Peritoneal Dialysis International, Vol. 34, pp. 12–23
doi: 10.3747/pdi.2012.00190

0896-8608/14 $3.00 + .00

ORIGINAL ARTICLES

PATIENT EDUCATION AND CARE FOR PERITONEAL DIALYSIS CATHETER PLACEMENT: A QUALITY IMPROVEMENT STUDY

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♦ ***Background and Objectives:*** **Peritoneal dialysis catheter (PDC) complications are an important barrier to peritoneal dialysis (PD) utilization. Practice guidelines for PDC placement exist, but it is unknown if these recommendations are followed. We performed a quality improvement study to investigate this issue.**

♦ ***Methods:*** **A prospective observational study involving 46 new patients at a regional US PD center was performed in collaboration with a nephrology fellowship program. Patients completed a questionnaire derived from the International Society for Peritoneal Dialysis (ISPD) catheter guidelines and were followed for early complications.**

♦ ***Results:*** **Approximately 30% of patients reported not being evaluated for hernias, not being asked to visualize their exit site, or not receiving catheter location marking before placement. After insertion, 20% of patients reported not being given instructions for follow-up care, and 46% reported not being taught the warning signs of PDC infection. Directions to manage constipation (57%), immobilize the PDC (68%), or leave the dressing undisturbed (61%) after insertion were not consistently reported. Nearly 40% of patients reported that their PDC education was inadequate. In 41% of patients, a complication developed, with 30% of patients experiencing a catheter or exit-site problem, 11% developing infection, 13% needing PDC revision, and 11% requiring unplanned transfer to hemodialysis because of catheter-related problems.**

♦ ***Conclusions:*** **There were numerous deviations from the ISPD guidelines for PDC placement in the community. Patient satisfaction with education was suboptimal, and complications were frequent. Improving patient education and care coordination for PDC placement were identified as specific quality improvement needs.**

Perit Dial Int **2014; 34(1):12–23** **www.PDIConnect.com**
epub ahead of print: 01 Jul 2013 **doi:10.3747/pdi.2012.00190**

KEY WORDS: Complications; patient education; peritoneal dialysis catheter; practice guidelines; quality improvement.

Skilled peritoneal dialysis catheter (PDC) placement is vital to the success of any peritoneal dialysis (PD) program (1–9). The PDC is the lifeline for PD patients and an important target for quality improvement efforts (1–5,8,10–13). Malfunction of the PDC and related complications can lead to patient discomfort, infection, a need for revision, and technique failure (3,4,6,12–15). These events can be quite frustrating for patients and providers, increasing health care costs and potentially contributing to reduced utilization of PD (6,7,12,13,15–17). Although the technical competence of operators is vital, successful PDC placement involves more than just the insertion procedure; it relies on adherence to established protocols and care before, during, and after surgery (1,2,4–6,13,16,18–22). Expert bodies have established clinical practice guidelines providing specific recommendations for each step involved in PDC placement (1–5).

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Received 25 July 2012; accepted 23 November 2012

Although some evidence is inconclusive, strong consensus has developed about most components of PDC care (1–5,23). Evaluation for proper catheter and exit-site location and detection of hernias are recommended during the preoperative assessment (1–3,6,19,24). Screening for nasal carriage of methicillin-resistant *Staphylococcus aureus* and antibiotic prophylaxis during insertion are supported by evidence (1–5). Strict postoperative exit-site and bowel care are essential to prevent complications (1–5).

Despite the existence of best-practice guidelines, concerns have been raised that these recommendations are not followed by practitioners (11,12,21,22,25). Furthermore, deviation from recommendations may be an underappreciated contributor to PD technique failure (11,12,21,22).

Quality improvement for PDC placement may be challenging because of deficiencies in physician and nursing knowledge, lack of established protocols, and inconsistent practice patterns (10,12,21,22,26). In particular, the education and care patients receive related to PDC placement may be difficult to assess because of a lack of available metrics. Additionally, the domain of patient experience and perspective about their dialysis care is poorly studied, but has gained increasing recognition as a relevant and necessary measure of quality (10,27).

At a large regional PD center, we devised a quality improvement project in conjunction with a nephrology fellowship program to examine PDC placement in the community. We sought to determine the extent of PDC placement care from the patients' perspective and to measure early PDC complications. We gathered this data to identify targets for quality improvement and to provide systems-based education to nephrology fellows (28).

METHODS

This prospective observational study of PD patients was conducted at the Northwest Kidney Centers, a regional PD program serving the greater urban Seattle community and a mixed base of private and academic nephrologists. The study took place between January and December 2010 and was designed as a quality improvement study by University of Washington nephrology fellows under the guidance of the PD medical director and nursing leadership. Fellow participation was authorized by the fellowship training program director. The study protocol was approved by the Institutional Review Board of the University of Washington. All patients provided written informed consent.

STUDY POPULATION

All patients presenting for PD-related services were evaluated. Patients less than 18 years of age and those who were pregnant, who left PD before recruitment, or whose nephrologist declined participation in the study were not eligible for enrollment. Only English- or Spanish-speaking patients were eligible. The study population was divided into new and existing patients. "New patient" was defined as any incident PD patient or any patient transferring from hemodialysis (HD) or a failed transplant with a new PDC. Initiation of PD was defined as the first day that Medicare or private insurance was billed for treatment; new patients were typically enrolled within 30 days of that date. "Existing patient" was defined as any patient enrolled who had already been on PD for more than 30 days.

DATA COLLECTION

Based on the 2005 and 1998 catheter guidelines and the best practice recommendations published by the International Society for Peritoneal Dialysis (3,4,6), investigators and PD nurses developed a questionnaire about preoperative and postoperative PDC patient education and care (Table 1). The questionnaire was given to all patients after written consent had been obtained. Information on age, ethnicity, sex, history of previous dialysis, body mass index, comorbidities, and education level was obtained. Local concerns communicated to investigators during study design suggested that linking complications to specific providers would discourage study participation, and so explicit assurances were issued that no physician-specific data would be gathered.

Because of concerns about recall bias affecting the responses of patients less proximate to their PDC placement, the responses of existing patients were recorded for information purposes only. New PD patients who completed the questionnaire were followed prospectively for complications from study entry to 90 days after PD initiation, including the time period before PD training. The investigators and PD nurses met regularly to review study enrollment and data collection, and to adjudicate reported complications. Patients who failed to complete the questionnaire or for whom significant clinical data were missing were subsequently excluded.

STUDY ENDPOINTS

Questionnaire responses were grouped into two categories: preoperative PDC preparation and postoperative PDC care. Only "yes" and "no" responses were included in the study. Patients who answered "I don't

TABLE 1
Patient Questionnaire

1. Did a surgeon place your PD catheter?
2. Did you see your surgeon at his or her office before your PD catheter surgery?
3. Did your surgeon check you for a hernia before your PD catheter surgery?
4. Did your surgeon talk with you about where your PD catheter would come out of your abdomen after surgery?
5. Did your surgeon ask you where you usually wear your pants or belt on your waist?
6. Did anyone mark where your PD catheter would come out of your abdomen with a pen or stencil before surgery?
7. Were you told to take a shower or bathe with soap before your PD catheter surgery?
8. Were you told to clean out your bowel with stool softeners or an enema **before** your PD catheter surgery?
9. Did anyone put a cotton swab into your nostrils to check for bacteria **before** your PD catheter surgery?
10. Right **after** your PD catheter surgery, who were you told to contact to arrange care for your catheter and dressing?
11. Right **after** your PD catheter surgery, who were you told to call in case of a problem or emergency with your catheter or dressing?
12. Were you told to avoid taking a bath or getting your PD catheter wet after surgery?
13. Were you told to avoid letting your PD catheter move around after surgery?
14. Were you told to avoid changing the PD catheter dressing yourself after surgery?
15. Were you given instructions on how to treat and avoid constipation after surgery?
16. **Before your first visit with the PD nurse,** were you taught the warning signs of an infected PD catheter?
17. Did your surgeon place a stitch around your catheter at your exit site?
18. Did your surgeon see you in clinic to examine your PD catheter **before** you started PD training?
19. Did your nephrologist see you in clinic to examine your PD catheter **before** you started PD training?
20. When was your first visit with the PD nurse to have your catheter flushed or dressing changed?
21. Do you think you received enough teaching about your PD catheter **before** surgery?
22. Do you think you received enough teaching about care of your PD catheter **right after** surgery?

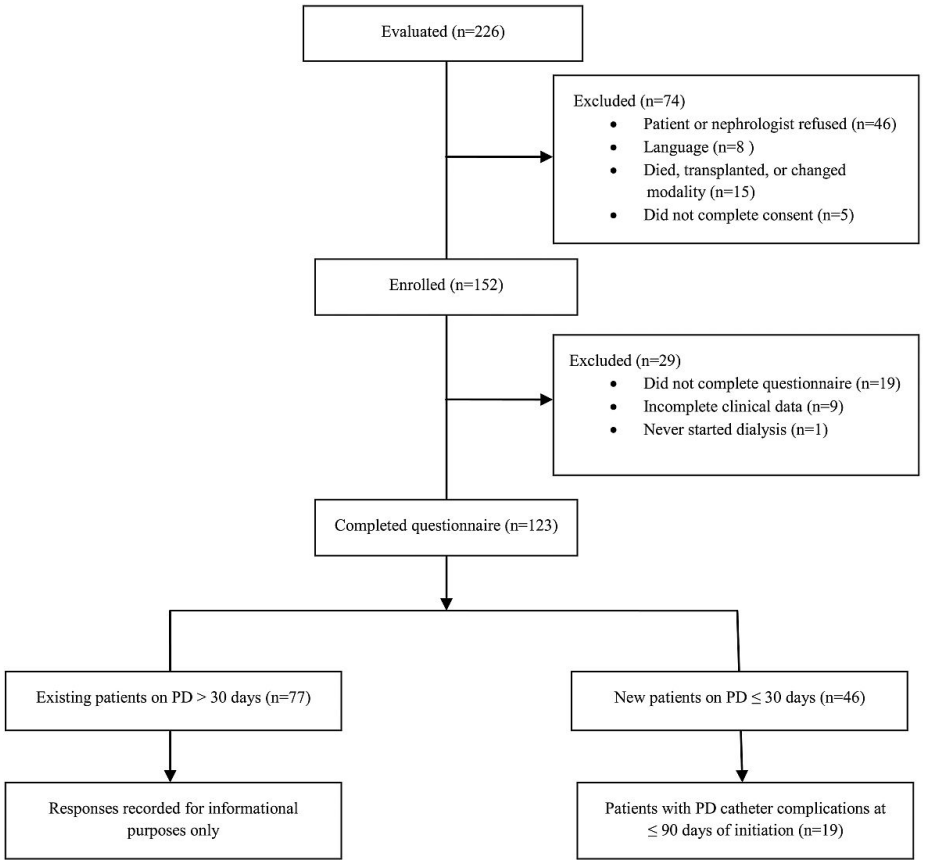

Figure 1 — Flow diagram of patient selection. PD = peritoneal dialysis.

remember" or who did not respond to a particular question were not included in the denominator for that analysis. Patients were followed prospectively for these categories of complications:

- Infection (peritonitis or exit-site infection)
- Catheter or exit-site problem (hardware problem, tip migration, kinking, flow problems significant enough to interrupt therapy, exit-site suture, upward-facing exit site, or cuff extrusion)
- Anatomic problems (hernia, dialysate leak, omental wrapping, or hydrothorax)
- Need for intervention (catheter revision or replacement)
- Unplanned transfer to HD (temporary or permanent) resulting from catheter-related problems

Need for intervention or HD were counted as separate events in addition to any underlying complications. Events were reported by the nursing staff to investigators using a standardized tracking form and were verified from medical records by investigator adjudication. Patient characteristics were compared between groups with and without complications.

STATISTICAL ANALYSIS

Continuous variables are expressed as means ± standard deviation or medians with interquartile range (or the full range). Categorical variables are expressed as proportions. Between-group differences were analyzed using the Student t-test, the Mann–Whitney test, the chi-square test, or the Fisher exact test. We considered two-tailed *p* values less than 0.05 to be statistically significant. All statistical analyses were performed using the SAS software application (version 9.3: SAS Institute, Cary, NC, USA).

RESULTS

Figure 1 shows patient selection for the study. Of 226 potential participants, 74 were excluded, largely because of patient or nephrologist refusal to participate. Of 152 patients enrolled, 29 were subsequently excluded after failing to complete the questionnaire or for incomplete clinical data. The characteristics and responses from 77 existing PD patients were recorded for information purposes only (Tables 2 – 4). The 46 new PD patients who completed the questionnaire were followed prospectively until 90 days after PD initiation. Of those patients, 19 (41%) developed a complication during the study.

Table 5 shows the characteristics of the new patients. Mean age was 57 years, with 30% of patients being 65 years of age or older. Men constituted 57% of the study population, and 39% of the patients were obese (body mass index > 30). Median time on PD at enrollment was 3 days. A sizeable proportion of the patients (43%) had transferred from HD. Hypertension (96%), diabetes (43%), congestive heart failure (35%), and atherosclerotic heart disease (33%) were common comorbidities. Most patients were white (64%) and educated, with 68% having attended college or graduate school. Patients with

TABLE 2
Characteristics of Existing and New Patients

Characteristic	Patient group: Existing (*n*=77)	Patient group: New (*n*=46)
Demographics		
Age (years)		
Mean	57±15	57±17
≥65 Years [*n* (%)]	26 (34)	14 (30)
Sex [*n* (%) men]	37 (48)	26 (57)
Body mass index		
Mean	27±7	29±7
≥30 [*n* (%)]	17 (22)	18 (39)
Time on PD at enrollment (days)		
Median (IQR)	346 (232 to 774)	3 (–7 to 15)
No previous dialysis [*n* (%)]	52 (68)	26 (57)
Cause of ESRD [*n* (%)]		
Diabetes	19 (25)	17 (37)
Hypertension	15 (19)	9 (20)
Glomerulonephritis	18 (23)	12 (26)
Other	25 (32)	8 (17)
Comorbidities[a] [*n* (%)]		
Diabetes mellitus	27 (35)	20 (43)
Congestive heart failure	13 (17)	16 (35)
Atherosclerotic heart disease	17 (22)	15 (33)
Peripheral vascular disease	8 (10)	8 (17)
Hypertension	69 (90)	44 (96)
Stroke	7 (9)	5 (11)
Ethnicity[b] [*n* (%)]		
White	41 (55)	29 (64)
African American	6 (8)	9 (20)
Asian	19 (26)	6 (13)
Hispanic	2 (3)	1 (2)
Other	6 (8)	—
Education level [*n* (%)]		
Elementary	3 (4)	—
High school	20 (26)	15 (33)
College	41 (53)	21 (46)
Graduate school	13 (17)	10 (22)

IQR = interquartile range; ESRD = end-stage renal disease.
[a] From Medicare 2728 form.
[b] Four patients (3 existing, 1 new) did not respond.

TABLE 3
Preoperative Peritoneal Dialysis (PD) Catheter Education and Care: Existing Patients and New Patients

Question	Results by patient group [*n* (%)][a] Existing (*n*=77)	New (*n*=46)
Preoperative surgical evaluation		
Surgeon placed catheter	76/77 (99)	46/46 (100)
Surgeon saw patient in clinic before surgery	70/76 (92)	42/45 (93)
Surgeon evaluated patient for hernia before surgery	33/42 (79)	21/29 (72)
Surgeon discussed location of catheter exit site with patient	66/70 (94)	42/46 (91)
Surgeon asked if patient could visualize planned catheter exit site	41/51 (70)	25/34 (74)
Surgeon asked about patient's beltline position	38/58 (66)	26/40 (65)
Preoperative care and education		
PD catheter location marked with pen or stencil before surgery	36/54 (67)	25/38 (66)
Marked by surgeon	32	20
Marked by nephrologist	2	3
Marked by PD nurse	2	2
Patient instructed to shower or bathe with soap before surgery	40/59 (68)	28/42 (67)
Patient instructed to cleanse bowels before surgery	18/59 (31)	8/40 (20)
Patient nostrils swabbed for bacterial colonization before surgery	4/46 (9)	6/38 (16)
Patient satisfaction		
Patient reported adequate education before PD catheter surgery	52/69 (75)	29/45 (64)

[a] Results reported as number of affirmative responses divided by number of actual responses (percentage actual responses). Patients who answered "I don't remember" or who did not respond to the question were not included in the denominator.

complications were more likely to be obese ($p = 0.03$) or to have peripheral vascular disease ($p = 0.05$). We observed no other significant differences between patients with and without complications.

Table 6 shows responses by patients about preoperative PDC preparation. All PDCs were placed by surgeons. Most patients reported being seen by the surgeon before PDC placement. Among the responding patients, 72% reported being evaluated for a hernia, though 37% of the patients did not remember an evaluation or did not answer the question. Only 74% reported their surgeon asking if they could visualize their exit site, and 65% reported being asked about beltline location. Only 66% of patients reported having their PDC location marked preoperatively. Instructions to bathe before surgery were reported by 67% of patients. Only 20% of patients reported being directed to cleanse their bowels before surgery. Nasal swabbing for *S. aureus* was rarely reported. Among responding patients, 64% reported receiving adequate education about their catheter before surgery. Responses did not differ between patients with and without complications.

Table 7 shows responses related to postoperative PDC care. Of responding patients, 80% reported being given instructions to arrange for PDC care after surgery. Patients chiefly reported being told to visit the PD nurse or the surgeon for this care. Not being given instructions about whom to contact in case of a problem or emergency after surgery was reported by 11% of patients. Postoperative instructions to avoid bathing or getting the PDC wet (89%), to keep the PDC immobilized (68%), or to leave the PDC dressing undisturbed (61%) were not consistently reported. Directions about how to treat and avoid constipation—a preventable cause of PDC malfunction—were reported by only 57% of patients. Only 54% of patients reported being taught the warning signs of PDC infection before their first visit with the PD nurse. Although 85% of patients reported being seen by the PD nurse within 2 weeks of surgery, only about half reported seeing either their surgeon or nephrologist in the interval between surgery and PD training. A suture at the exit site was reported by 61% of patients. Only 63% of patients reported receiving adequate PDC education after surgery. We observed no differences between the responses of patients with and without complications.

Figure 2 categorizes 33 PDC events observed in 19 patients. As Table 8 shows, 11% of patients developed an infection, and 30% experienced a catheter or exit-site problem. Most problems involving the PDC or exit site were detected by the PD nurses.

Overall, 13% of patients required intervention, and 11% required unplanned HD—some of whom had multiple

TABLE 4
Postoperative Peritoneal Dialysis (PD) Catheter Education and Care: Existing Patients and New Patients

Question	Results by patient group [*n* (%)][a] Existing (*n*=77)	New (*n*=46)
Postoperative care and education		
Patient given instructions to arrange PD catheter care after surgery	57/62 (92)	33/41 (80)
Follow-up with surgeon	18	14
Follow-up with nephrologist	7	1
Follow-up with PD nurse	32	18
Patient given instructions on who to contact in case of a problem or emergency with catheter or dressing after surgery	62/63 (98)	39/44 (89)
Contact surgeon	36	26
Contact nephrologist	1	3
Contact PD nurse	25	10
Patient instructed to avoid bathing or getting catheter wet after surgery	69/71 (97)	39/44 (89)
Patient instructed to keep catheter immobilized after surgery	46/61 (75)	28/41 (68)
Patient instructed not to disturb catheter dressing after surgery	29/57 (51)	25/41 (61)
Patient given instructions on how to treat or avoid constipation	50/67 (75)	25/44 (57)
Patient taught warning signs of catheter infection before first visit with PD nurse	49/68 (72)	22/41 (54)
Patient reported suture at exit site	28/56 (50)	22/36 (61)
Surgeon saw patient to examine catheter before PD training	44/68 (65)	25/45 (56)
Nephrologist saw patient to examine catheter before PD training	44/62 (71)	23/44 (52)
Timing of first visit with PD nurse after surgery		
<1 Week	18/67 (27)	16/45 (36)
1–2 Weeks	30/67 (45)	22/45 (49)
2–3 Weeks	12/67 (18)	6/45 (13)
>3 Weeks	7/67 (10)	1/45 (2)
Patient satisfaction		
Patient reported adequate education after PD catheter surgery	68/73 (93)	26/41 (63)

[a] Results reported as number of affirmative responses divided by number of actual responses (percentage actual responses). Patients who answered "I don't remember" or who did not respond to the question were not included in the denominator.

concurrent PDC issues. Reasons for intervention included poor flow, hole in the PDC (2 patients), hernia with kinked catheter and tip migration, exit-site infection and tip migration, and tip migration alone. All interventions were performed by surgeons. The PDC-related reasons for unplanned HD included dialysate leak, tip migration, hernia with kinked catheter and tip migration, exit-site infection and tip migration, and omental wrap (resulting in permanent HD).

As seen in Table 8, 19 of 46 patients (41%) experienced a complication within 90 days of PD start (median onset: 3 days), with 14 of the 19 (74%) experiencing a complication before being on PD more than 14 days (median onset: 9 days). Overall, 30% of new PD patients experienced a catheter-related complication before being on PD more than 2 weeks. Ten patients (22% overall) experienced more than 1 complication. Given the small sample size, we did not perform any further analysis of outcomes.

DISCUSSION

A fundamental requirement for successful PDC placement is a team approach involving nephrologists, PD nurses, surgeons, and increasingly, interventional nephrologists and radiologists (1–5,12,13,29–32). Each member of this access team must understand and appreciate the details involved in PDC placement (1–5). Our study suggested care deficiencies at all stages of the PDC placement process.

Of responding patients, 7% reported seeing their surgeon only at the time of surgery. Inconsistent reports of preoperative hernia evaluation and exit-site marking reinforced concerns about operator knowledge of best demonstrated practices (6,16,17). Simple instructions such as bathing before surgery and bowel preparation in particular were not always reported. Surveillance for *S. aureus* did not appear to be widely practiced. We did not

TABLE 5
Patient Characteristics

Characteristic	Overall	Patient group: Complications: No	Patient group: Complications: Yes	*p* Value
Patients (*n*)	46	27	19	
Demographics				
Age (years)				
Mean	57±17	54±17	61±16	0.1
≥65 [*n* (%)]	14 (30)	7 (26)	7 (37)	0.4
Sex [*n* (%) men]	26 (57)	15 (56)	11 (58)	0.9
Body mass index				
Mean	29±7	28±6	31±8	0.08
≥30 [*n* (%)]	18 (39)	7 (26)	11 (58)	0.03
Time on PD at enrollment (days)				
Median (IQR)	3 (–7 to 15)	4 (–10 to 15)	1 (0 to 16)	0.9
No previous dialysis [*n* (%)]	26 (57)	15 (56)	11 (58)	0.9
Cause of ESRD [*n* (%)]				
Diabetes	17 (37)	8 (30)	9 (47)	0.7
Hypertension	9 (20)	6 (22)	3 (16)	
Glomerulonephritis	12 (26)	8 (30)	4 (21)	
Other	8 (17)	5 (19)	3 (16)	
Comorbidities[a] [*n* (%)]				
Diabetes mellitus	20 (43)	9 (33)	11 (58)	0.1
Congestive heart failure	16 (35)	9 (33)	7 (37)	0.8
Atherosclerotic heart disease	15 (33)	8 (30)	7 (37)	0.6
Peripheral vascular disease	8 (17)	2 (7)	6 (32)	0.05
Hypertension	44 (96)	25 (93)	19 (100)	0.5
Stroke	5 (11)	1 (4)	4 (21)	0.1
Ethnicity[b] [*n* (%)]				
White	29 (64)	17 (63)	12 (67)	0.5
African American	9 (20)	5 (19)	4 (22)	
Asian	6 (13)	5 (19)	1 (6)	
Hispanic	1 (2)	—	1 (6)	
Education level [*n* (%)]				
High school	15 (33)	8 (30)	7 (37)	0.9
College	21 (46)	13 (48)	8 (42)	
Graduate school	10 (22)	6 (22)	4 (21)	

IQR = interquartile range.
[a] From Medicare 2728 form.
[b] One patient did not respond.

ask patients about prophylactic antibiotic use because of an inability to verify administration and the possibility that the question might be misinterpreted.

Our patients reported that basic precautions such as catheter immobilization, an undisturbed dressing, and who to contact for problems were not consistently communicated. Although the onus is on the operator to ensure that adequate postoperative care is given, a gap may occur if the operator does not or chooses not to provide that care. Invariably, the PD nurse assumes this responsibility, but may be greatly disadvantaged if there is inadequate handoff or communication from the operator, who may not appreciate the strict attention to detail needed for PDC care (personal observation). Poor understanding of this role by some operators may stem from inadequate training in PDC placement, a prevalent issue in the United States (17). This lack of effective coordination between caregivers may explain why so many patients rated their PDC-related education as inadequate.

TABLE 6
Preoperative Peritoneal Dialysis (PD) Catheter Education and Care

Question	Results by patient group [*n*/*N* (%)][a] Overall (*n*=46)	Complications No (*n*=27)	Complications Yes (*n*=19)	*p* Value
Preoperative surgical evaluation				
Surgeon placed catheter	46/46 (100)	27/27 (100)	19/19 (100)	—
Surgeon saw patient in clinic before surgery	42/45 (93)	24/26 (92)	18/19 (95)	1.0
Surgeon evaluated patient for hernia before surgery	21/29 (72)	11/15 (73)	10/14 (71)	1.0
Surgeon discussed location of catheter exit site with patient	42/46 (91)	26/27 (96)	16/19 (84)	0.3
Surgeon asked if patient could visualize planned catheter exit site	25/34 (74)	15/20 (75)	10/14 (71)	1.0
Surgeon asked about patient's beltline position	26/40 (65)	18/26 (69)	8/14 (57)	0.5
Preoperative care and education				
PD catheter location marked with pen or stencil before surgery	25/38 (66)	18/24 (75)	7/14 (50)	0.2
Marked by surgeon	20	15	5	
Marked by nephrologist	3	2	1	
Marked by PD nurse	2	1	1	
Patient instructed to shower or bathe with soap before surgery	28/42 (67)	13/23 (57)	15/19 (79)	0.1
Patient instructed to cleanse bowels with stool softeners or enema before surgery	8/40 (20)	3/24 (13)	5/16 (31)	0.2
Patient nostrils swabbed for bacterial colonization before surgery	6/38 (16)	1/20 (5)	5/18 (28)	0.08
Patient satisfaction				
Patient reported receiving adequate education before PD catheter surgery	29/45 (64)	19/26 (73)	10/19 (53)	0.2

[a] Results reported as number of affirmative responses divided by number of actual responses (percentage actual responses). Patients who answered "I don't remember" or who did not respond to the question were not included in the denominator.

Defining PDC complications is not always straightforward or consistent (1–5,12,29,31,33). A strict classification of PDC complications includes only those resulting in intervention or technique failure, including death (31). To capture the entire spectrum of PDC problems encountered, we set a lower threshold for defining complications. Even if a complication does not lead to an intervention, the increased morbidity adds to the psychological burden of PD, which may contribute to patient burnout (6,15–17). Although some complications (such as upward-facing exit sites and exit-site sutures) may not result in discontinuation of PD, they are completely avoidable and attributable solely to poor operator technique. These potential targets for quality improvement might be missed with a higher threshold for classification. In the present report, the incidence of serious complications requiring intervention or unplanned HD appeared high compared with those in other series (13,29,31,33). Although only 1 patient experienced permanent technique failure, the situation could have been worse were it not for the experienced staff of a large regional PD center.

Our study has several strengths. The reported experience represents a realistic practice environment and illustrates the challenge of addressing PDC complications in a diverse community of surgeons and nephrologists. Delivery of PD care can be hindered if the various providers are not aligned with respect to best practices, coordination of care, and communication (27). Our experience may be valuable for other PD programs in the United States to review, because PD access may be one of the factors limiting PD growth in their communities (7,9). Because we examined patient experiences with their PDC care, rather than survey providers, our study is an example of patient-centered quality improvement (10,27). Education content is important, but the perception and retention of that content by patients largely determines its effectiveness. Those concepts

TABLE 7
Postoperative Peritoneal Dialysis (PD) Catheter Education and Care

Question	Results by patient group [*n/N* (%)][a] Overall (*n*=46)	Complications No (*n*=27)	Complications Yes (*n*=19)	*p* Value
Postoperative care and education				
Patient given instructions to arrange catheter and dressing care after surgery	33/41 (80)	21/25 (84)	12/16 (75)	0.7
Follow-up with surgeon	14	11	3	
Follow-up with nephrologist	1	1	0	
Follow-up with PD nurse	18	9	9	
Patient given instructions on who to contact in case of a problem or emergency with catheter or dressing after surgery	39/44 (89)	23/26 (88)	16/18 (89)	1.0
Contact surgeon	26	17	9	
Contact nephrologist	3	1	2	
Contact PD nurse	10	5	5	
Patient instructed to avoid bathing or getting catheter wet after surgery	39/44 (89)	23/26 (88)	16/18 (89)	1.0
Patient instructed to keep catheter immobilized after surgery	28/41 (68)	17/23 (74)	11/18 (61)	0.4
Patient instructed not to disturb catheter dressing after surgery	25/41 (61)	15/22 (68)	10/19 (53)	0.3
Patient given instructions on how to treat and avoid constipation after surgery	25/44 (57)	14/25 (56)	11/19 (58)	0.9
Patient taught warning signs of catheter infection before first visit with PD nurse	22/41 (54)	11/24 (46)	11/17 (65)	0.2
Patient reported suture at exit site	22/36 (61)	13/21 (62)	9/15 (60)	0.9
Surgeon saw patient to examine catheter before PD training	25/45 (56)	15/26 (58)	10/19 (53)	0.7
Nephrologist saw patient to examine catheter before PD training	23/44 (52)	13/25 (52)	10/19 (53)	1.0
Timing of first visit with PD nurse after surgery				
<1 Week	16/45 (36)	7/26 (27)	9/19 (47)	0.2
1–2 Weeks	22/45 (49)	14/26 (54)	8/19 (42)	
2–3 Weeks	6/45 (13)	5/26 (19)	1/19 (5)	
>3 Weeks	1/45 (2)		1/19 (5)	
Patient satisfaction				
Patient reported receiving adequate education after PD catheter surgery	26/41 (63)	16/23 (70)	10/18 (56)	0.4

[a] Results reported as number of affirmative responses divided by number of actual responses (percentage actual responses). Patients who answered "I don't remember" or who did not respond to the question were not included in the denominator.

should not be neglected, because experience and satisfaction of patients with their modality education may influence outcomes by affecting their behavior and feelings about PD (10,27). We did not observe a difference in complications for patients who rated their teaching as inadequate, but that finding does not disprove the impact of education. The next step in the quality improvement process would be to act by implementing education measures and measuring the results, repeating the cycle as necessary until the desired results are achieved (27,34).

A primary tenet of quality improvement is that outcomes should be studied and root causes identified to help drive process change (27,34–36). Although we assured referring nephrologists that neither they nor their surgeons would be identified, a number of providers

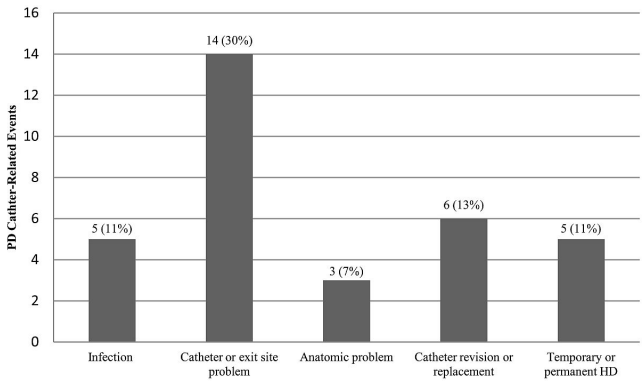

Figure 2 — Peritoneal dialysis (PD) catheter–related complications by category [*n* (%) new patients]. HD = hemodialysis.

declined participation. Those choices may reflect reluctance by physicians in general to address negative patient outcomes. Unfortunately, many physicians lack training in quality improvement, and few detailed examples of PD quality improvement are available (8,10,11,27). Although our goal was to improve nephrology fellowship training, it is imperative that all stakeholders involved in PDC placement—dialysis nurses, nephrologists, surgeons, interventional nephrologists, and interventional radiologists—be educated about best practices and participate in quality improvement (1,2,6,8,27). One step would be for institutions to recognize this need and devote resources to ensure adequate training of operators (16,17).

Limitations of our study include its observational design, questionnaire validity, lack of physician-specific data, and sample size. Patient responses were subject to recall bias, and we could not validate whether a particular intervention was actually performed or not. Non-responses could have affected the results. For example, approximately 40% of patients did not remember being checked for a hernia or did not respond to the question. It is possible that underreporting of care occurred if patients did not understand or realize that care was being delivered to them. Measurement error and response bias may have occurred. For example, 61% of patients reported an exit-site suture, but a suture was detected in only 7% on exam. A number of patients were not permitted to enroll, which might have resulted in non-response bias. It is possible that the participants, many of whom were highly educated, had higher-than-average expectations about their teaching. We did not attempt to compare placement techniques, PDC types, or PD modalities. Because all catheters were placed surgically, we had no data about interventional nephrology or radiology practices. We were not permitted to gather physician-specific data and did not study patterns of operator PDC placement.

TABLE 8
Timing of Peritoneal Dialysis (PD) Catheter-Related Complications

Event	Occurrence in 46 new patients [*n* (%)]	Days to onset[a] [median (range)]
Infection	5 (11)	8 (–26 to 51)
Exit-site infection	3 (7)	
Peritonitis	2 (4)	
Catheter or exit-site problem	14 (30)	–9 (–114 to 73)
Poor flow	3 (7)	
Kinked catheter	1 (2)	
Kinked catheter and tip migration	1 (2)	
Tip migration	3 (7)	
Exit-site suture	2 (4)	
Exit-site suture and upward-facing exit site	1 (2)	
Upward-facing exit site	1 (2)	
Hole in catheter	2 (4)	
Anatomic problem	3 (7)	9 (5 to 39)
Hernia	1 (2)	
Dialysate leak	1 (2)	
Omental wrap	1 (2)	
Catheter revision or replacement	6 (13)	25 (–61 to 73)
Temporary or permanent hemodialysis	5 (11)	9 (3 to 51)
Permanent hemodialysis	1 (2)	
Temporary hemodialysis	4 (9)	
Any complication	19 (41)	3 (–114 to 73)
Any complication up to 14 days after PD initiation	14 (30)	–9 (–114 to 9)

[a] Relative to PD initiation; range shows minimum to maximum.

CONCLUSIONS

The recommended patient education and care for PDC placement at a large US regional PD program appeared inconsistent and suboptimal. Many patients reported their PDC education as inadequate, and catheter-related complications were significant in number. Quality improvement efforts should aim to increase physician awareness of International Society for Peritoneal Dialysis catheter guidelines, to improve patient education, and to develop better care processes by stakeholders to ensure a more coordinated approach to PDC placement. Whether such interventions will affect outcomes is not known, but they seem prudent based on current standards.

ACKNOWLEDGMENTS

The authors thank the PD staff of Northwest Kidney Centers and Dr. Rudolph Rodriguez, VA Puget Sound Health Care System, for their support. These data were presented as an abstract at the American Society of Nephrology Renal Week; Denver, Colorado; 16–21 November 2010.

DISCLOSURES

There were no sources of funding or author financial conflicts of interest related to this study.

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