Urgent Start Peritoneal Dialysis: A Population-Based Cohort Study

Neelam M. Bhalla, Neiha Arora, Jeanne A. Darbinian, and Sijie Zheng

Rationale & Objective: It is a common practice to start patients in urgent need of dialysis on hemodialysis via a central venous catheter. Because central venous catheter use is associated with increased risk of infections, hospitalizations, and mortality, urgent start peritoneal dialysis (PD) increasingly represents a viable alternative. This study aimed to examine clinical outcomes, complications, mortality, and modality retention in patients who initiated urgent start PD.

Study Design: Retrospective cohort study.

Setting and Participants: Eighty-four adult members of a large integrated health care system who initiated urgent start PD between January 1, 2011, and December 31, 2014.

Exposure: Urgent start PD.

Outcomes: Retention rates at 30, 90, and 365 days; time to the development of noninfectious and infectious complications, modality failure, and all-cause mortality.

Analytical Approach: Cumulative incidence of all-cause mortality was estimated using the Kaplan-Meier method. Retention rates for PD were computed using binomial proportions.

Approximately 600,000 patients in the United States have end-stage kidney disease, 460,000 of whom are receiving dialysis annually. The overwhelming majority (92%) are started on in-center hemodialysis (HD), of which 80% do so via a central venous catheter (CVC). Moreover, in patients with unplanned dialysis initiation, HD with a CVC is the default method. CVC use has been shown to be associated with increased infectious complications, hospitalizations, and mortality.

In the last decade, peritoneal dialysis (PD) has been used in patients requiring urgent start of dialysis. PD is a safe and effective home modality and has several advantages over HD. In urgent start PD, the catheter is placed and can be used within 24 hours, rather than the traditional 2 weeks. The treatment is modified at initiation (low fill volumes, supine position, cycler use) and increased as tolerated. It can be started in the hospital and transitioned to an outpatient clinic, where it is done by a PD nurse several times per week. Training of PD is given concurrently at the outpatient PD unit.

Urgent start PD has been shown to have a low incidence of complications, including peritonitis, leaks, catheter malfunction, hospitalizations, and modality failure, with favorable 90-day outcomes. The objectives of this study were to examine the demographic and clinical characteristics in patients who were initiated on urgent start PD and to assess complications, survival rate, and modality failure at defined time intervals. We also followed the retention rate of urgent start PD and examined factors leading to a change in modality. We hypothesized that urgent start PD would have low complication rates and high retention rates and thus would be a viable alternative to urgent start HD via CVC.

METHODS

Study Design

This retrospective cohort study was conducted within the membership of Kaiser Permanente Northern California (KPNC), an integrated health care system with more than 4.5 million members. The membership is racially and ethnically diverse, with demographic characteristics similar to that of the underlying population, except at the extremes of income.

Study Eligibility

From electronic hospitalization discharge records, we identified a preliminary cohort of adult KPNC members who underwent placement of a catheter for PD between January 1, 2011, and December 31, 2014. The ascertainment of relevant procedures was based on the International
The traditional practice of starting people in urgent need of dialysis on hemodialysis via central venous catheter is associated with increased risk of infection, mortality, and hospitalization. Increasingly, peritoneal dialysis (PD) is being used in patients requiring urgent start of dialysis. We studied patients who underwent urgent start PD in a large, integrated, racially and ethnically diverse health care system and assessed retention, complications, and mortality during the first year after the initiation of the modality. Our results showed that there was a high retention rate of the PD modality at the end of 1 year, as well as a high survival rate. These results help validate that PD is a safe and sustainable treatment option for patients requiring prompt and unplanned dialysis.

Classification of Diseases, Ninth Revision (ICD-9) and Current Procedural Terminology codes for the creation of cutaneoperitoneal fistula and insertion of tunneled intraperitoneal catheter for dialysis, performed surgically or laparoscopically. Qualifying procedures must have been linked to 1 or more supporting ICD-9 diagnosis codes for acute kidney injury, stage 5 chronic kidney disease, or both, made within 7 days before or after the procedure, hospital admission, or discharge. Tables S1 and S2 provide the complete list of diagnosis codes and Table S3 provides the complete list of procedure codes included in the initial ascertainment of eligible cases. In addition, the ICD-9 procedure code for the PD modality (54.98) was captured from the index hospital discharge records where available.

After excluding members aged <18 years on the date of the procedure, we identified 1,675 health plan members who met the initial procedural and diagnostic criteria for urgent start PD. The identification of eligible urgent start PD cases is depicted in Fig 1. We excluded 1,478 of the initial 1,675 cases for the reasons shown in Fig 1. Of the remaining 197 patients, 96 were deemed potentially eligible urgent start PD cases after preliminary medical record review. A subsequent review confirmed that 84 were eligible urgent start cases, and these comprised the final participants for the study.

The insertion of PD catheters was performed by surgeons (via laparoscopic placement) or interventional radiologists (by percutaneous placement), depending on the local expertise at the medical center where the patient was treated. Surgeons repaired hernias or performed omentopexy based on surgical findings. The 84 patients requiring urgent start PD received care at 16 different hospitals throughout the region.

Per current clinical practice, urgent start PD is initiated at low fill volumes (1.0-1.2 L) in the supine position and employing a cycler; volume is increased as tolerated. The initiation can occur in the hospital or at the outpatient clinic (PD unit), where it is performed by a PD nurse 3-5 times per week for 6-8 hours per day. Training of PD is done at the same time.

The KPNC Institutional Review Board (IORG #00001045) approved this study with a waiver of informed consent due to the retrospective, data-only design of the study.

Data Collection
Data were obtained from electronic clinical and administrative databases and included hospital discharge records, outpatient clinical encounters, patient demographic and clinical characteristics, acute inpatient hospitalizations, and deaths during the study period. We calculated the Deyo version of the Charlson Comorbidity Index using a 1-year precatheter insertion capture of diagnosis and procedure codes linked to inpatient and outpatient encounters.27,28 Prior kidney care was ascertained from the number of clinical encounters linked to nephrology clinics or providers between 1 and 6 months before the initiation of urgent start dialysis. Chart review was conducted by the study’s investigators to confirm urgent start PD status. This was defined as the need to initiate dialysis urgently, secondary to late referral or unexpected deterioration in kidney function, in patients without a pre-existing arteriovenous fistula or arteriovenous graft. Patients who were initiated on PD within 2 weeks after the placement of the intraperitoneal catheter also met criteria for urgent start PD.

Study Outcomes and Definitions
For all valid urgent dialysis patients, the investigators collected data on complications and outcomes that occurred during the 1-year period after the initiation of dialysis using a structured data collection tool. Complications were broadly categorized as noninfectious or infectious. The noninfectious complications were classified further as major (hernia, hydrocele, and catheter injury) and minor (bleeding managed conservatively, pericatheter leak, and catheter malfunction). The infectious complications included peritonitis and exit site infection. The outcomes of interest were death (secondary to any cause), cessation of dialysis modality, kidney transplant, and recovery of kidney function.

Statistical Analysis
For the final cohort, the cumulative incidence of all-cause mortality at 12 months was estimated using the Kaplan-Meier method. Associated pointwise 95% confidence intervals for the survivor function were computed using a log-log transformation. Retention rates for PD at 1, 3, and 12 months were computed using binomial proportions with exact 95% confidence intervals.

The follow-up began at study entry (initiation of urgent start dialysis); for analyses that examined mortality risk, the follow-up ended with death, loss to follow-up because...
of disenrollment from the health plan, or 1 year after study entry, whichever occurred first. To calculate PD retention rates, the follow-up ended with the first occurrence of initial dialysis modality cessation, death, kidney transplant, recovery of kidney function, loss to follow-up, or 1 year after study entry, whichever occurred first. At each time point examined, patients whose follow-up ended for reasons other than not tolerating PD (medical or psychosocial reasons) before the end point were excluded from the denominator. All analyses were performed using SAS version 9.3 (SAS Institute).

**RESULTS**

The final analytic cohort consisted of 84 urgent start PD cases. As presented in Table 1, 54 (64.3%) cases were men, and roughly one-third comprised each of the 3 groups shown for age at dialysis initiation. Asians/Pacific Islanders were the largest racial/ethnic group with 29 (34.5%) patients, followed by 20 (23.8%) non-Hispanic Whites, 16 (19.1%) African Americans, and 16 (19.1%) Hispanics. Progressive stage 5 chronic kidney disease was the major reason for the initiation of urgent start PD in 53
Table 1. Characteristics of the 84 Urgent Start Peritoneal Dialysis Cases

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>30 (35.7%)</td>
</tr>
<tr>
<td>Male</td>
<td>54 (64.3%)</td>
</tr>
<tr>
<td>Age (y), median (IQR)</td>
<td></td>
</tr>
<tr>
<td>18-49</td>
<td>28 (33.3%)</td>
</tr>
<tr>
<td>50-64</td>
<td>27 (32.1%)</td>
</tr>
<tr>
<td>≥65</td>
<td>29 (34.5%)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>20 (23.8%)</td>
</tr>
<tr>
<td>African American</td>
<td>16 (19.1%)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>29 (34.5%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>16 (19.1%)</td>
</tr>
<tr>
<td>Otherb</td>
<td>3 (3.6%)</td>
</tr>
<tr>
<td>BMI (kg/m²), median (IQR)</td>
<td></td>
</tr>
<tr>
<td>&lt;25.0</td>
<td>30 (35.7%)</td>
</tr>
<tr>
<td>25.0-29.9</td>
<td>28 (33.3%)</td>
</tr>
<tr>
<td>≥30.0</td>
<td>26 (31.0%)</td>
</tr>
<tr>
<td>Charlson Comorbidity Indexc</td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>4.0 (3.0, 5.0)</td>
</tr>
<tr>
<td>0-2</td>
<td>18 (21.4%)</td>
</tr>
<tr>
<td>3-4</td>
<td>29 (34.5%)</td>
</tr>
<tr>
<td>5+</td>
<td>37 (44.1%)</td>
</tr>
<tr>
<td>Prior renal cared</td>
<td>55 (65.5%)</td>
</tr>
<tr>
<td>Reason urgent start dialysis initiated</td>
<td></td>
</tr>
<tr>
<td>AKI associated with infection</td>
<td>3 (3.6%)</td>
</tr>
<tr>
<td>AKI not associated with infection</td>
<td>28 (33.3%)</td>
</tr>
<tr>
<td>Progressive CKD5</td>
<td>53 (63.1%)</td>
</tr>
<tr>
<td>Backup HD</td>
<td>23 (27.4%)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; HD, hemodialysis; IQR, interquartile range; AKI, acute kidney injury; CKD5, chronic kidney disease stage 5.
a Includes multiracial, American Indian, and unknown race/ethnicity.
b Weighted score (Deyo method) based on 17 comorbid conditions ascertained from in- and outpatient clinical encounters in year before the initiation of urgent start dialysis. For the highest category (index score ≥ 5), the range was 5-9.
c First occurrence.
d With ≥1 visit to nephrology clinic 1-6 months before the initiation of urgent start dialysis. Encounter types included telephone (scheduled or otherwise), office visit (face-to-face), or secure messaging.

(63.1%) patients, and 55 (65.5%) patients had nephrology clinic encounters before the initiation of dialysis.

The complications incurred up to 1 year after the initiation of urgent start dialysis are summarized in Table 2. Major noninfectious complications were rare, occurring in 4 (4.8%) patients, and included right inguinal hernia, hydrocele, and catheter injury. Among minor noninfectious complications, catheter malfunction occurred in 5 (6.0%), bleeding that was managed conservatively occurred in 2 (2.4%), and pericatheter leaks occurred in 6 (7.1%). Catheter patency was re-established in 4 of the 5 (80%) occurrences of catheter malfunction. Infectious complications occurred in 17 (20%) patients and included peritonitis in 8 (9.5%), exit site infections in 6 (7.1%), and both complications in 3 (3.6%). We selected the cutoff point of 21 days (3 weeks) to attribute complications to the urgent start procedure versus other factors. Among the 17 patients with noninfectious complications, we observed that 1 had a major complication (right inguinal hernia) and 9 had minor complications (4 had catheter malfunctions, 3 pericatheter leaks, and 2 bleeding managed conservatively) that occurred less than 3 weeks after the initiation of urgent start PD and thus were potentially attributable to the procedure. For the remaining 7 patients with noninfectious complications, 3 had major complications (right inguinal hernia, hydrocele, and catheter injury) and 4 minor (1 had a catheter malfunction and 3 pericatheter leaks) that occurred 3 or more weeks after the initiation of urgent start PD and were less likely to be attributed to the procedure itself. All 17 cases of infectious complications occurred more than 21 days after initiation of urgent start PD.

The PD retention rates were calculated at 3 end points: 30 days, 90 days, and 1 year after the initiation of urgent start dialysis (Fig 2). The retention rate was 98.8% at 30 days after study entry, with 83 patients remaining on PD; 1 patient switched to HD after 9 days for psychosocial reasons. By 90 days, the follow-up ended for 4 patients because of kidney transplant (n = 2), recovery of kidney function (n = 1), or death (n = 1). Among the remaining 80 patients, 73 still received PD (91.3% retention rate) and 7 stopped for medical (n = 3, 42.9%) or psychosocial (n = 4, 57.1%) reasons. Within 1 year after PD initiation, the follow-up ended for 14 patients secondary to kidney transplant (n = 4, 28.6%), death (n = 5, 35.7%), recovery of kidney function (n = 1, 7.1%), or health plan disenrollment (n = 4, 28.6%). The retention rate was 80% at 1 year, with 70 patients remaining under observation and, among these, 56 still receiving PD. Of the 14 patients no longer receiving PD, 12 (86%) switched to HD. The reasons for discontinuing PD were psychosocial for 6 (42.9%) patients, medical for 5 (35.7%) patients, peritonitis for 2 (14.3%) patients, and catheter malfunction for 1 (7.1%) patient.

Acute inpatient hospitalizations during follow-up are summarized in Table 3. In the first year after the initiation of dialysis, 43 (51.2%) patients who underwent urgent start PD were hospitalized; the median length of stay was 3.0 days. In total, there were 96 unique inpatient
encounters; the reasons for hospitalization (based on principal discharge ICD-9 diagnosis codes) were cardiovascular complications for 35 (36.5%) encounters, dialysis related for 4 (4.2%), kidney, excluding dialysis, for 2 (2.1%), infection for 23 (24.0%), and other for 32 (33.3%).

The outcomes by 1 year after the initiation of urgent start PD are shown in Table 4. Seven of the 84 patients died during the follow-up period; the cumulative incidence of all-cause mortality was 9.7% (95% CI, 4.7%-19.4%). For the survival analysis, the mean (± standard deviation) follow-up time was 302 ± 155 days and ranged from 9-365 days. The underlying cause of death (ascertained from the patient’s state death certificate record) included complications related to cardiovascular disease in 1 (14.3%), diabetes-related complications in 3 (42.9%), infection in 1 (14.3%), malignancy in 1 (14.3%), and kidney disease in 1 (14.3%).

**DISCUSSION**

Within a large integrated health care system comprised of a diverse population, we have observed that urgent start PD is a feasible and sustainable modality, with high retention and low catheter malfunction rates and an overall survival rate of 90.3% at 1 year after initiation. This study demonstrates that urgent start PD is a viable alternative to traditional urgent start HD with a CVC.

Based on historical precedent, the default treatment of patients with acute kidney injury is in-center HD via CVC. A recent position paper from the Renal Physicians Association has called for the reassessment of this paradigm. Patients starting dialysis with a CVC have higher rates of infection, hospitalization, and mortality.

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**Table 3. Acute Inpatient Hospitalizations During the Follow-up for the 84 Urgent Start Peritoneal Dialysis Cases**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute inpatient hospitalizations</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>41 (48.8%)</td>
</tr>
<tr>
<td>1</td>
<td>17 (20.2%)</td>
</tr>
<tr>
<td>2+</td>
<td>26 (31.0%)</td>
</tr>
<tr>
<td>Median (IQR)a</td>
<td>1.0 (0.0, 2.0)</td>
</tr>
<tr>
<td>Length of stay (d), median (IQR)b</td>
<td>3.0 (1.0, 5.0)</td>
</tr>
</tbody>
</table>

Abbreviation: IQR, interquartile range.

aRange: 0-10.

bLength of stay (days) for subset of cases with ≥1 hospital encounter where admission was after the initiation of urgent start dialysis modality. Range: 1-32.

**Table 4. Outcomes for the 84 Urgent Start Peritoneal Dialysis Cases**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modality failurea</td>
<td>14 (16.7)</td>
</tr>
<tr>
<td>Kidney transplant</td>
<td>4 (4.8)</td>
</tr>
<tr>
<td>Recovery of kidney function</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>Deathtb</td>
<td>7 (8.3)</td>
</tr>
</tbody>
</table>

aReasons for failure: catheter malfunction (n = 1); peritonitis (n = 2); medical (n = 5, including hydrothorax, hydrocele, calciphylaxis, and malignancy); psychosocial (n = 6).

bDeaths occurred >30 days after the initiation of urgent start dialysis modality (by design).
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compared with patients starting HD with a mature arteriovenous fistula or arteriovenous graft.\textsuperscript{1-7} PD is greatly underutilized, despite patients starting PD having lower mortality in the first 2 years than patients starting HD.\textsuperscript{1,16-19} After the 2011 Medicare prospective payment system reform, PD prevalence only increased from 9.4% to 12.6%.\textsuperscript{20} The reasons for this are multifactorial and include less emphasis on PD education in nephrology training programs.\textsuperscript{31} Even fewer programs offer urgent start PD in the United States.

KPNC provides health care to 4.5 million members in the region, and The Permanente Medical Group is the largest multispecialty group therein, encompassing 21 medical centers. KPNC and The Permanente Medical Group have increased PD incidence from 15% to 33% over the past 10 years through a multidisciplinary system-wide approach.\textsuperscript{32}

In this study, complications incurred by PD urgent starts, including infectious complications, were not associated with increased morbidity or mortality, in contrast to bacteremia often seen with CVC in HD urgent starts. The longer-term outcome of urgent start PD was excellent, with a notably high retention rate. There were 14 events of modality failure among urgent start PD cases (16.7%) attributable to the following: psychosocial reasons in 6 (42.9%); catheter malfunction in 1 (7.1%); peritonitis in 2 (14.2%); medical causes in 5 (35.7%: 2 calciphylaxis; 1 malignancy; 1 hydrothorax; 1 hydrocele). Most of these occurred after 90 days.

Our study results are consistent with other reports from the literature. Masseur et al\textsuperscript{14} followed 81 patients who started PD urgently and had a 92.6% retention rate at 90 days. Lobbedez et al\textsuperscript{23} compared outcomes between 34 PD urgent starts and 26 HD urgent starts with a CVC. They reported similar survival, unaffected by dialysis modality. The actuarial technique survival was 90% at 6 months and 88% at 1 year in the patients who underwent urgent start PD.\textsuperscript{24}

Koch et al\textsuperscript{25} noted no difference in survival between HD and PD groups at 6 months in their study. Patients who underwent HD had a higher overall and infectious mortality risk.\textsuperscript{25} Similarly, Iverson and Povlsen\textsuperscript{10} reported 3-month technique survival of 75% in 52 patients who underwent urgent start PD. Xu et al\textsuperscript{24} investigated the prevalence of mechanical complications related to the PD catheter and abdominal wall in 922 patients started on urgent PD. Abdominal wall complications developed in 4.8% (hernia 55%; hydrothorax 25%; hydrocele 14%; leak 7%), whereas catheter complications were seen in 9.5%. The overall technique survival was 92%, and peritonitis rate was low.\textsuperscript{24}

Urgent start PD has been shown to be more cost effective than urgent start HD via CVC. Liu et al\textsuperscript{11} assessed the costs associated with urgent start PD, urgent start HD, or dual approach over the first 90 days. The estimated per patient cost was $16,398 for urgent PD, $19,352 for urgent HD, and $19,400 for HD and PD.\textsuperscript{33} Given the small number of patients in this study, we did not perform cost analysis.

Ideally, all patients with chronic kidney disease should start dialysis optimally, that is, either on HD with a mature access or on PD as a planned elective start. However, many patients continue to be started in an unplanned way on HD using a CVC, despite the associated increased risk of complications and reduced survival. Urgent start PD has the potential to reduce the use of CVC and increase the utilization of PD.

The Advance America Kidney Health initiative has provided an impetus to increase home dialysis and preemptive transplant, with a goal of reaching an 80% incidence of either or both by 2025. To achieve this goal, the nephrology community must take bold steps to change the current approach of providing suboptimal kidney replacement therapy for incident dialysis patients. This study demonstrates that urgent start PD is safe and feasible and can increase home dialysis in accordance with the Advance America Kidney Health initiative.

Since the COVID-19 pandemic began, preliminary data have shown that patients receiving PD have lower risk of infection for COVID-19 than those receiving in-center HD,\textsuperscript{34} underscoring the need to provide the option of urgent start PD. During the pandemic, many medical centers have considered arteriovenous fistula/arteriovenous graft placement surgery as nonurgent, leading to delayed access creation. In our experience, patients delayed laboratory surveillance of kidney function because of the fear of coming to medical facilities, with resultant acute kidney injury or occult chronic kidney disease progression in some, necessitating urgent dialysis. Urgent start PD is a good alternative in this setting.

A major strength of our study is that it derived from a large, contemporary, diverse population in an integrated health care system in Northern California.\textsuperscript{36} Furthermore, we had a wealth of electronic clinical data that supported our analysis. Our study did have limitations. We were unable to identify a comparable (well-matched) group of patients requiring urgent start HD; thus, our study was limited to reporting outcomes and complications among patients requiring urgent start PD only. Furthermore, our cohort comprised a small number of patients within a single integrated health care system, in which health care delivery is well coordinated. It is unclear whether our results are generalizable to other health care systems, where the delivery of care historically has been more fragmented. Ideally, a prospective, multicenter randomized study should be conducted to confirm the results.

In conclusion, within an integrated health care system, urgent start PD was shown to be a safe, viable, and sustainable treatment option. Given the recent executive order for increasing home dialysis incidence, urgent start PD should be more widely used for patients needing prompt and unplanned dialysis initiation.
SUPPLEMENTARY MATERIAL

Table S1: ICD-9 Diagnosis Codes for Chronic Kidney Disease (CKD)

Table S2: ICD-9 Diagnosis Codes for Acute Kidney Injury (AKI) and Acute Kidney Failure (AKF)

Table S3: ICD-9 and CPT-4 Procedure codes for Peritoneal Dialysis (PD) Access

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REFERENCES


