Association of Peritonitis with Hemodialysis Catheter Dependence after Modality Switch

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Abstract

Background and objectives Few studies have evaluated vascular access use after transition from peritoneal dialysis to hemodialysis. Our study characterizes vascular access use after switch to hemodialysis and its effect on patient mortality and evaluates whether a peritonitis event preceding the switch was associated with the timing of permanent vascular access placement and use.

Design, setting, participants, & measurements The US Renal Data System data were used to evaluate the establishment of a permanent vascular access in 1165 incident Medicare–insured adult patients on dialysis who initiated peritoneal dialysis between July 1, 2010 and June 30, 2011 and switched to hemodialysis within 1 year.

Results The proportions of patients using a hemodialysis catheter were 85% (744 of 879), 76% (513 of 671), and 51% (298 of 582) at 30, 90, and 180 days, respectively, after the switch from peritoneal dialysis to hemodialysis. Patients who switched from peritoneal dialysis to hemodialysis with a previous peritonitis episode were more likely to dialyze with a catheter at 30 days (90% [379 of 421] versus 80% [365 of 458]; P=0.03), 90 days (82% [275 of 334] versus 71% [238 of 337]; P=0.03), and 180 days (57% [166 of 289] versus 45% [132 of 293]; P=0.04) after the switch and less likely to dialyze with an arteriovenous fistula at 30 days (8% [32 of 421] versus 16% [73 of 458]; P=0.01), 90 days (13% [42 of 334] versus 23% [76 of 337]; P=0.03), and 180 days (31% [91 of 289] versus 43% [126 of 293]; P=0.04). Patients using a permanent vascular access 180 days after switching from peritoneal dialysis to hemodialysis had better adjusted survival during the ensuing year than those using a catheter (hazard ratio, 0.66; 95% confidence interval, 0.44 to 1.00; P=0.05).

Conclusions Among patients who switch from peritoneal dialysis to hemodialysis, prior peritonitis is associated with a higher rate of persistent hemodialysis catheter use, which in turn, is associated with lower patient survival. Studies addressing vascular access planning and implementation are needed in this group of patients.

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Introduction

Although there has been a greater emphasis on increasing peritoneal dialysis (PD) utilization in the United States in recent years, nearly 20% of incident patients on PD switch to hemodialysis (HD) within 1 year after initiation of PD (1). Similar to in patients with CKD who initiate HD, establishing a permanent vascular access in patients switching to HD after failed PD remains a high priority. Many studies have reported that late referral of patients with CKD for predialysis vascular access placement is associated with increased morbidity and mortality (2–5). Given that patients on PD are already a captive audience with ESRD care by a nephrologist, one might expect better vascular access outcomes in patients transitioning from PD to HD than in patients with CKD and *de novo* HD initiation. Few published studies have evaluated the vascular access transition from PD to HD. Furthermore, the association of a prior peritonitis episode with vascular access outcomes among patients switching from PD to HD has not been assessed.

The objective of this study was to characterize in patients who failed PD and switched to HD (*1*) the initial vascular access used within 30 days after HD initiation, (*2*) vascular access utilization at 90 and 180 days after the switch to HD, (*3*) whether a peritonitis event preceding the PD to HD switch was associated with the timing of permanent vascular access placement and use, and (*4*) the association of vascular access type 180 days after the switch from PD to HD with subsequent patient mortality.

Materials and Methods

Data Sources and Study Population

The Institutional Review Board at the University of Alabama at Birmingham approved this study. We used data from the US Renal Data System (USRDS) to conduct this study. We used the USRDS standard analytic files from January 1, 2010 to December 31, 2012, the most recent data available to researchers. Using the USRDS definition to ascertain dialysis modality, PD was determined by first identifying use of PD modality on day 90 after dialysis initiation

with continuous treatment using PD for 60 days subsequently (60-day rule). Using this definition, we identified 4398 adult patients on dialysis initiating PD therapy between June 1, 2010 and June 1, 2011. Patients with incomplete data in the medical evidence file were excluded (n=36). The remaining 4362 patients were followed for 1 year to determine switch to HD (n=1165) indicated by HD monthly claims, continued PD use throughout the year or received kidney transplant (n=2624), a gap in dialysis services defined as no data in the USRDS for >90 days (n=163), or death (n=410). There were no missing data among the 1165 patients analyzed in this study. Patients had to be on HD for a minimum of 1 month before they were considered to have switched from PD to HD as reported by the monthly vascular access modifier codes (V codes) by each dialysis unit.

Variables of Interest

At dialysis initiation, the Medical Evidence Form was used to determine patient demographics (age, sex, and race) and comorbidities, including diabetes, hypertension, cardiovascular disease, cancer, and chronic obstructive pulmonary disease. Effective July of 2010, all dialysis units have been required by the Center for Medicare and Medicaid Services to provide monthly vascular access use at the end of each calendar month for all active patients on HD using vascular access modifiers V5 (central venous catheter), V6 (arteriovenous graft [AVG]), or V7 (arteriovenous fistula [AVF]). These codes are used to determine vascular access used at various time points after switching from PD to HD as described below.

Statistical Analyses

Our analysis focused on the 1165 patients who switched from PD to HD in the 1-year period after initiation of PD therapy. Among this cohort, we examined the following patient outcomes: maintained on HD, switched back to PD, died, and lost to follow-up at three different time periods: 30, 90, and 180 days after the first switch from PD to HD. In our cohort, with outcomes that were assessed at three different time points, we evaluated vascular access used for dialysis at the end of each time period by using recently available monthly V code modifiers to indicate use of catheter, AVG, or AVF. Furthermore, we disaggregated the study population by evidence of peritonitis in the 60-day period before the switch from PD to HD. Peritonitis was identified using the International Classification of Diseases, Ninth Revision codes 567.2 and 567.9 and Common Procedural Terminology (CPT-4) code 99778 as a reason for hospitalization or outpatient physician visit, respectively. We examined the distribution of vascular access surgeries using CPT-4 codes for AVF and AVG creation by peritonitis status in the 2 months before and 6 months after switch from PD to HD by type of vascular access actually used for dialysis 180 days after the switch; 12-month adjusted Kaplan–Meier survival curves on the basis of vascular access used 180 days after first switch from PD to HD were derived. The covariates in the adjusted analysis included age, sex, race, diabetes, hypertension, cardiovascular disease, cancer, chronic obstructive pulmonary disease, and prior peritonitis at the time of the switch. All of the analyses were conducted by SAS, version 9.2 (SAS Institute Inc., Cary, NC).

Results

Baseline Characteristics of Patients Switching from PD to HD

During the 1-year period from June 1, 2010 to June 1, 2011, 4362 patients used PD as their initial dialysis modality. Of this patient cohort, 27% (n=1165 of 4362) switched to HD within 1 year. The median switch time from PD to HD was 156 days. Table 1 presents the baseline patient demographics and comorbidities of the patient cohort that switched from PD to HD. Almost one half were ≥65 years of age, 74% (857 of 1165) were white, and 26% (308 of 1165) were nonwhite. Diabetes was present in 52% (609 of 1165), hypertension was in 89% (1039 of 1165), and cardiovascular disease was in 46% (537 of 1165). Among patients switching to HD, 75% (879 of 1165) remained on HD at 30 days; among those patients still on HD at 30 days, 76% (671 of 879) remained on HD at 90 days, and among those patients still on HD at 90 days, 87% (582 of 671) remained on HD at 180 days (Table 2). Among patients who switched from PD to HD, those with prior peritonitis were similar to those without prior peritonitis in terms of age, race, sex, cardiovascular disease, hypertension, chronic obstructive pulmonary disease, and cancer (data not shown). Diabetes was slightly more frequent in the peritonitis group versus the nonperitonitis group: 56% (314 of 560) versus 50% (303 of 605), respectively; P=0.04. The proportion of patients who switched from PD to HD without prior peritonitis remained at approximately 50% (458 of 879, 337 of 671, and 293 of 582, respectively) of

Table 1. Characteristics of patients who used peritoneal dialysis as initial dialysis modality between June of 2010 and June of 2011 and switched to hemodialysis in the following year

Characteristics	No.	Percentage
Total patients	1165	100
Age, yr		
18–44	208	18
45–64	442	38
≥65	515	44
Men	698	60
White	857	74
Full-time employment	80	7
Diabetes	609	52
Hypertension	1039	89
Cardiovascular disease	537	46
Cancer	74	6
COPD	76	7
Prior peritonitis	560	48

Note that 4398 adult patients on dialysis initiating peritoneal dialysis therapy between June 1, 2010 and June 1, 2011 were identified. Patients with incomplete data were excluded (n=36). The remaining 4362 patients were followed for 1 year to determine switch to hemodialysis (n=1165), continued peritoneal dialysis use throughout the year or received a kidney transplant (n=2624), a gap in dialysis services defined as no data in the US Renal Data System for >90 days (n=163), or death (n=410). Younger age, men, diabetes, and cardiovascular disease were each associated with a higher likelihood of switching from peritoneal dialysis to hemodialysis (P<0.05). COPD, chronic obstructive pulmonary disease.

Table 2. Patient outcomes after first switch from peritoneal dialysis to hemodialysis in 30, 90, and 180 days

Parameter	30 d after Switch	90 d after Switch	180 d after Switch
Total patients on HD at the beginning of each period	1165	879	671
Maintained HD (%)	879 (75)	671 (76)	582 (87)
With peritonitis	421	334	289
Without peritonitis	458	337	293
Return to PD (%)	254 (22)	159 (18)	45 (7)
Transplanted (%)	—	3 (0.3)	10 (1)
Loss to follow-up (%)	—	16 (2)	5 (1)
Died (%)	32 (3)	30 (3)	29 (4)

HD, hemodialysis; PD, peritoneal dialysis; —, zero patients.

patients initially switching to HD and still on HD at 30, 90, and 180 days, respectively (Table 2).

Vascular Access Utilization after Transition from PD to HD

We evaluated the vascular access type used for HD at 30, 90, and 180 days after the switch from PD to HD. Catheter use remained high (85% [744 of 879] and 76% [513 of 671] at 30 and 90 days, respectively) after the switch. Even 180 days after the switch to HD, 51% (298 of 582) of patients were still catheter dependent. Conversely, the proportions of patients using an AVF for HD were only 12% (105 of 879) and 18% (118 of 671) at 30 and 90 days, respectively. Even at 180 days after the switch, only 37% (217 of 582) of patients were using an AVF.

Among the patients switching from PD to HD, 48% (560 of 1165) had a peritonitis episode in the 2-month period before the switch (Table 1). We determined whether an episode of peritonitis preceding the PD to HD switch was associated with the likelihood of a permanent vascular access use in the ensuing 6 months. Compared with patients who switched from PD to HD without a prior peritonitis episode, those who had a prior peritonitis episode were more likely to dialyze with a catheter at 30 days (90% [379 of 421] versus 80% [365 of 458], respectively; P=0.03), 90 days (82% [275 of 334] versus 71% [238 of 337], respectively; P=0.03), and 180 days (57% [166 of 289] versus 45% [132 of 293], respectively; P=0.04) after the switch (Figure 1). Conversely, patients with a prior peritonitis episode were less likely to dialyze with an AVF than those without a prior peritonitis episode at 30 days (8% [32 of 421] versus 16% [73 of 458], respectively; P=0.01), 90 days (13% [42 of 334] versus 23% [76 of 337], respectively; P=0.03), and 180 days (31% [91 of 289] versus 43.0% [126 of 293], respectively; P=0.04), respectively (Figure 1). Likewise, utilization of AVG was nonsignificantly lower at each of these time periods in patients with a peritonitis episode before switching to HD (Figure 1).

Timing of Vascular Access Surgery Relative to the Switch to HD from PD

We also examined the effect of a peritonitis episode before the switch from PD to HD on the timing of AVF placement (Figure 2). Among those patients without a

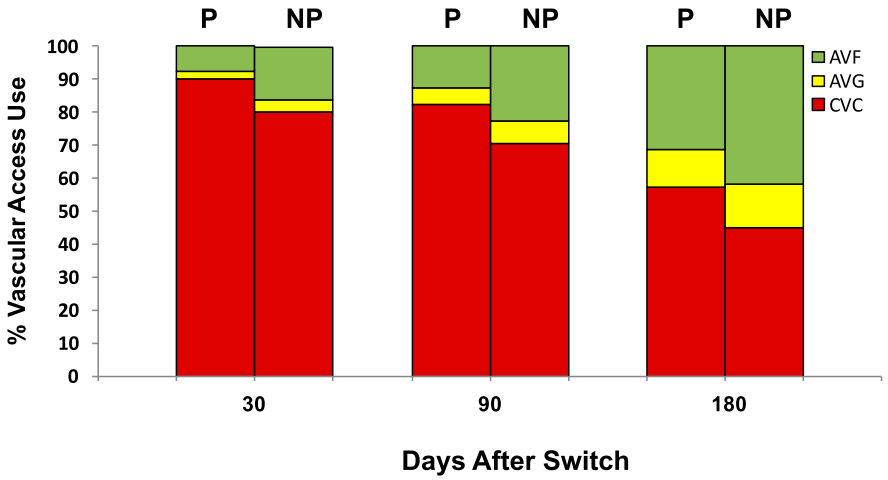

Figure 1. | Patients who switch from peritoneal dialysis to hemodialysis with a prior episode of peritonitis are more likely to be catheter-dependent and less likely to be using an AVF at 30, 90 and 180 days after the switch. P<0.05 for all comparisons between patients with and without P before the modality switch for arteriovenous fistula (AVF) and CVC. AVG, arteriovenous graft; CVC, central venous catheter; NP, nonperitonitis; P, peritonitis.

prior peritonitis episode compared with those with peritonitis, placement of an AVF occurred in 21% (26 of 126) versus 12% (11 of 91), respectively, in the 2 months before the switch (P=0.02) (Figure 2).

Vascular Access Utilization and Mortality after Switch from PD to HD

We assessed the effect of type of vascular access used for HD at 6 months after the PD to HD switch on patient mortality during the subsequent 1 year of follow-up. Among patients dialyzing with a permanent vascular access (AVF or AVG) at 6 months after the switch from PD to HD, the 1-year adjusted mortality was significantly lower compared with that in patients dialyzing with a catheter (hazard ratio, 0.66; 95% confidence interval, 0.44 to 1.00; P=0.05) (Figure 3).

Discussion

We found that 27% of patients initiating dialysis with PD transitioned to HD within 1 year. Among those transitioning to HD, the great majority initiated HD with a catheter, and approximately 50% remained catheter dependent, even 180 days after the switch. Patients with an episode of peritonitis in the 2 months before the switch to HD had delayed vascular access creation and as a result, were more likely to be catheter dependent and less likely to use an AVF for dialysis 180 days after the switch. Finally, patients dialyzing with a catheter 180 days after the switch to HD were more likely to die during the ensuing year than those using an AVF.

The high rate (27%) of patients switching from PD to HD during the first year after initiation of PD in this study is in agreement with previous publications. Pulliam *et al.* (1) reported that 21% of patients starting dialysis with PD switched to HD within 1 year. In the Choices for Healthy Outcomes in Caring for ESRD Study, 25% of incident patients on PD switched to HD during follow-up, with 45% of them doing so during the first year (2). Finally, an Australian/New Zealand registry reported that 19% of incident patients on PD transferred to HD after 1 year (6).

Among patients switching from PD to HD in this study, >75% remained on HD at 30, 90, and 180 days after the switch. Given this compelling evidence that most patients did not return to PD, timely HD vascular access planning (as soon as the switch occurs) is paramount. In the USRDS registry, among patients with CKD who progress to ESRD, nearly 80% initiate dialysis with a catheter (7), despite vascular access initiatives to increase permanent vascular access use at dialysis initiation (8,9). Subsequently, there is a gradual reduction in catheter dependence (68% at 90 days and 44% at 180 days), with a parallel increase in AVF use (25% at 90 days and 45% at 180 days) (7). In our study, 85% of patients were catheter dependent at 30 days after the switch from PD to HD. The high rate of catheter dependence at 30 days is not surprising and likely reflects that one cannot prepare for PD failure, especially if it is caused by peritonitis. However, given the close follow-up of patients on PD by nephrologists and dialysis nurses, one might have expected better vascular access outcomes by 90 and 180 days after the modality switch compared with the rate observed in patients with advanced CKD initiating HD. Unexpectedly, these outcomes were actually worse in the patients switching from PD to HD, with 76% and 51% remaining catheter dependent at 90 and 180 days, respectively, and 18% and 37% using an AVF at 90 and 180 days, respectively. Similarly, other investigators have observed a high frequency of catheter dependence in patients switching from PD to HD. Pulliam *et al.* (1) observed in a large United States dialysis chain that, at 90 days after the switch to HD, 78% used a catheter. Lam *et al.* (6) reported from an Australian/New Zealand cohort that 76% of these patients used a dialysis catheter as their initial access at the time of switch to HD.

What are some potential explanations for delayed placement and use of a permanent vascular access in patients switching from PD to HD? First, patients may switch from PD to HD for a variety of reasons, with the leading ones

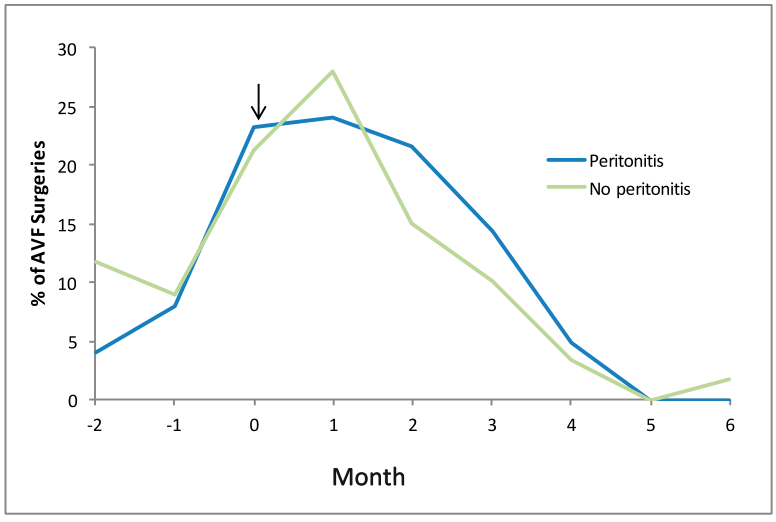

Figure 2. | Patients who switch from peritoneal dialysis to hemodialysis with a prior episode of peritonitis are less likely to undergo AVF surgery in the 2 months preceding the switch. P=0.02 for the comparison of patients with and without peritonitis before the modality switch. The arrow refers to month 0 and the time from the peritoneal dialysis switch to hemodialysis.

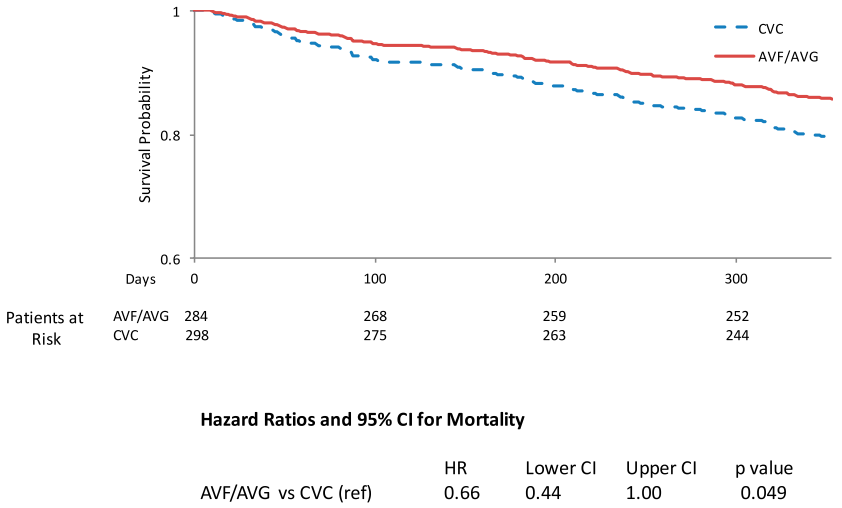

Figure 3. | Patients using a CVC 6 months following the switch from peritoneal dialysis to hemodialysis have a higher mortality in the ensuing year, as compared to those using an AVF or AVG. Covariates adjusted for include age, sex, race, diabetes, hypertension, cardiovascular disease, cancer, chronic obstructive pulmonary disease, and prior peritonitis. Note better survival among patients using permanent vascular access (arteriovenous fistula [AVF] or arteriovenous graft [AVG]) at 6 months compared with those who remained catheter dependent (hazard ratio [HR], 0.66; 95% confidence interval [95% CI], 0.44 to 1.00; *P*=0.05). CVC, central venous catheter.

being technique failure and prior peritonitis (10–12). Other common etiologies of PD modality switch include ultrafiltration failure, patient fatigue from daily PD procedure, development of omental wrap, technical issues, or worsening quality of life. Peritonitis preceded the switch in 48% of our study cohort, similar to the rate reported in two previous studies (35%–42%) (1,6). Whereas technique failure typically entails a permanent switch to HD, patients with peritonitis are frequently expected to resume PD. Thus, it seems reasonable to delay placement of a vascular access, because it may not be needed. However, contrary to that expectation, we found that the likelihood of the switch from PD to HD being permanent was similar in patients with or without a prior peritonitis episode. Our data show a greater delay in placing and using a permanent vascular access in patients with a peritonitis episode before the PD to HD switch. As a consequence, this patient subset had higher rate of catheter dependence at 30, 90, and 180 days after the switch.

Second, another potential explanation for the prolonged catheter dependence in patients switching from PD to HD is that some patients deliberate for a prolonged period of time about whether they wish to resume PD at a later time. Such patients are unlikely to be referred for a permanent vascular access until they commit to staying on HD. Al-Jaishi *et al.* (13) reported from a Canadian registry that, among those without vascular access creation before switching from PD to HD, only 46% and 52% had an arteriovenous access created within 12 and 18 months, respectively. The delay in using an AVF after the PD to HD use can be attributed to not only the delay in AVF creation but also, the high nonmaturation rate of new AVF and the prolonged interval from AVF creation to its successful use. AVF maturation failure may be as high as 60% (14–17). Recent data from the USRDS report that AVF maturation failure rate in the United States is currently 36%, with a mean interval of 135 days from AVF creation to first successful use among patients whose AVF matured (7).

The clinical consequences of delayed transition to permanent vascular access in patients switching from PD to HD are substantial. In this study, patients who remained catheter dependent at 6 months after the PD to HD switch had greater mortality in the subsequent year compared with those using a permanent vascular access. Similarly, an Australian/New Zealand cohort study reported that, among patients switching from PD to HD, those who commenced HD with a permanent vascular access had superior survival than those who commenced with a catheter (6). These findings highlight the urgent need to develop programs and strategies to optimize vascular access planning in patients transitioning from PD to HD. Finally, vascular access placement should be just as expeditious in those patients switching from PD to HD after an episode of peritonitis as it is in those patients switching for other reasons.

One major strength of this study is the use of a national cohort of all Medicare–insured patients on dialysis available from the USRDS. A second strength is the ability to determine the timing of vascular access placement relative to the switch from PD to HD by using V codes reported monthly by every dialysis unit. These codes, collected only since July of 2010, allow for direct assessment of the vascular access type used at the end of each month. Our study also has some limitations. First, we were not able to collect information regarding the actual reasons for switching from PD to HD. We inferred that peritonitis was the reason for the switch in patients who had a peritonitis episode in the 2-month period preceding the switch. However, it is possible that some of them actually switched because of an unrelated reason. Second, there may be residual confounding because of patient characteristics that were not available in the datasets used for this study and therefore, were not incorporated into the statistical models. Third, our study included only patients who were on PD at day 90 and continued on PD continuously

for at least 60 days. Although there may be different methods to classify such patients, we adopted the standard definition of PD used in prior PD studies using the USRDS (18–21). The limitations mentioned above are inherent to all observational studies using large administrative datasets.

In conclusion, among patients who switch from PD to HD, prior peritonitis is associated with a high rate of persistent HD catheter use, which in turn, is associated with lower patient survival. Studies addressing vascular access planning and implementation are needed in this group of patients.

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Disclosures

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