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Research Article

Implementation of Urgent Start Peritoneal Dialysis Reduces Hemodialysis Catheter Use and Hospital Stay in Patients with Unplanned Dialysis Start

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Keywords
Dialysis · Urgent start · Peritoneal dialysis · Unplanned · Hemodialysis catheter · Hospital stay

Abstract
Background: Unplanned start of renal replacement therapy is common in patients with end-stage renal disease and often accomplished by hemodialysis (HD) using a central venous catheter (CVC). Urgent start using peritoneal dialysis (PD) could be an alternative for some of the patients; however, this requires a hospital-based PD center that offers a structured urgent start PD (usPD) program. ***Methods:*** In this prospective study, we describe the implementation of an usPD program at our university hospital by structuring the process from presentation to PD catheter implantation and start of PD within a few days. For clinical validation, we compared the patient flow before (2013–2015) and after (2016–2018) availability of usPD. ***Results:*** In the 3 years before the availability of usPD, 14% (n = 12) of incident PD patients (n = 87) presented in an unplanned situation and were initially treated with HD using a CVC. In the 3 years after implementation of the usPD program, 18% (n = 18) of all incident PD patients (n = 103) presented in an unplanned situation of whom n = 12 (12%) were treated with usPD and n = 6 (6%) with initial HD. usPD significantly reduced the use of HD by 57% (p = 0.0005). Hospital stay was similar in patients treated with usPD (median 9 days) compared to those with elective PD (8 days), and significantly lower than in patients with initial HD (26 days, p = 0.0056). ***Conclusions:*** Implementation of an usPD program reduces HD catheter use and hospital stay in the unplanned situation.

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Introduction

Unplanned start of renal replacement therapy (RRT) can be defined as initiation of dialysis without a permanent access or in a life-threatening situation [1, 2]. Unplanned start of dialysis is very common and occurs in 24–49% of all patients with end-stage renal disease (ESRD) [3]. In a study involving 840 Scandinavian patients, 43% of all patients experienced unplanned dialysis start, which was due to acute progression (15%), uremia (8%), late referral (6%), delayed planning (5%), patient noncompliance (2%), initial refusal of dialysis (2%), and other reasons (5%) [4]. Despite efforts to increase early referral and close monitoring of ESRD patients, unplanned start cannot be completely prevented and will continue to challenge nephrologists worldwide.

In most instances, unplanned start of dialysis is often accomplished by hemodialysis (HD) using a central venous catheter (CVC) that exposes the patients to the risks of infection and other catheter-related complications [5–7]. A study investigating the influence of dialysis timing and access in incident HD patients found that unplanned dialysis start was associated with increased mortality and that patients with unplanned start using a CVC had the highest mortality [8]. The increased mortality risk associated with CVC use in an unplanned situation was also found in the Danish Nephrology Registry [9].

To improve patient outcomes by avoiding CVC use, unplanned dialysis start using peritoneal dialysis (PD) could be an alternative for some patients. Normally, PD is started 2–4 weeks after elective catheter implantation allowing adequate healing as recommended by the guidelines of the International Society of PD [10]. In unplanned or urgent start PD (usPD), PD treatment is started within a few days after PD catheter implantation, either using automated PD (APD) or manual changes [9, 11–13]. In the past years, usPD has emerged as a treatment modality for patients with unplanned dialysis start [9, 11, 14]. Multiple studies have found that usPD was not associated with increased mortality compared to unplanned HD [9, 15, 16] and planned PD [17]. However, usPD requires a hospital-based PD center that is able to ensure PD catheter implantation and initiation of PD treatment in an urgent manner within a few days. To offer usPD, PD centers must be highly structured and organized involving not only a PD committed nephrology team but also a close collaboration with surgeons, anesthesiologists, and hospital management. Ghaffari reported the development of an usPD program using a standardized patient flow chart [18]. Patients eligible for usPD were those with an urgent need for dialysis initiation within 48 h to 14 days, whereas patients with an emergent dialysis indication within 48 h due to a life-threatening situation were excluded [18]. Although usPD provides adequate solute removal using either manual bag exchanges or APD, there have been concerns about early mechanical complications such as dialysate leakage and catheter dysfunction that arise from the immediate use of the PD catheter [17–20].

In this prospective study, we describe the successful implementation of an usPD program at our PD center that allowed PD initiation within a few days using APD in eligible patients. Within a 3-year clinical validation period, we demonstrate that implementation of usPD reduces the use of CVC and shortens hospital stay in the patients with unplanned dialysis start.

Methods

Development of an usPD Program

In 2015, we developed an usPD program at our nephrology division, which is part of the Department of Internal Medicine of the University Hospital Tuebingen, Germany. We optimized structural and organizational processes to offer PD catheter implantation and PD treatment within a few days from presentation of the patient. We used the patient flow chart

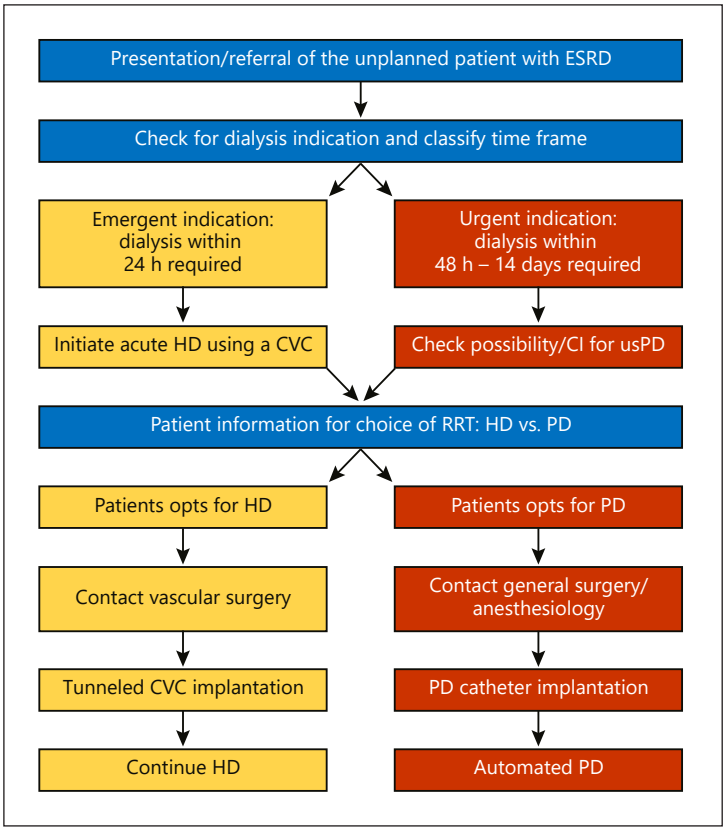

Fig. 1. Patient pathway developed for the implementation of a usPD program at our center. usPD was offered to ESRD patients requiring dialysis between 48 h and 14 days, whereas those with an emergent indication received acute HD. All patients underwent a structured information on HD and PD to opt for their renal replacement treatment of choice. usPD was started only in patients who actively opted for PD. In patients opting for HD, creation of an arteriovenous fistula or graft at the time of implantation of a tunneled CVC is a desirable option. CI contraindications for usPD such as large hernias or active bowel disease. HD, hemodialysis; CVC, central venous catheter; PD, peritoneal dialysis; RRT, renal replacement therapy; ESRD, end-stage renal disease.

published by Ghaffari [18] as a basis for developing our own patient pathway as shown in Figure 1. All patients with irreversible renal failure due to ESRD who were referred from external nephrologists or practitioners or presented with symptoms of ESRD at our hospital were assessed by a nephrologist of our team for indication to initiate RRT. If RRT was indicated, the patient was assessed with regard to the need of emergent dialysis within the same day or urgent dialysis in a time window of 48 h until 14 days. In patients with an emergent dialysis indication (nausea, vomiting, foetor, cardiac decompensation, hyperkalemia >6.5 mM, base excess <–12 mM), acute HD using a temporal CVC was started. In patients with an urgent dialysis indication, PD was considered by checking the feasibility (including assisted PD) and ruling out contraindications such as large hernias, active bowel disease, presence of tubes perforating the abdominal wall (e.g., gastrostomy). All patients considered eligible for usPD received structured information on the choice of dialysis modality (HD vs. PD) including their relatives within 48 h. Patients treated with acute HD also received the same structured information; however, this was done after 1–2 weeks of in-patient treatment.

PD Catheter Implantation and PD Regimen in usPD

If the patient with an urgent dialysis indication opted for PD and no contraindications were present, the nephrology team contacted the department of surgery and anesthesiology to arrange PD catheter implantation within the next 2–3 days. PD catheters were implanted surgically via paramedian abdominal incision and lateral exit of the catheter using an arcuate tunnel. To ensure seal of the peritoneal cavity and to minimize the risk of leakage, we generally use dual cuffed catheters with a disk-and-ball deep cuff, either with a straight (Swan-neck) or curled (Oreopoulus-Zellermann) intraperitoneal segment depending on the patient's height

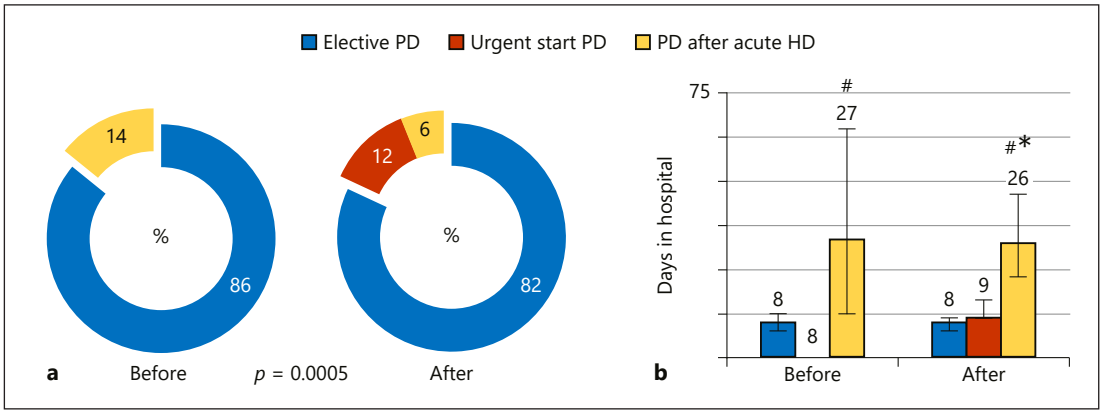

Fig. 2. Distribution of incident PD patients (**a**) before and after implementation of an usPD program and hospital stay (**b**). Implementation of an usPD program significantly reduced the proportion of patients with acute HD. Patients treated with usPD had a hospital stay (median with IQR) comparable to those with elective planned PD. Statistical testing was done using the χ^2 test. # Significant difference to elective PD, * significant difference to usPD. HD, hemodialysis; PD, peritoneal dialysis.

and waistline. Standard prophylactic antibiotic treatment with 2 g cephazolin was given the evening before, during, and 8 h after implantation.

usPD was commenced the next day using APD and 5 or 10 L dialysate (lowest or middle glucose concentration) over 10 h with 6–13 cycles and 50–70% tidal to reduce abdominal discomfort [17]. The first and last fill volume was 1,000 and 500 mL, respectively. APD treatments were performed at daytime every day, and after improvement of the patient's condition, PD training was started over 5 days for the PD modality to be used after discharge at home (APD or continuous ambulatory PD, CAPD).

In planned or elective PD (pPD), patients received only flushes of the peritoneum after PD catheter implantation using 200–300 mL for 3 days. During subsequent training, dialysate was only filled into the peritoneum with maximally 1,000 mL without intending effective clearance as in usPD.

Study Design and Study Cohort

The study cohort included all patients with ESRD who underwent de novo PD catheter implantation and started PD in our center through the years 2013–2018. These incident patients were stratified according to presentation into 3 groups. The first group was planned patients referred by external nephrologists in an elective manner after the patient had opted for PD. The second group was patients who had to be acutely hemodialyzed before they opted for PD and were switched during the same hospital stay. The third group was patients who underwent usPD, which was implemented after January 1, 2016, at our center. Data acquisition after this date was prospective, and for comparison we analyzed patients treated in the 2013–2015 retrospectively in a before-and-after design. Informed consent was obtained for data acquisition and analysis.

Statistical Analysis

Differences between the treatment groups were tested for significance using the chi-square-test or Wilcoxon test (Fig. 2) as well as ANOVA (Table 1). Proportions were tested for significance using the Fisher's exact test. All statistical analyses were done with MedCalc Statistical Software version 16.4.2 (MedCalc Software bvba, Ostend, Belgium). A p value <0.05 was considered statistically significant.

Table 1. Patient characteristics of incident PD patients after implementation of the urgent start PD program

	PD after acute HD	Urgent start PD	Planned PD	*p* value
Number	6	12	64	
Males, n (%)	4 (66)	6 (50)	36 (56)	0.319
Age, years	37 (33–61)	58 (46–68)	60 (51–66)	<0.001
Renal disease	Glomerulonephritis (*n* = 3), aHUS (*n* = 1), cardiorenal syndrome (*n* = 1), diabetic nephropathy (*n* = 1)	Nephrosclerosis (*n* = 5), renal graft failure (*n* = 4), glomerulonephritis (*n* = 2), cardiorenal syndrome (*n* = 1)	Diabetic nephropathy (*n* = 13), nephrosclerosis (*n* = 12), glomerulonephritis (*n* = 17), polycystic disease (*n* = 9), renal graft failure (*n* = 9), others (*n* = 4)	
Duration of CKD, years	1 (0–2)	8 (2–16)	11 (8–20)	0.002
Prior follow-up by nephrologist, n (%)	2 (33)	11 (92)	64 (100)	<0.001
Plasma creatinine, mg/dL	12.7 (7.6–15.7)	7.4 (5.7–12.9)	7.0 (5.7–7.7)	0.001
MDRD-GFR, mL/min/1.73 m^2	4.4 (3.0–7.7)	6.4 (4.0–8.6)	7.7 (6.2–9.6)	0.051
Plasma urea, mg/dL	252 (190–276)	205 (180–258)	165 (134–197)	<0.001
Plasma phosphate, mM	2.5 (2.4–2.8)	2.5 (2.0–2.6)	1.9 (1.6–2.2)	0.034
Plasma K, mM	4.8 (4.0–6.1)	4.8 (3.9–5.1)	4.7 (4.2–5.1)	0.513
Standard bic., mM	20 (15–23)	18 (16–19)	22 (19–24)	0.007
Hemoglobin, g/dL	9.2 (7.2–11.3)	10.0 (8.2–11.0)	10.7 (9.8–11.5)	0.005

Patients were stratified according to their presentation mode elective (planned) PD, urgent start PD or acute HD prior to PD between 2016 and 2018. Laboratory values are those at admission before any dialysis. In the group of patients with planned PD, those switching from HD to PD were excluded (n = 21). Median with interquartile range unless otherwise stated. p derived from ANOVA.

HD, hemodialysis; PD, peritoneal dialysis; CKD, chronic kidney disease.

Results

Implementation of an usPD Program Reduces CVC Use and Hospital Stay in the Unplanned Situation

Between 2013 and 2018, *n* = 190 patients with ESRD underwent de novo PD catheter implantation in our center. In the years 2013–2015 before usPD was available, *n* = 75 (86%) patients underwent elective PD catheter implantation for pPD, and *n* = 12 (14%) had to be treated with acute HD using a CVC before PD was commenced. After implementation of an usPD program, the proportion of elective PD catheter implantation for pPD remained almost constant (82% or *n* = 85 patients). usPD was realized in *n* = 12 patients (12%), and the number of patients with acute HD treatment significantly ($p = 0.0056$) decreased to *n* = 6 (6%; Fig. 2a). Thus, usPD reduced the need for HD by 57% in the unplanned situation.

Hospital stay was 27 days (interquartile range 10–52) and 26 days (18–37) in patients with unplanned dialysis start using HD before and after implementation of usPD, respectively (Fig. 2b). Hospital stay of patients treated with usPD (9 days [9–13]) was similar to that of patients with pPD (8 [6–9]) and significantly lower than in patients treated with acute HD ($p = 0.0056$).

Patients Treated with usPD Are in an Intermediate State between Those Treated with Elective PD and Those Treated with Acute HD

As shown in Table 1, the characteristics of the incident patients treated with pPD, usPD, or PD after acute HD revealed significant differences with the latter group having most advanced renal failure. This was reflected by higher uremic burden (higher plasma creatinine, urea, and phosphate concentration), lower residual renal function (estimated GFR), and uncorrected anemia compared to patients with pPD. In the PD after acute HD-group, duration of chronic kidney disease (CKD) was shorter and the proportion of patients undergoing follow-up by a nephrologist was lower pointing to a rapid decline of hitherto unknown renal disease. Patients treated with usPD were in an intermediate state within this spectrum (Table 1). They had a longer duration of CKD, higher percentage of nephrology follow-up, and higher residual kidney function compared to patients treated with acute HD. However, compared to patients with elective PD, usPD patients were worse in terms of residual renal function and uremic burden, hyperphosphatemia, and acidemia (Table 1).

usPD was Not Associated with Mechanical Complications or Technical Failure

Within the first 12 months, there were no cases of dialysate leakage, catheter dysfunction, or technical failure, but 3 episodes of peritonitis and one death in the 12 usPD patients. In patients with pPD ($n = 85$), there were 2 episodes of leakage, 2 episodes of catheter dysfunction, and 10 episodes of peritonitis. Seven patients died, 8 experienced technical failure and were switched to HD, and 3 were transplanted. The incidence of these complications was not different between these 2 groups ($p = 0.38$ for peritonitis, $p = 1.0$ for leakage and catheter dysfunction, $p = 0.59$ for technical failure, and $p = 1.0$ for death). In patients with acute HD before PD, there were no complications in the first 12 months, 1 patient was transplanted.

Discussion

Our study demonstrates that the implementation and validation of a structured usPD program decrease the proportion of patients with acute HD before initiation of PD in the unplanned situation. usPD was associated with reduced hospital stay, which is expected to reduce treatment costs, and avoided the use of a CVC, thereby preventing catheter-related complications both in the short and long term [21]. However, we could not treat all patients in the unplanned situation with usPD and those with life-threatening complications such as hyperkalemia, hypervolemia, or overt uremia had to undergo acute HD. According to our approach and that of other authors [18, 19, 22, 23], usPD is not synonymous with acute PD, and usPD also does not apply to patients with acute kidney injury. Koch et al. [15] reported the outcomes of acute PD in a life-threatening situation of patients with advanced CKD and in some instances superimposed acute kidney injury. Acute PD was provided as a hospital-based intermittent regimen thrice a week and was continued after discharge on an outpatient basis (in-centre PD). In contrast to the present study, PD treatment was not intended as home dialysis, and patients' choice for PD did not depend on the willingness and ability of the patient to perform PD autonomously or in an assisted outpatient setting after discharge. It can be assumed that the possibility to offer PD as in-center RRT in addition to a home treatment will increase the application of PD to the patients with unplanned dialysis start.

It is important to acknowledge that patients starting RRT in an unplanned situation are different from those with a planned start. Patients with unplanned dialysis start are mostly sicker and have worse laboratory values due to critical reduction in residual renal function. Therefore, all comparisons between unplanned and planned dialysis must take this into account. In our cohort, we confirmed this fact and found that the laboratory values of patients

with usPD and acute HD before PD were worse than in those patients with planned PD start (Table 1). It is noteworthy that despite these differences, mortality in patients with usPD does not seem to be substantially increased compared to those treated with planned HD or PD according to data of the Danish dialysis registry [9]. In the same registry, patients treated with acute HD using a CVC (temporary or permanent) had increased risk for mortality (OR 1.5–1.7). Data from the French registry show that patients with an unplanned PD start after HD bridging using a CVC did not have an increased mortality risk compared to patients with planned PD [24]. However, the use of the CVC was confined to 30 days prior to PD initiation. Overall, there is no evidence showing an increased mortality risk in patients treated with usPD compared to planned PD.

Due to the immediate use of the PD catheter prior to healing, usPD might be associated with the development of dialysate leakage or catheter dysfunction. In a prospective study randomizing patients to PD treatment within different time intervals, 11 out of 39 patients (28%) starting PD within 1 week and 4 out of 42 patients (10%) starting PD within 2 weeks had a leakage compared to 1 out of 41 (2%) [25]. In a recent meta-analysis involving Chinese patients by majority, the increased risk for leakage was noted [20]. However, some studies did not notice an increased risk for leakage including the present one [22, 26]. This most likely reflects differences in the studied cohort, practice of PD catheter implantation, catheter design, and PD treatment. In our center, we implant double-cuffed catheters with a disk-and-ball deep cuff using open surgery and provide a tight purse string suture at the entry point of the catheter into the peritoneum. We also check the peritoneum and make sure that there is no increased risk for leakage. It is conceivable that different implantation techniques and catheter types will affect the risk for leakage.

The present study is limited by its low number to detect differences between usPD and pPD, particularly with regard to complications. This is inherent to nearly all studies dealing with usPD from a single-center perspective. The prolonged hospital stay of those 6 patients treated with acute HD after availability of usPD was confounded by an indication bias and therefore cannot be directly compared to the hospital stay of patients with elective PD or usPD. Still, a substantial proportion of patients formerly treated with acute HD could effectively be treated with usPD with a shortened hospital stay. The strength of the study is the validation of the implementation of usPD in a prospective manner and the comparison in a before-after approach. In conclusion, implementation and offering of usPD improves the care of ESRD patients with unplanned dialysis start by reducing CVC use and shortening of hospital stay. The presented patient pathway may serve as a validated model structure for the implementation of usPD in other centers.

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Disclosure Statement

F.A., H.B., M.G. received speaker's honoraria from Baxter. NH received speaker's honoraria, serves as an advisor to and has received scientific grants from Baxter.

Statement of Ethics

Ethical approval was obtained for data acquisition and analysis (local approval number 233/2019/BO2). The study was in accordance with the Helsinki Declaration of 1975, as revised in 2000.

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Author Contributions

F.A., S.R., K.T., C.T., K.L., D.B., H.B., T.M., M.M., M.S., M.P., M.G., and N.H.: data collection. F.A. and N.H.: discussion of the results and, editing of the manuscript. F.A.: study design, analyses, drafting of the manuscript.

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