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Original Paper

Impact of an in-Hospital Patient Education Program on Choice of Renal Replacement Modality in Unplanned Dialysis Initiation

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Key Words
Education program • Hemodialysis • Unplanned dialysis • Urgent start • Peritoneal dialysis

Abstract
Background/Aims: Up to 50% patients requiring dialysis receive an urgent, unplanned start (UPS) to renal replacement therapy (RRT). Most of these are initiated with an intravenous catheter and commenced and maintained on hemodialysis (HD). Although peritoneal dialysis (PD) could be an equipotent initial modality for RRT, it is used less frequently as long-term RRT in UPS patients. This multicenter-study aimed to evaluate the impact of a structured, in-hospital education program and factors influencing PD rates, especially in UPS patients. ***Methods:*** Three German nephrology departments collaborated to implement an in-hospital education program. Retrospective analysis included 336 subjects and compared the rates of HD and PD in consecutive patients who started RRT 12 months prior (two centers) and for 12 months after (three centers) implementing the education program. ***Results:*** PD rates increased significantly ($p < 0.05$) by 66% in all planned and unplanned dialysis starts after implementation of a structured, patient-centered education program. A highly significant ($p < 0.0001$) rise in utilization of PD was found, especially in UPS patients. In logistic regression analysis, PD modality choice was significantly influenced by age ($p < 0.0001$) and gender ($p = 0.006$). ***Conclusions:*** A structured, patient-centered in-hospital education program increases the frequency of PD in patients needing unplanned RRT. PD modality choice is significantly higher in young ($p < 0.0001$) and male ($p = 0.006$) patients.

Introduction

Starting dialysis in an unplanned manner constitutes an important issue both for medical staff and patients, and especially those progressing from chronic kidney disease

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(CKD) to end stage renal disease (ESRD). Many dialysis patients present late in the course of kidney disease to a nephrologist. Therefore, an unplanned, urgent start of renal replacement therapy (RRT) often is inevitable. In Europe it is estimated that approximately 30% of new dialysis patients are initiated in an unplanned manner [1], and other estimates suggest rates up to 50% [2, 3].

There is no uniform definition of an unplanned start (UPS), but it is often characterized by utilization of temporary dialysis access because of a life-threatening condition without existence of definitive dialysis access such as a permanent fistula, and patients are often unknown to the nephrology department prior to dialysis initiation [2]. It has been shown that UPS bears several disadvantages: besides an increased mortality and hospitalization rates, higher total costs have been recorded [4-6].

The main factor implicated in UPS is late referral to nephrologists [7, 8]. In instances of rapid disease progression or acute onset [9], a planned start may not be guaranteed even if referral to a nephrologist had been ensured in timely manner [10]. Therefore, UPS cannot be completely avoided and will remain a clinical issue.

Data shows that UPS leads to a higher rate of hemodialysis (HD) as the RRT modality in the unplanned, urgent dialysis initiation [11, 12] and peritoneal dialysis (PD) is used to a lesser extent as long-term method [13]. In addition, the risk of prolonged utilization of temporary dialysis access is increased in UPS patients [14].

The reason for underutilization of PD in UPS can be attributed to organizational concerns: eligible patients are frequently not informed about the alternative treatment option [13, 15, 16]. Therefore, in clinical practice these uninformed, unplanned dialysis patients usually are not treated with PD [17].

There is growing evidence that PD in unplanned starters is feasible, and this is known as urgent-start PD [16]. PD as compared with HD, even in an urgent-start setting, has several advantages: PD is mainly a home-based therapy that can provides higher quality of life, greater autonomy, and potentially better survival at lower annual costs in most countries for many patients in the first few years after start of dialysis [18-21]. Even in the acute, unplanned setting, urgent-start PD appears to be safe. Urgent-start PD is not inferior regarding infectious complications, peritoneal leaks, hospitalization or short-term survival in comparison with routine initiation of PD [16, 22, 23].

Therefore, increasing PD rates in the unplanned setting could improve patient satisfaction and reduce health expenditure. A lack of a patient-centered, structured, education program seems to be a major obstacle regarding deployment of PD. Several studies support the central role of patient education in dialysis modality choice [17, 24, 25].

The aim of the present multicenter-study was to evaluate the impact of a structured, in-hospital education program on HD and PD rates for all patients starting dialysis. Furthermore, we wanted to investigate the factors that may have influenced the choice of PD modality after implementation of the education program.

Materials and Methods

Study design

This study was a collaboration of three German nephrology departments implementing a, structured in-hospital education program. Participating centers were: Division of General Internal Medicine and Nephrology, Robert-Bosch-Hospital in Stuttgart (Germany), Division of Nephrology, Coburg Hospital, Coburg (Germany) and the Nephrological Center Emsland, which is associated with St. Bonifatius-Hospital, Lingen (Germany).

This was a retrospective analysis in all three centers, which introduced a similar education program for all new dialysis patients. The retrospective analysis of patient flow was performed over a 12-month period in two centers (Stuttgart and Lingen) to assess different modality rates of RRT in all consecutive patients who started dialysis (hereafter referred to as group 1) before the education program was introduced. A second

analysis of patient flow over 12 months was performed in the same manner after the implementation of the structured, in-hospital education program for all new dialysis patients in each center (hereafter referred to as group 2).

The rates of HD and PD patients before and after implementation of the program were analyzed. In addition, patients were classified as planned and unplanned dialysis starters: patients admitted with prior knowledge of the necessity for RRT and scheduling of dialysis initiation were termed as planned dialysis starters.

In contrast, patients admitted with an acute deterioration of renal function reaching ESRD or with generally accepted acute dialysis indications (refractory fluid overload, severe metabolic acidosis, hyperkalemia, uremia with complications such as pericarditis or encephalopathy) without known prior history of ESRD, were termed as unplanned dialysis starters. Dialysis indications were determined at the discretion of the responsible nephrologist in the participating center.

Baseline characteristics (age, gender, etiology of ESRD and comorbidities) of all patients were collected and compared between group 1 and group 2.

Inclusion criteria for data analysis were: age ≥18 years, dialysis initiation in one of the participating dialysis centers during the corresponding 12-month time frame, availability of data and knowledge of the implemented modality. PD starters utilized solely the continuous ambulatory peritoneal dialysis (CAPD) technique.

This study was approved by the ethics committee of the University of Tuebingen (Germany). All patient information was anonymized prior to analysis.

In-hospital education program

The in-hospital education program was implemented to improve patient knowledge in a structured manner and to assist the dialysis starters in their choice by means of education tools. Specially trained dialysis nurses provided education for the dialysis starters about different RRT modalities by using flipcharts and manuals (most of the material was provided by an educational package from Baxter Healthcare) to support the decision process. The aim of the structured education program was to present both modalities, PD and HD, in an objective way as similar options. The nurses addressed all aspects of home-dialysis modalities versus in-center dialysis, offered the possibility to get in contact to patients on different modes of RRT and involved family members of the new RRT patients. Education and information was given in a structured way, but nevertheless dialysis nurses could respond to the patients' needs individually, according to their information needs and depending on their existing knowledge. The education materials were standardized. As far as there were no contraindications against one of the two modalities (especially PD), patients decided the RRT modality (hereafter referred to as "free choice"). Contraindications were not pre-specified, but grounded on clinical judgment of the responsible nephrologist and based on the current state of the art. In some cases the choice of modality was made by the responsible nephrologist in the participating center if in his opinion certain factors could have complicated a PD start (e.g. cognitive impairment or anatomical problems). All patients, except those with definite instructions from the nephrologist to the contrary, received the education program. Prior to the implementation of the program patients were offered free choice of RRT modality, however the education was not as structured or comprehensive.

Statistical analysis

For comparison of baseline characteristics of discrete or continuous data Fisher's exact test or Wilcoxon rank-sum were used, respectively. Statistical correlation of binary data and several factors was investigated by multivariable logistic regression. The fit of a logistic regression model was assessed by Nagelkerke's pseudo-R^2. P-values in Table 3 relate to the Wald statistic. Statistical analysis was performed using GraphPad Prism (CA, USA) and Statistical Environment R (Vienna, Austria), version 3.3.2, and R-package rms [26].

Results

Baseline characteristics

In total, our study involved 336 subjects. In the 12 months prior to introduction of the

education program, 151 consecutive subjects started dialysis (group 1). In the 12 months after implementation of the education program, dialysis was initiated in 185 consecutive subjects (group 2). Group 1 comprised 45 (29.8%) planned and 106 (70.2%) unplanned patients. Group 2 consisted of 72 (38.9%) planned and 113 (61.1%) unplanned new dialysis patients (Fig. 1). No significant differences ($p > 0.05$) in the degree of urgency were found between those two groups before and after introduction of the structured in-hospital education program (Table 1). Further comparison of the two patient collectives showed no significant differences in age (mean age of 68.7 vs. 67.6 years, $p > 0.05$) and gender (male gender 59.6% vs. 66.0%, $p > 0.05$). The different etiologies of ESRD did not vary significantly between group 1 and group 2 ($p > 0.05$). Most of the patients had diabetes (25.8% vs. 27.6%), hypertension (16.6% vs. 20.0%), and glomerulonephritis (13.9% vs. 15.1%) as the underlying condition causing ESRD. Patients with glomerulonephritis as the underlying disease were significantly younger ($p<0.0001$) compared with the entire cohort. Concerning the distribution of relevant comorbidities between the groups, only the percentage of patients with hypertension was significantly higher in group 2 (59.6% vs. 72.4%, $p = 0.02$). There were no significant differences for diabetes, coronary heart disease, heart failure, peripheral arterial disease or malignancy as comorbidities ($p > 0.05$). The baseline characteristics of group 1 and group 2 are summarized in Table 1.

Modality choice

The percentage of patients who had a free choice (not preselected by the physician) between dialysis modalities, increased from 28.5% (43/151) in group 1 to 62.7% (116/185) in group 2 after implementing of the patient education. This increase was statistically significant ($p < 0.0001$).

Concerning the modality chosen, we found a significant ($p = 0.02$) rise in the percentage of patients starting on PD after the beginning of the education program. In total, the percentage increased from 16.6% (25/151) in group 1 to 27.6% (51/185) in group 2. Especially in the subgroup of unplanned patients, PD rates rose significantly ($p < 0.0001$) from 0% (0/106) in group 1, to 15% (17/113) in group 2. In the logistic regression model, the probability for

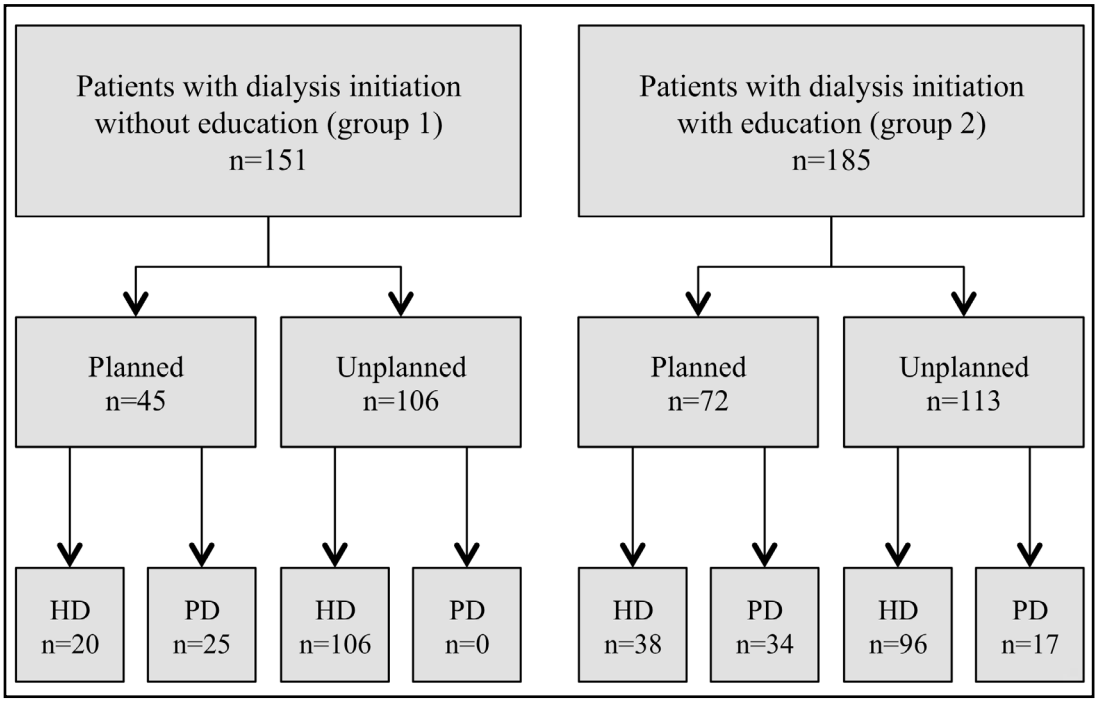

Fig. 1. Patient flow analysis of all new dialysis patients without (group 1) and with (group 2) an in-hospital education program. HD: Hemodialysis; PD: Peritoneal dialysis.

Table 1. Baseline characteristics of patients without (n=151, group 1) and with (n=185, group 2) initiation of patient education program. CHD: Coronary heart disease, ESRD: End stage renal disease, PAD: Peripheral arterial disease, PD: Peritoneal dialysis. *p<0.05

n (%)	Without education (group 1)	With education (group 2)	p-value
Age at dialysis initiation, (years, mean (95%-CI))	68.7 (66.6-70.8)	67.6 (65.6-69.6)	0.5
Gender, male	91 (59.6)	122 (66.0)	0.3
PD	25 (16.6)	51 (27.6)	0.02*
Unplanned initiation	106 (70.2)	113 (61.1)	0.09
Choice	43 (28.5)	116 (62.7)	<0.0001*
Total number	151	185	
Etiology of ESRD			
Diabetes	39 (25.8)	51 (27.6)	0.8
Hypertension	25 (16.6)	37 (20.0)	0.5
Glomerulonephritis	21 (13.9)	28 (15.1)	0.9
Cardiorenal	17 (11.3)	14 (7.6)	0.3
Ischemic nephropathy	8 (5.3)	16 (8.6)	0.3
Kidney transplant failure	1 (0.7)	4 (2.2)	0.4
Drug-induced nephrotoxicity	1 (0.7)	2 (1.1)	1.0
Others	42 (27.8)	40 (21.6)	0.2
Comorbidities			
Hypertension	90 (59.6)	134 (72.4)	0.02*
Diabetes	64 (42.4)	78 (42.2)	0.1
CHD	47 (31.1)	60 (32.4)	0.8
Heart failure	42 (27.8)	51 (27.6)	1.0
PAD	29 (19.2)	27 (14.6)	0.7
Malignancy	16 (10.6)	13 (7.0)	0.3

choosing the PD modality was higher after education in planned and especially unplanned patients starting dialysis in all centers (Table 2 and Fig. 2).

Factors influencing PD modality choice

We examined factors influencing PD modality choice in a logistic regression model (Table 3). Young age had a highly significant ($p < 0.0001$) impact on the decision to favor PD (Fig. 2). Younger patients chose PD more often after the education program. Gender was another factor, which significantly ($p = 0.006$) influenced the decision (Fig. 3). In male patients, PD was chosen more often after the education program, whereas in female subjects an education program did not increase PD rates. Furthermore, patient education had a highly significant ($p = 0.001$) positive influence on PD as the modality choice as already demonstrated in the comparison of baseline characteristics. The Stuttgart center also had a significant ($p =$

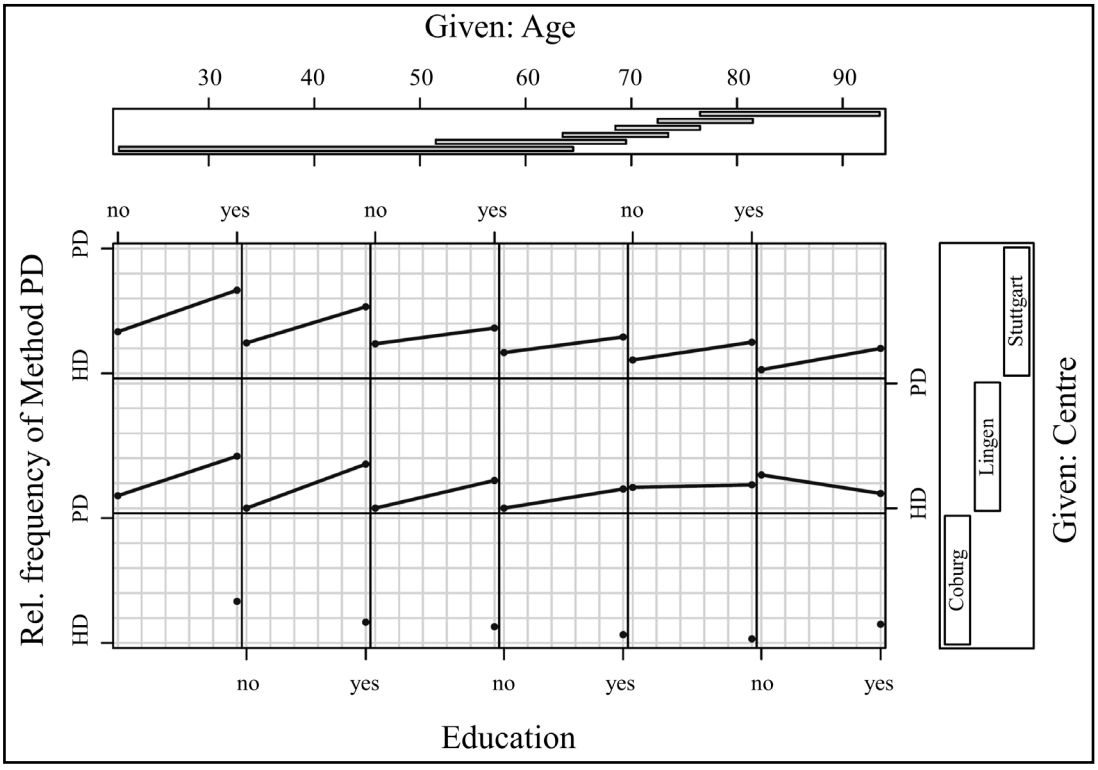

Fig. 2. Center specific relative frequency of PD distribution depending on participation of education program. PD-rates prior to introduction of education program (Education "no") were compared to those after the implementation (Education "yes"). Especially in patients younger than 75 years PD rates increased after education. HD: Hemodialysis; PD: Peritoneal dialysis.

Table 2. Centre specific proportion for choosing PD based on clinical model. NA: Not available

Centre	Education	Type	Estimated probability for choosing PD (95%-CI)
Lingen	no	planned	0.28 (0.10-0.53)
		acute	0.00 (0.00-0.14)
	yes	planned	0.50 (0.28-0.72)
		acute	0.12 (0.03-0.27)
Stuttgart	no	planned	0.74 (0.54-0.89)
		acute	0.00 (0.00-0.04)
	yes	planned	0.77 (0.55-0.92)
		acute	0.22 (0.10-0.38)
Coburg	no	planned	NA
		acute	NA
	yes	planned	0.21 (0.08-0.41)
		acute	0.12 (0.04-0.26)

0.001) impact on the PD modality choice. After adjusting for the factors mentioned above, we examined the impact of underlying disease or comorbidities on the decision for PD (Table 3). Glomerulonephritis ($p = 0.0007$) or cardiorenal syndrome ($p = 0.04$) as the ESRD etiology affected the modality choice significantly whereas the other underlying diseases did not. The comorbidities of coronary artery disease ($p = 0.04$) and diabetes ($p = 0.004$) had a significant influence on PD choice.

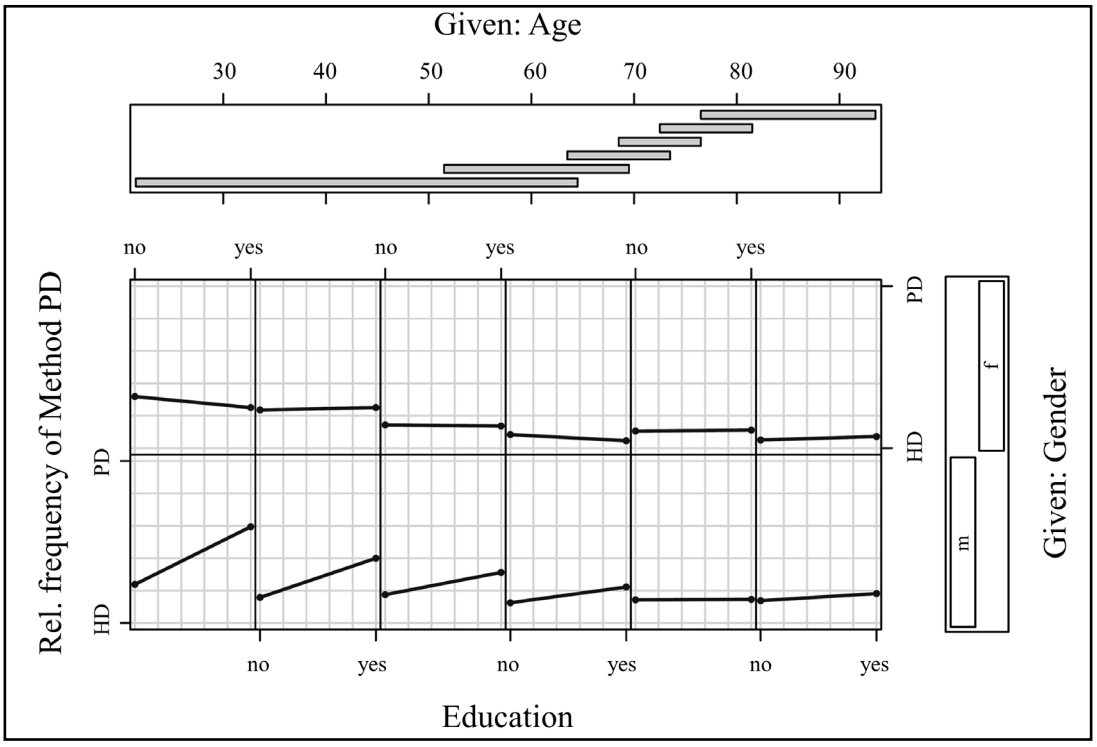

Fig. 3. Gender specific relative frequency of PD distribution depending on participation of education program. PD-rates prior to introduction of education program (Education "no") were compared to those after the implementation (Education "yes"). Especially in male patients younger than 75 years PD rates increased after education. HD: Hemodialysis; PD: Peritoneal dialysis.

Discussion

There are only a few comparable decisions in the treatment of chronic diseases that have such a profound impact on patients' everyday lives as the choice of dialysis modality in ESRD. Therefore, it seems crucial to inform patients in the most careful way possible. In our study we implemented a structured, education program with detailed information about the pros and cons of both modalities, and showed how this helps to draw together many aspects of this substantial decision making process. Additionally, we identified which subgroups demonstrate preferences concerning PD modality choice.

A comparison of baseline characteristics between the patient cohorts prior to introduction of education program (group 1) and the group after implementation (group 2) revealed no relevant differences.

There are several known adverse outcomes associated with UPS, including increased mortality [27, 28] and prolonged hospitalization [29], and it is recognized that PD rates in UPS are lower [13]. Nevertheless, PD has several advantages in eligible patients, such as higher quality of life and improved patient autonomy. Recent studies showed that an urgent start of PD in an unplanned setting is feasible [30] without considerable inferiority to planned PD initiation [16, 22]. Furthermore, Koch et al. revealed a comparable outcome of the urgent PD starters compared to urgent HD starters in a cohort with an overall high PD rate [31].

Therefore, it would indeed be unfortunate to deny PD to unplanned starters.

In general, dialysis starters are often not informed of the alternative modality of PD [29]. Several years ago, Mehrotra et al. reported from an US American cohort that PD was presented as a possible RRT modality only in 34% of planned dialysis patients. The authors identified two factors that were significantly associated with first-line initiation of PD: structured presentation of PD, and the time spent on patient education, suggesting that

Table 3. Factors possibly influencing PD modality choice using multivariable logistic regression models. In a first step we investigate a model including the baseline factors Age, Gender, Education and Center. In a second step we check which of the etiology and comorbidity factors are significant after adjusting for the baseline factors. Enhancing the baseline model by one additional factor could possibly influence the effect size of the baseline model (not shown). CAD: Coronary artery disease, df: degrees of freedom, ESRD: End stage renal disease, PAD: Peripheral artery disease, SE: Standard error. *p<0.05

Model including baseline factors	p-value	Log-Odds-Ratio (SE)	chi² (df = 5)	Pseudo-R^2
Age	<0.0001*	2.40 (0.74)		
Gender	0.006*	-0.88 (0.32)		
Education	0.001*	1.04 (0.32)	51.86	0.22
Center Lingen versus Center Stuttgart	0.09	-0.59 (0.34)		
Center Coburg versus Center Stuttgart	0.004*	-1.23 (0.43)		
Baseline model enhanced by one of the following factors (Consisting of all baseline factors plus one of the following factors)	**p-value**	**Log-Odds-Ratio (SE)**	**chi² (df = 6)**	**Pseudo-R^2**
ESRD etiology				
Cardiorenal	0.04*	0.96 (0.48)	55.69	0.23
Diabetes	0.36	-0.32 (0.35)	52.72	0.22
Drug-induced nephrotoxicity	0.80	-6.27 (25.25)	53.26	0.22
Kidney transplant failure	0.99	-7.15 (31.64)	54.00	0.23
Glomerulonephritis	0.0007*	1.24 (0.37)	62.91	0.26
Hypertension	0.41	-0.33 (0.40)	52.56	0.22
Ischemic nephropathy	0.16	-1.47 (1.06)	54.74	0.22
Others	0.14	-0.51 (0.35)	54.17	0.23
Comorbidities				
CAD	0.04*	-0.77 (0.37)	54.17	0.23
Diabetes	0.004*	-0.93 (0.32)	60.94	0.25
Heart failure	0.40	0.28 (0.34)	52.56	0.22
Hypertension	0.77	0.10 (0.33)	51.95	0.22
Malignancy	0.06	-1.95 (1.04)	58.02	0.24
PAD	0.38	-0.40 (0.46)	52.67	0.22

insufficient education is an important factor for PD underutilization [15]. Recently, Brown et al. affirmed in a retrospective analysis that unplanned start patients are less likely to receive modality education [32].

In our study, the percentage of patients who were offered the choice increased significantly ($p < 0.0001$). A certain percentage of patients are not eligible for PD due to contraindications, therefore a truly free choice for the entire group will not be available.

Accordingly, PD rates increased significantly ($p < 0.05$) by 66% in all planned and unplanned dialysis starts after implementation of a structured and patient-centered education program. Especially in UPS, we found a highly significant ($p < 0.0001$) rise in utilization of the PD modality. This reinforces the deficiency in modality education in unplanned dialysis starters.

Our findings highlight and confirm previous findings that patient education in a structured way is of major importance for informed decision making and is critical with regard to clinical responsibility in order to offer the best possible treatment to all patients suffering from end-stage renal disease [33]. Patients are more likely to select PD compared with HD if they receive comprehensive, intelligible information about all available modalities of RRT [15, 34]. Lacson et al. confirmed that pre-dialysis treatment options education in planned dialysis starters increases PD rates and reduces short-term mortality [24]. The observation of better clinical outcome related to pre-dialysis education is also described by Cho et al [33].

According to the literature in unplanned dialysis starters, education seems to play a major role as well. In line with our results, Marron et al. reported in 2005 that in unplanned, urgent dialysis starts there was less education about modality options and greater use of hemodialysis [17].

The findings of our present multicenter study, showing increased PD rates in UPS after an education program, are supported by several single center experiences [35-37] and a

multicenter study by Machowska et al. [38]. Interestingly, in logistic regression analysis the patient age significantly ($p < 0.0001$) influenced PD modality choice. PD rates increased especially in younger patients whereas in dialysis starters at age >75 years this effect was less pronounced. Although it is known that even in older ESRD patients, quality of life is comparable or better with PD compared with HD [39], our data indicate that younger patients especially seem to benefit from modality education in UPS. This is in accordance with previous studies investigating PD rates in older patients. Jager et al. demonstrated in a Dutch cohort that older age was associated with increased contraindications for PD and a higher preference for the HD modality, and older ESRD patients were more likely to start with HD therapy [40].

Surprisingly, male gender significantly ($p = 0.006$) influenced the preference for PD. Gender-specific differences in PD have been highlighted before [41], but the reasons are unclear.

The Stuttgart center revealed higher PD rates after their education program than the other centers. As Stuttgart is a referral center with many scientific projects concerning PD, this might have influenced patient decisions.

In addition to baseline characteristics, logistic regression analysis revealed that education expectedly had a highly significant ($p < 0.001$) impact on PD modality choice. This is supported by the findings described previously [32, 35, 38].

After adjusting for the influencing factors mentioned above, we found some additional factors which had an impact on the choice of modality in our study collective. Regarding ESRD etiology, cardiorenal syndrome ($p = 0.04$) and glomerulonephritis ($p = 0.0007$) were significantly associated with PD modality choice. Especially in cardiorenal syndrome, studies describe beneficial effects regarding hospitalization rate, functional status and quality of life when pharmacological therapy has failed [42]. This could be an explanation for the influence on PD choice and we cannot exclude the influence of any physician advice on the decision. Higher rates of glomerulonephritis are described in PD [43], therefore the influence of this underlying disease on PD rates could be related to this issue. Patients with glomerulonephritis were significantly ($p < 0.0001$) younger compared with the entire cohort, which may contribute to the correlation between this disease and PD.

We found that diabetes ($p = 0.004$) and coronary artery disease ($p = 0.04$) had significant impact on PD rates. Such differences have been found in other studies describing the distribution of comorbidities between PD and HD modality [35, 43]. However, comorbidity rates vary between studies and the percentage of diabetic patients is usually higher in HD [43]. One explanation could be the recommendation by the German diabetes guidelines to use PD as the first RRT in diabetic patients [44]. The fact that presence of diabetes as the underlying ESRD etiology does not influence PD modality choice suggests that diabetic patients tend to choose PD more often if the diabetes is not advanced. A reduced mortality is described at the beginning of PD for younger diabetic PD patients and could be a possible explanation for this issue [43, 45].

Conclusion

Our study confirms that a structured, patient-centered in-hospital education program increases the frequency of PD as the first therapeutic modality in patients needing unplanned RRT. Interestingly PD modality choice is significantly higher in young ($p < 0.0001$) and male ($p = 0.006$) patients.

Abbreviations

CHD (Coronary heart disease); CKD (Chronic kidney disease); ESRD (End stage renal disease); HD (Hemodialysis); PAD (Peripheral arterial disease); PD (Peritoneal dialysis); RRT (Renal replacement therapy); UPS (Unplanned dialysis start).

Disclosure Statement

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References

1 Baer G, Lameire N, Biesen WV: Late referral of patients with end-stage renal disease: an in-depth review and suggestions for further actions. NDT plus 2010;3:17-27.

2 Mendelssohn DC, Malmberg C, Hamandi B: An integrated review of "unplanned" dialysis initiation: reframing the terminology to "suboptimal" initiation. BMC Nephrol 2009;10:22.

3 Collins AJ, Foley RN, Herzog C, Chavers B, Gilbertson D, Ishani A, Kasiske B, Liu J, Mau LW, McBean M, Murray A, St Peter W, Guo H, Gustafson S, Li Q, Li S, Peng Y, Qiu Y, Roberts T, Skeans M, Snyder J, Solid C, Wang C, Weinhandl E, Zaun D, Arko C, Chen SC, Dalleska F, Daniels F, Dunning S, Ebben J, Frazier E, Hanzlik C, Johnson R, Sheets D, Wang X, Forrest B, Constantini E, Everson S, Eggers P, Agodoa L: US Renal Data System 2010 Annual Data Report. Am J Kidney Dis 2011;57:A8, e1-526.

4 Gorriz JL, Sancho A, Pallardo LM, Amoedo ML, Martin M, Sanz P, Barril G, Selgas R, Salgueira M, Palma A, de la Torre M and Ferreras I: [Prognostic significance of programmed dialysis in patients who initiate renal substitutive treatment. Multicenter study in Spain]. Nefrologia 2002;22:49-59.

5 Metcalfe W, Khan IH, Prescott GJ, Simpson K, MacLeod AM: Can we improve early mortality in patients receiving renal replacement therapy? Kidney Int 2000;57:2539-2545.

6 Piwko C, Vicente C, Marra L, Jivraj F, Appel E, Wolpin J, Camacho F, Mendelssohn DC, McFarlane PA: The STARRT trial: a cost comparison of optimal vs sub-optimal initiation of dialysis in Canada. J Med Econ 2012;15:96-104.

7 Goransson LG, Bergrem H: Consequences of late referral of patients with end-stage renal disease. J Intern Med 2001;250:154-159.

8 Roderick P, Jones C, Drey N, Blakeley S, Webster P, Goddard J, Garland S, Bourton L, Mason J, Tomson C: Late referral for end-stage renal disease: a region-wide survey in the south west of England. Nephrol Dial Transplant 2002;17:1252-1259.

9 Tennankore KK, Soroka SD, Kiberd BA: The impact of an "acute dialysis start" on the mortality attributed to the use of central venous catheters: a retrospective cohort study. BMC Nephrol 2012;13:72.

10 Singhal R, Hux JE, Alibhai SM, Oliver MJ: Inadequate predialysis care and mortality after initiation of renal replacement therapy. Kidney Int 2014;86:399-406.

11 Heatley SA: Optimal referral to pre-dialysis services: one center's experience. Perit Dial Int 2009;29:S115-116.

12 Kinchen KS, Sadler J, Fink N, Brookmeyer R, Klag MJ, Levey AS, Powe NR: The timing of specialist evaluation in chronic kidney disease and mortality. Ann Intern Med 2002;137:479-486.

13 Marron B, Ortiz A, de Sequera P, Martin-Reyes G, de Arriba G, Lamas JM, Martinez Ocana JC, Arrieta J, Martinez F, Spanish Group for CKD: Impact of end-stage renal disease care in planned dialysis start and type of renal replacement therapy--a Spanish multicentre experience. Nephrol Dial Transplant 2006;21:ii51-5.

14 Astor BC, Eustace JA, Powe NR, Klag MJ, Sadler JH, Fink NE, Coresh J: Timing of nephrologist referral and arteriovenous access use: the CHOICE Study. Am J Kidney Dis 2001;38:494-501.

15 Mehrotra R, Marsh D, Vonesh E, Peters V, Nissenson A: Patient education and access of ESRD patients to renal replacement therapies beyond in-center hemodialysis. Kidney Int 2005;68:378-390.

16 Ghaffari A: Urgent-start peritoneal dialysis: a quality improvement report. Am J Kidney Dis 2012;59:400-408.

17 Marron B, Martinez Ocana JC, Salgueira M, Barril G, Lamas JM, Martin M, Sierra T, Rodriguez-Carmona A, Soldevilla A, Martinez F: Analysis of patient flow into dialysis: role of education in choice of dialysis modality. Perit Dial Int 2005;25:S56-59.

18 Karopadi AN, Mason G, Rettore E, Ronco C: Cost of peritoneal dialysis and haemodialysis across the world. Nephrol Dial Transplant 2013;28:2553-2569.

19 Rubin HR, Fink NE, Plantinga LC, Sadler JH, Kliger AS, Powe NR: Patient ratings of dialysis care with peritoneal dialysis vs hemodialysis. JAMA 2004;291:697-703.

20 Kutner NG, Zhang R, Barnhart H, Collins AJ: Health status and quality of life reported by incident patients after 1 year on haemodialysis or peritoneal dialysis. Nephrol Dial Transplant 2005;20:2159-2167.

21 Berger A, Edelsberg J, Inglese GW, Bhattacharyya SK, Oster G: Cost comparison of peritoneal dialysis versus hemodialysis in end-stage renal disease. Am J Manag Care 2009;15:509-518.

22 Ivarsen P and Povlsen JV: Can peritoneal dialysis be applied for unplanned initiation of chronic dialysis? Nephrol Dial Transplant 2014;29:2201-2206.

23 Xu D, Liu T, Dong J: Urgent-Start Peritoneal Dialysis Complications: Prevalence and Risk Factors. Am J Kidney Dis 2017;70:102-110.

24 Lacson E, Jr., Wang W, DeVries C, Leste K, Hakim RM, Lazarus M, Pulliam J: Effects of a nationwide predialysis educational program on modality choice, vascular access, and patient outcomes. Am J Kidney Dis 2011;58:235-242.

25 Machowska A, Alscher MD, Reddy Vanga S, Koch M, Aarup M, Qureshi AR, Lindholm B, Rutherford PA: Factors influencing access to education, decision making, and receipt of preferred dialysis modality in unplanned dialysis start patients. Patient Prefer Adherence 2016;10:2229-2237.

26 R Development Core Team: R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria 2016. http://www.R-project.org/ Harrell Jr FE: rms: Regression Modeling Strategies. R package version 5.1-1. 2017. https://CRAN.R-project.org/package=rms

27 Chan MR, Dall AT, Fletcher KE, Lu N, Trivedi H: Outcomes in patients with chronic kidney disease referred late to nephrologists: a meta-analysis. Am J Med 2007;120:1063-1070.

28 Mendelssohn DC, Mujais SK, Soroka SD, Brouillette J, Takano T, Barre PE, Mittal BV, Singh A, Firanek C, Story K, Finkelstein FO: A prospective evaluation of renal replacement therapy modality eligibility. Nephrol Dial Transplant 2009;24:555-561.

29 Lorenzo V, Martn M, Rufino M, Hernandez D, Torres A, Ayus JC: Predialysis nephrologic care and a functioning arteriovenous fistula at entry are associated with better survival in incident hemodialysis patients: an observational cohort study. Am J Kidney Dis 2004;43:999-1007.

30 Arramreddy R, Zheng S, Saxena AB, Liebman SE, Wong L: Urgent-start peritoneal dialysis: a chance for a new beginning. Am J Kidney Dis 2014;63:390-395.

31 Koch M, Kohnle M, Trapp R, Haastert B, Rump LC, Aker S: Comparable outcome of acute unplanned peritoneal dialysis and haemodialysis. Nephrol Dial Transplant 2012;27:375-380.

32 Brown PA, Akbari A, Molnar AO, Taran S, Bissonnette J, Sood M, Hiremath S: Factors Associated with Unplanned Dialysis Starts in Patients followed by Nephrologists: A Retropective Cohort Study. PLoS One 2015;10:e0130080.

33 Cho EJ, Park HC, Yoon HB, Ju KD, Kim H, Oh YK, Yang J, Hwang YH, Ahn C, Oh KH: Effect of multidisciplinary pre-dialysis education in advanced chronic kidney disease: Propensity score matched cohort analysis. Nephrology (Carlton) 2012;17:472-479.

34 Manns BJ, Taub K, Vanderstraeten C, Jones H, Mills C, Visser M, McLaughlin K: The impact of education on chronic kidney disease patients' plans to initiate dialysis with self-care dialysis: a randomized trial. Kidney Int 2005;68:1777-1783.

35 Rioux JP, Cheema H, Bargman JM, Watson D, Chan CT: Effect of an in-hospital chronic kidney disease education program among patients with unplanned urgent-start dialysis. Clin J Am Soc Nephrol 2011;6:799-804.

36 Povlsen JV, Ivarsen P: How to start the late referred ESRD patient urgently on chronic APD. Nephrol Dial Transplant 2006;21:ii56-9.

37 Lobbedez T, Lecouf A, Ficheux M, Henri P, Hurault de Ligny B, Ryckelynck JP: Is rapid initiation of peritoneal dialysis feasible in unplanned dialysis patients? A single-centre experience. Nephrol Dial Transplant 2008;23:3290-3294.

38 Machowska A, Alscher MD, Vanga SR, Koch M, Aarup M, Qureshi AR, Lindholm B, Rutherford P: Offering Patients Therapy Options in Unplanned Start (OPTiONS): Implementation of an educational program is feasible and effective. BMC Nephrol 2017;18:18.

39 Brown EA, Johansson L, Farrington K, Gallagher H, Sensky T, Gordon F, Da Silva-Gane M, Beckett N, Hickson M: Broadening Options for Long-term Dialysis in the Elderly (BOLDE): differences in quality of life on peritoneal dialysis compared to haemodialysis for older patients. Nephrol Dial Transplant 2010;25:3755-3763.

40 Jager KJ, Korevaar JC, Dekker FW, Krediet RT, Boeschoten EW: The effect of contraindications and patient preference on dialysis modality selection in ESRD patients in The Netherlands. Am J Kidney Dis 2004;43:891-899.

41 Kitterer D, Segerer S, Braun N, Alscher MD, Latus J: Gender-Specific Differences in Peritoneal Dialysis. Kidney Blood Press Res 2017;42:276-283.

42 Francois K, Ronco C, Bargman JM: Peritoneal Dialysis for Chronic Congestive Heart Failure. Blood Purif 2015;40:45-52.

43 Weinhandl ED, Foley RN, Gilbertson DT, Arneson TJ, Snyder JJ, Collins AJ: Propensity-matched mortality comparison of incident hemodialysis and peritoneal dialysis patients. J Am Soc Nephrol 2010;21:499-506.

44 Bundesärztekammer (BÄK) KrBK, Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF). National disease management guidelines - Kidney diseases and diabetes in adults [German]. 1 Edition, Version 6, 2010;Last amended: Sept 2015 DOI: 10.6101/AZQ/000248.

45 Collins AJ, Hao W, Xia H, Ebben JP, Everson SE, Constantini EG, Ma JZ: Mortality risks of peritoneal dialysis and hemodialysis. Am J Kidney Dis 1999;34:1065-1074.