

## IMPACT OF CONTINUOUS QUALITY IMPROVEMENT INITIATIVES ON CLINICAL OUTCOMES IN PERITONEAL DIALYSIS

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◆ **Objective:** We evaluated the role of a quality improvement initiative in improving clinical outcomes in peritoneal dialysis (PD).

◆ **Methods:** In a retrospective analysis of 6 years of data from a hospital registry, the period between 1 July 2005 and 30 June 2008 (control group) provided baseline data from before implementation of systemic outcomes monitoring, and the period between 1 July 2008 and 30 June 2011 [continuous quality improvement (CQI) group] represented the time when a CQI program was in place. Peritonitis incidence, patient and technique survival, cardiovascular status, causes of death, and drop-out were compared between the groups.

◆ **Results:** In the 370 patients of the CQI group and the 249 patients of the control group, the predominant underlying kidney diseases were chronic glomerulonephritis and diabetic nephropathy. After implementation of the CQI initiative, the peritonitis rate declined to 1 episode in 77.25 patient-months from 1 episode in 22.86 patient-months. Ultrasound parameters of cardiac structure were generally unchanged in the CQI group, but significant increases in cardiothoracic ratio and interventricular septal thickness were observed in the control group (both  $p < 0.05$ ). Patient survival at 1, 2, and 3 years was significantly higher in the CQI group (97.3%, 96.3%, and 96.3% respectively) than in the control group (92.6%, 82.4%, and 67.3% respectively,  $p < 0.001$ ). Implementation of the CQI initiative also appeared to significantly improve technique survival rates: 95.6%, 92.6%, and 92.6% in the CQI group compared with 89.6%, 79.2%, and 76.8% in the control group ( $p < 0.001$ ) after 1, 2, and 3 years respectively.

◆ **Conclusion:** Integration of a CQI process into a PD program can significantly improve the quality of therapy and its outcomes.

KEY WORDS: Continuous quality improvement; outcomes.

Clinical studies have shown that mortality and technique survival rates in peritoneal dialysis (PD) are closely associated with the implementation of quality monitoring initiatives (1,2) and with the size and experience of the PD center (3). Adopting quality standards for PD is a key factor in improving outcomes in both developed and developing parts of the world. To enhance the quality of care, the International Society for Peritoneal Dialysis has developed a number of guidelines for managing PD. However, there is a lack of guidance on how to implement such models.

In recent years, the number of PD centers and the number of PD patients have both increased rapidly in China's Jiangsu Province as a consequence of the recommendations of the Chinese Medical Administrative Command, a provincial bureau responsible for medical insurance. That entity has reimbursed PD and hemodialysis (HD) equally since 2010. We established a PD program with a dedicated PD team in 2008, and since then, we have implemented guidelines and new procedures. The number of PD patients grew to 510 in 2011 from 50 in 2005 likely because of those two factors. In parallel, a number of key performance indicators such as the peritonitis incidence reached or exceeded internationally accepted levels. Here, we describe the effects on mortality and morbidity in PD of introducing a continuous quality improvement (CQI) program.

### METHODS

#### PATIENTS

Between July 2005 and June 2011, we inserted catheters for 624 PD patients (Figure 1). In the present study, we divided our 6 years of experience (2005 – 2011) into two time periods to compare the effects of a CQI program

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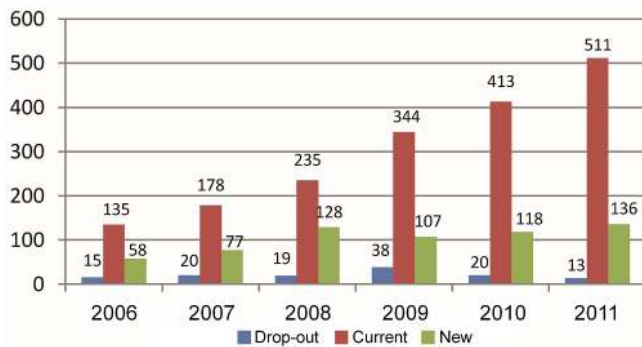


Figure 1 — Number of incident, prevalent, and drop-out patients at 30 June, by year.

on PD quality. The CQI group comprised PD patients who started PD between 1 July 2008 and 30 June 2011; the control group comprised patients initiating PD between 1 July 2005 and 30 June 2008—that is, before implementation of the CQI program. Patients who suffered acute kidney injury, who underwent HD or transplantation before PD, or who were not stabilized on PD within 3 months after initiation were excluded. Thus, 619 patients (18–75 years of age at start of PD) were included in the present study.

#### PD MANAGEMENT IN THE PRE-CQI PERIOD

Before July 2008, we did not have a dedicated PD team, and thus PD patients were usually managed by whichever nephrologist they met at the outpatient clinic. Follow-up was irregular, and patient records or data were incomplete. No comprehensive training program led by a PD nurse was available.

#### PD MANAGEMENT DURING THE CQI PROGRAM

In this period, the PD program was managed by a dedicated team. Three PD physicians were responsible for catheter insertion, follow-up, data analysis, and CQI, and four nurses were responsible for patient education (one nurse), follow-up and data collection (two nurses), and CQI (one nurse). All members of the team worked together in the clinic and at the ward. All data—such as those concerning dialysis adequacy, nutrition status, glomerular filtration rate, cardiac function, and so on—were collected and recorded in a PD database at our hospital.

The CQI program had 3 phases:

- The first phase included identification of the outcome parameters on which to focus, implementation of targets for those parameters, a comparison of center data with those targets, identification of the likely

causes of any differences, and development of an intervention strategy.

- The second phase of the program verified the feasibility of the proposed procedural changes. After the modifications had been implemented, data were collected and compared with the new targets.
- In the final phase, the robustness of the outcomes was ensured by continuation of the monitoring.

The PD team held monthly meetings to discuss and review each phase in the CQI process. This approach helped to identify and resolve procedural issues, and to maintain engagement in and motivation for the CQI program.

#### TWO EXAMPLES OF KEY PERFORMANCE INDICATOR TARGETS

Between 2005 and 2007, the most common causes of death and PD drop-out were cardio- and cerebrovascular diseases and peritonitis. Cardio- or cerebrovascular disease accounted for 60.9% of all deaths and 47.4% of all drop-outs. During the same period, the rate of peritonitis fluctuated at around 1 episode in 22 patient-months, and the percentage of patients with adequate blood pressure was low (47.4%). Because persistent high blood pressure is the most important risk factor for heart failure and cerebrovascular disease (4), we implemented a plan to achieve adequate blood pressure control ( $\leq 140/90$  mmHg) in 60% or more of the patients. In addition to prescribing hypertensive agents to treat hypertension, we provided 5 g spoons to all patients to encourage normal salt intake (5 g daily). Furosemide was also given in some patients.

At the start of this new initiative, we planned to achieve a peritonitis rate of 1 episode in 30 patient-months. The plan included an assessment, by telephone call or home visit, of risk factors for each patient—for example, failure to wear a mask, washing hands incorrectly, and so on. In most cases, the home environment was bad, the handwashing procedure was wrong, and some patients did not use a mask or wear clean clothes when performing bag exchanges. Our improvement strategy therefore focused on mandatory use of clean “PD clothes” for the exchanges. Our strategy was implemented using an education program and provision of free PD clothes every 3 months. Compliance with the changes was monitored by monthly telephone calls to each patient.

#### QUALITY EVALUATION

Mortality was defined as death related to the treatment being received. Death within 3 months of transfer to

HD was regarded as a PD-related death. Technique failure was defined as the need to transfer to HD permanently because of peritonitis, ultrafiltration failure, subcutaneous tunnel infection, or underdialysis.

#### STATISTICAL METHODS

Statistical analyses were performed using the Statistica software application (version 6.0: StatSoft, Tulsa, OK, USA). Quantitative data are presented as means with standard error, or as medians. Between-group differences were analyzed using chi-square tests. Kaplan–Meier analysis was used to calculate patient and technique survival rates according to the time of death or of last follow-up. Values of  $p < 0.05$  were considered statistically significant.

## RESULTS

### PATIENTS

There were no significant differences between the patient groups with respect to age or sex (Table 1). Chronic glomerulonephritis was the primary underlying kidney disease in both groups. The percentage of patients

with diabetic nephropathy was slightly higher in the control group than in the CQI group. Glomerulonephritis and diabetic nephropathy were both diagnosed clinically and not by renal biopsy.

### PERITONITIS RATE

In the first year after implementation of the CQI program, the peritonitis incidence had improved to 1 episode in 30.1 patient–months from 1 episode in 22.2 patient–months in the control group ( $p > 0.05$ , Figure 2). The incidences in years 2 and 3 were 1 episode in 71.1 and 77.3 patient–months in the CQI group and 1 episode in 22.6 and 22.9 patient–months in the control group ( $p < 0.01$  for the CQI group in both years).

### CARDIAC MORPHOLOGY

In the CQI group, no statistically significant change in cardiac morphology occurred during the 3-year monitoring period. However, in the control group, the cardiothoracic ratio ( $0.55 \pm 0.08$ ), interventricular septal thickness ( $11.07 \pm 1.66$  mm), and left ventricular wall thickness ( $10.79 \pm 1.47$  mm) were all significantly increased compared with values observed at the start of dialysis

TABLE 1  
Patients Characteristics at Baseline

Characteristic	CQI	Patient group Control	<i>p</i> Value
Patients ( <i>n</i> )	370	249	
Sex ( <i>n</i> men/women)	214/156	158/91	>0.05
Age at PD start			
Mean (years)	43.17±14.29	45.85±15.45	>0.05
16–30 Years [ <i>n</i> (%)]	63 (17.0)	40 (16.1)	>0.05
31–45 Years [ <i>n</i> (%)]	149 (40.3)	91 (36.6)	>0.05
46–60 Years [ <i>n</i> (%)]	101 (27.3)	71 (28.5)	>0.05
>60 Years [ <i>n</i> (%)]	57 (15.4)	47 (18.9)	>0.05
Primary disease [ <i>n</i> (%)]			
Chronic glomerulonephritis	273 (73.8)	159 (63.9)	<0.05
Diabetic nephropathy	34 (9.2)	37 (14.9)	<0.05
Lupus nephritis	20 (5.4)	16 (6.4)	>0.05
Hypertension	13 (3.5)	10 (4.0)	>0.05
Myeloma	2 (0.5)	2 (0.8)	>0.05
Others	24 (6.5)	19 (7.6)	>0.05
Duration of PD [ <i>n</i> (%)]			
3–12 Months	144 (38.9)	146 (58.6)	<0.05
13–24 Months	120 (32.4)	59 (23.7)	<0.05
25–36 Months	106 (28.7)	44 (17.7)	<0.05
Mean eGFR (mL/min)	8.7±4.6	7.94±4.2	<0.05

CQI = continuous quality improvement; eGFR = estimated glomerular filtration rate.

( $0.51 \pm 0.05$ ,  $10.25 \pm 1.38$  mm, and  $9.38 \pm 1.06$  mm respectively; all  $p < 0.05$ ).

PATIENT AND TECHNIQUE SURVIVAL RATES

Figures 3 and 4 show patient and technique survival rates. Patient survival in the CQI group at 1, 2, and 3 years was 97.3%, 96.3%, and 96.3% respectively, significantly higher ( $p < 0.001$ ) than in the control group (92.6%, 82.4%, and 67.3%). Technique survival at 1, 2, and 3 years was also significantly higher in the CQI group than in the control group: 95.6% versus 89.6%, 92.6% versus 79.2%, and 92.6% versus 76.8% respectively ( $p < 0.001$ ).

Table 2 summarizes the causes of death and drop-out. The number of patients with fatal cardio- or cerebrovascular complications was significantly lower in the CQI group than in the control group ( $p < 0.001$ ). Cardio- or cerebrovascular complications accounted for 50% of deaths in the CQI group and for 60.9% of deaths in the control group.

Further analysis showed that cardio- and cerebrovascular complications accounted for 47.4% of technique failures in the CQI group and for 31% in the control group (Table 2) Peritonitis accounted for 10.5% of technique failures in the CQI group and for 17.2% in the control group. Those differences were not statistically significant.

DISCUSSION

Although PD has been used in China for more than 30 years, the rate of uptake for the technique lags far behind that of HD. The difference is related not only to financial factors and medical policy, but also to a lack of advancement in PD management.

Based on data provided by Baxter Healthcare, there were, at the end of March 2012, fewer than 30 PD centers

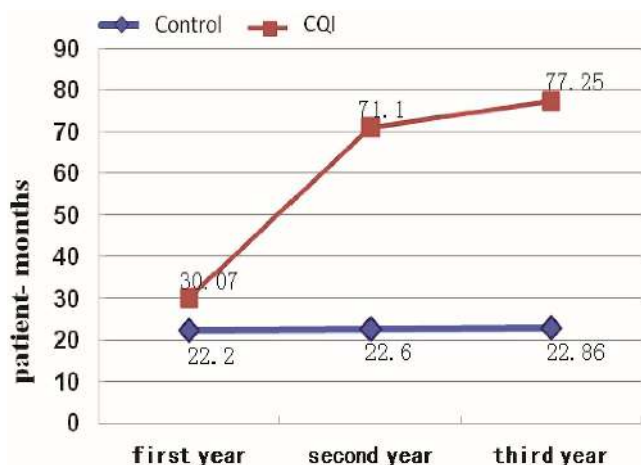


Figure 2 — Peritonitis rates, first three years, by study group.

in China managing more than 200 patients. Reports from 13 of the Chinese centers showed that 1-year patient and technique survival were about 82% and 88.7% respectively in 2007 (5). Data from our center during 2005 – 2007 (the control group) showed similar patient and technique survival rates, which were markedly lower than the rates achieved in Europe, Japan, Korea, and Hong Kong (1,6–8). It has been reported that patient and technique survival rates are higher in larger centers than in smaller centers and that the PD drop-out rate is negatively correlated with the size of the PD program (3,5).

A key impediment to the improvement of PD quality in our unit before 2008 was the lack of individually designed PD prescriptions, which affected patient compliance.

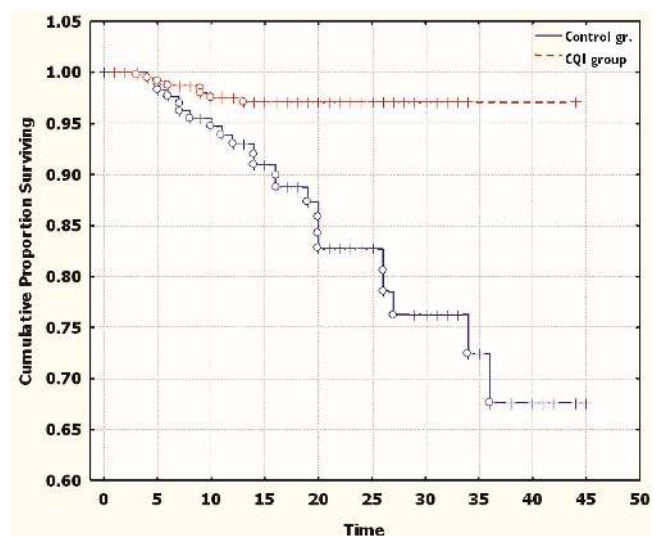


Figure 3 — Patient survival by the Kaplan–Meier method ( $p = 0.00146$ ). CQI = continuous quality improvement.

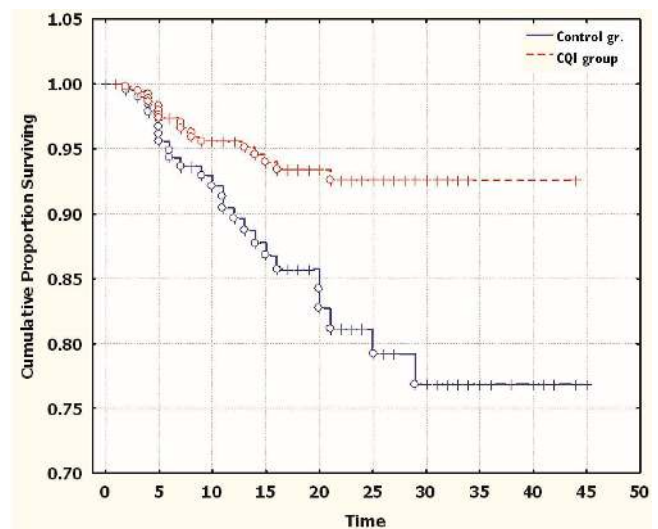


Figure 4 — Technique survival by the Kaplan–Meier method ( $p = 0.0014$ ). CQI = continuous quality improvement.

TABLE 2  
Causes of Death and Technique Failure in the Patient Groups

Outcome	Patient group				p Value
	CQI (n=370) (n)	(%)	Control (n=249) (n)	(%)	
Death	8	2.2	23	9.1	<0.001
Cardio- or cerebrovascular event	4	1.1	14	5.6	<0.001
Infection	0	0	4	1.6	<0.05
Malignant tumor	1	0.3	2	0.8	>0.05
Economic reason <sup>a</sup>	3	0.8	2	0.8	>0.05
Trauma	0	0	1	0.4	>0.05
Technique failure	71	19.2	54	21.7	>0.05
Cardiac dysfunction	9	2.4	9	3.6	>0.05
Peritonitis	2	0.5	5	2	>0.05
Ultrafiltration failure	5	1.4	8	3.2	>0.05
Leakage	2	0.5	1	0.4	>0.05
Catheter displacement	1	0.3	4	1.6	>0.05
Exit-site infection	0	0	1	0.4	>0.05
Tunnel infection	0	0	1	0.4	>0.05
Transplantation	52	14.1	25	10	>0.05

CQI = continuous quality improvement.

<sup>a</sup> Patients who withdrew from dialysis because of financial problems; most self-paid the dialysis costs.

Other problems included incoherence of care and training between the ward and the clinic, and lack of a PD quality evaluation system. Moreover, after the patient was discharged from hospital, health care was provided by a different physician, which further hampered the identification of problems and made implementation of an appropriate management plan more difficult.

To address those issues, we established a dedicated PD center in 2008. We used the CQI concept to improve the quality of PD provided to patients. The specific procedures we used were assembling a core team, assigning responsibilities to the team members, and monitoring their progress. To that end, we identified workflow issues, defined criteria for evaluation, and made every team member independently responsible for specific issues. We also established an evaluation system based on workload data and monthly group discussion of quality issues.

Our results indicate that drop-out from PD during the period 2005 – 2008 was most commonly a result of cardio- or cerebrovascular complications and peritonitis. Those two factors were also the leading causes of death. Further analysis of the data showed that drop-out was closely correlated with inadequate control of blood pressure and lack of guidance on dietary sodium intake. Those issues were addressed with training and retraining programs that also included standardization of sodium intake, prescription of loop diuretics and antihypertensive agents, and provision of clean “PD clothes” to all patients. Those

measures resulted in noticeable improvements in blood pressure control, cardiac pathology, and procedural key performance indicators. The most important outcome of our CQI program was that the rate of drop-out from PD was reduced to 16%, suggesting that optimized management can play a key role in improving the quality of PD. In parallel, the patient and technique survival rates increased markedly in response to CQI initiatives aimed at reducing cardio- and cerebrovascular complications and peritonitis. As Table 3 shows, our current patient and technique survival rates are comparable to those reported by advanced PD centers in other countries (9–16).

## SUMMARY

Implementing CQI at a PD center can optimize management procedures and significantly improve dialysis outcomes.

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## DISCLOSURES

The authors have no financial conflicts of interest to disclose.

TABLE 3  
Patient and Technique Survival in Various Countries

Reference	Country	Pts (n)	Age at PD start (mean or median years)	Diabetes (%)	Study period	Death-censored					
						Patient survival (%)			Technique survival (%)		
						Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Brown <i>et al.</i> , 2003 (17)	Europe	177	54	15	1999–2000	—	78	—	—	62	—
Chung <i>et al.</i> , 2005 (16)	Sweden	106	55.6	37	1994–2000	95	83	64	90	66	52
Han <i>et al.</i> , 2007 (12)	Korea	1656	48.9	27.8	1981–2005	93	—	82	95	—	84
Nakamoto <i>et al.</i> , 2007 (13)	Japan	139	49.6	41	1995–1999	—	—	—	94	86	79
Fang <i>et al.</i> , 2008 (15)	Canada	256	58.8	27.7	2000–2004	90	79	72	92	88	85
Li and Szeto, 2008 (11)	Hong Kong	328	57.6	38	2000–2004	—	91	—	—	82	—
USRDS, 2009 (14)	USA	—	—	—	1998–2002	82	66	53	—	—	—
Yang <i>et al.</i> , 2011 (10)	China	841	48.1	22.9	2006–2009	94	87	83	98	95	91
Present study	China										
CQI group		370	43.17	9.19	2008–2011	97	96	96	96	93	93
Control		249	45.85	14.86	2005–2008	93	82	67	90	79	77

Pts = patients; PD = peritoneal dialysis; USRDS = US Renal Data System; CQI = continuous quality improvement.

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