDOQI/); accessed: June 9, 2009]

*Corresponding author:*

Beth Piraino, MD, 3504 Fifth Avenue, Suite 200, Pittsburgh, Pennsylvania 15213 U.S.A.

*E-mail:*

Piraino@pitt.edu