Published in final edited form as:

Am J Kidney Dis. 2016 April ; 67(4): 629–637. doi:10.1053/j.ajkd.2015.11.003.

Factors Associated With Discontinuation of Home Hemodialysis

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Abstract

Background—Home hemodialysis (HHD) is associated with improved clinical and quality of life outcomes compared with in-center hemodialysis but remains an underused modality in the United States. Discontinuation from HHD may be an important contributor to the low utilization of this modality. This study aimed to describe the rate and timing of HHD discontinuation, or technique failure, and identify contributing factors.

Study Design—Retrospective cohort study

Setting & Participants—Using data from a large dialysis provider, we identified a nationally representative cohort of patients who initiated HHD from 2007 – 2009 (N=2840).

Factors—Demographics, ESRD duration, kidney transplant listing status, co-morbid conditions, level of urbanization or rurality based on residence zip code, socioeconomic status based on residence zip code, and dialysis facility factors.

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Financial Disclosure: The other authors declare that they have no other relevant financial interests.

Contributions: Research idea and study design: RKS, NM, CMC, DN, JDG, LMD; data acquisition: RKS, CMC, LMD; data analysis/interpretation: RKS, CMC, DN, JDG, LMD; statistical analysis: RKS, NM, JL, CW; supervision or mentorship: DN, JDG, LMD. Each author contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. RKS takes responsibility that this study has been reported honestly, accurately, and transparently; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Peer Review: Evaluated by 3 external peer reviewers, 1 statistician, and an Acting Editor-in-Chief.

Supplementary Material

Table S1: Patient factors and discontinuation sensitivity analysis.

Note: The supplementary material accompanying this article (doi:_____) is available at www.ajkd.org

Supplementary Material Descriptive Text for Online Delivery

Supplementary Table S1 (PDF). Patient factors and discontinuation sensitivity analysis.

Outcomes—Discontinuation from HHD, defined as 60 days with no HHD treatments.

Measurements—Competing risk models were used to produce cumulative incidence plots and to identify socio-demographic and clinical variables associated with HHD discontinuation. Transplantation and death were treated as competing risks for HHD discontinuation.

Results—The 1-year incidence of discontinuation was 24.9% and the 1-year mortality estimate was 7.6%. Median ESRD duration prior to initiating HHD was 2.1 years. Diabetes and smoking/alcohol/drug use were associated with increased risk of HHD discontinuation (HRs of 1.34 [95% CI, 1.07–1.68] and 1.34 [95% CI, 1.01–1.78], respectively). Listing for kidney transplant and rural residence (rural-urban commuting area 7) were associated with decreased risk of HHD discontinuation (HRs of 0.73 [95% CI, 0.61–0.87] and 0.78 [95% CI, 0.59–1.02], respectively).

Limitations—Limited to variables available within the DaVita dialysis and US Renal Data System datasets.

Conclusions—A substantial proportion of patients discontinue HHD within the first 12 months of use of the modality. Patients with diabetes, substance use, non-listing for kidney transplant, and urban residence are at greater risk for discontinuation. Targeting high-risk patients for increased support from clinical teams is a potential strategy for reducing HHD discontinuation and increasing technique survival.

Index words

hemodialysis; home dialysis; home hemodialysis (HHD); discontinuation; technique failure; technique survival; end stage renal disease (ESRD); renal replacement therapy (RRT); RRT modality; US Renal Data System (USRDS)

Approximately 450,000 people in the United States are treated with maintenance dialysis for end-stage renal disease (ESRD) and approximately 90% receive thrice weekly in-center hemodialysis.¹ Although dialysis is life-saving, the mortality rate is 6.1–7.8 times greater for dialysis patients than for age-matched Medicare beneficiaries, the hospitalization rate is 1.73 admissions per patient-year, and quality of life and functional status are low.^{2,3} An interest in alternative dialysis modalities to combat these poor outcomes has led to a recent increased focus on home hemodialysis (HHD).

Accumulating evidence suggests that more frequent dialysis, which is usually performed at home, has benefits for blood pressure, mineral metabolism, cardiovascular-related hospitalization rates, quality of life and survival compared with conventional thrice weekly dialysis.^{4–16} However, despite these potential advantages, HHD remains under-utilized in the United States.¹⁷ Low utilization can stem both from low rates of initiation as well as high rates of discontinuation of the modality. Reasons identified for low utilization of HHD include lack of patient awareness of home modalities, lack of physician experience prescribing the modality, and patient fear of self-cannulation and complications in the home^{17–21}, all of which lead to low rates of HHD initiation. A less recognized contributor to low HHD utilization is discontinuation of HHD with transfer to another dialysis modality.^{22,23} Discontinuation of HHD, also referred to as technique failure, is reported to occur at rates as high as 20%–25% within the first year of HHD in the United States and can have a deleterious impact on both facilities and patients given the large upfront costs,

personnel time, and patient and family commitment required for HHD training and initiation.^{4,12,24,25}

In this study, using a large, national cohort, we aimed to estimate the rate and timing of discontinuation from HHD and to identify patient and dialysis facility factors associated with discontinuation. Understanding the contributors to HHD discontinuation could facilitate the development and targeting of interventions to reduce its occurrence, improve HHD modality selection and target high-risk patients for increased support to reduce HHD discontinuation.

Methods

Study Cohort

The cohort comprised all adult patients who initiated HHD at DaVita dialysis facilities in the United States during the three year period from January 1, 2007– December 31, 2009. Most patients were using NxStage equipment and performing short daily hemodialysis treatments. The DaVita dataset included dates of HHD service and, when applicable, the dialysis modality preceding and following HHD. The HHD initiation date indicated the first day that the patient dialyzed at home and excluded dates of HHD training. We excluded 399 patients who were already using HHD prior to January 1, 2007 to restrict the analyses to incident HHD patients. We also excluded 141 individuals who initiated HHD after November 1, 2009, the date at which we censored subjects still using HHD. We excluded 137 patients who had an isolated HHD episode of <10 days making the assumption that these were erroneous classifications and did not represent an actual HHD experience, since it is unlikely that a patient who completed the requisite 4–6 weeks of training without discontinuation would discontinue within the first few treatments at home. Finally, we excluded 5 patients who were younger than 18 years. Our final study cohort comprised 2840 patients.

The DaVita dataset was linked to the US Renal Data Systems (USRDS) database by the USRDS Coordinating Center in Minneapolis, MN, under a data use agreement between the USRDS and researchers at the University of Pennsylvania. Almost all of the records (99.8%) were linked to patients in the USRDS database. We received a file linking the DaVita identification number with the USRDS identification number but with personal identifiers removed. The study was approved by the University of Pennsylvania Institutional Review Board (protocol number 817208), with a waiver of informed consent due to the de-identified nature of the data.

Data Elements

For each patient we obtained age, race, ethnicity, gender, primary cause of ESRD, ESRD duration, and kidney transplant listing status from the USRDS Standard Analysis Files. Kidney transplant waiting list status was defined at the time of HHD initiation. We identified co-morbid conditions including hypertension, diabetes, peripheral vascular disease, heart disease, cerebrovascular disease, congestive heart failure, cancer, COPD, inability to ambulate or transfer, and current substance use (which included smoking,

alcohol and drug use) from the most recent Medical Evidence Report form (Center for Medicare and Medicaid Services form CMS-2728).

Dialysis facility variables were obtained from the USRDS facility files from January 1, 2007 through December 31, 2008. Information from the 2000 US Census was used to define median household income quartiles based on residence zip codes. The level of urbanization or rurality of residence zip code was categorized using the US Department of Agriculture rural-urban commuting area (RUCA) designation. The RUCA codes are based on sizes of cities and towns and the commuting patterns from the 2000 US Census data, and are defined on a scale from 1–10.6 (1, least rural; 10.6, most rural). A file linking RUCA code to zip code is available from the University of Washington Rural Health Research Center. We defined rural as RUCA ≥ 7 , to increase the sensitivity of the designation.^{26,27}

Facility level variables were examined in the subset of patients for whom they were available (n= 2055). Variables included the number of HHD patients in a facility, ratio of HHD patients to total number of patients in the facility, ratio of HHD patients to total number of home dialysis patients (HHD plus peritoneal dialysis patients), in-center census and number of in-center hemodialysis stations as two indicators of facility size, and years of Medicare certification.

Outcomes

The primary outcome was discontinuation from HHD. Discontinuation was defined as a change in dialysis modality after initiating HHD. A patient was considered to have discontinued if there were no HHD treatments for a 60-day period. Intervals of no HHD treatments that were shorter than 60 days were collapsed as we assumed these gaps in treatment were not true discontinuations but instead were interruptions for hospitalizations or brief periods of in-center dialysis for travel or administration of intravenous antibiotics. If a patient returned to HHD after more than 60 days, we included only the first episode of HHD. Dates of kidney transplantation and death were obtained from the USRDS transplant and death files, respectively. If kidney transplantation or death occurred within 30 days of the last HHD treatment, the event was classified as a transplantation or death rather than as HHD discontinuation. Patients were followed up from initiation of HHD until HHD discontinuation, kidney transplantation, death or November 1, 2009, 60 days before the end of the dataset.

Statistical Analysis

Descriptive statistics were used to describe baseline characteristics of the cohort. Continuous variables are presented as either means $\pm$ standard deviations or medians with interquartile ranges. Column percentages are listed for categorical variables. Diabetes, inability to ambulate or transfer and smoking/alcohol/drug use were analyzed as independent categorical variables. The remaining comorbid conditions were counted and analyzed as 0, 1, or ≥ 2 conditions combined.

We used a competing risks framework to assess factors associated with discontinuation. In this framework we treated transplantation and death as competing risks. Competing-risks regression based on Fine and Gray's proportional sub-hazards model was used to produce

unadjusted cumulative incident plots and survival estimates.²⁸ Competing risks Cox regression was used to estimate univariate and multivariable hazard ratios (HRs) for predictors of interest. There were 2,628 subjects included in the multivariable analysis. The final model included all variables that were thought to be clinically relevant a priori. Sensitivity analyses were performed in which we defined HHD discontinuation as 30 days without any HHD treatments. We used the same competing risks frameworks to assess the association between discontinuation and facility level variables.

Additionally, we stratified patients based on HHD vintage prior to discontinuation into three groups: those with early discontinuations (less than 3 months of HHD), those with discontinuations at 3–12 months, and those with delayed discontinuations (greater than 12 months of HHD prior to discontinuation). Chi-squared tests and one way ANOVA tests were used to compare the patient, clinical, and demographic characteristics of the early and delayed discontinuation groups.

All statistical analyses were performed using Stata Version 12 (StataCorp LP, College Station, TX). The type 1 error rate for each test was set at $\alpha = 0.05$ and all tests were 2-tailed.

Results

Patient Characteristics

The study cohort included 2840 patients treated with HHD. Over the 3-year study period, 729 patients discontinued HHD and switched to another dialysis modality, 232 patients underwent kidney transplantation, and 253 patients died. Average follow-up time was 8.26 (interquartile range, 3.6–16.3) months. The baseline characteristics of the patients are summarized in Table 1. The mean age at the time of HHD initiation was 52 years, 66.1% were male, and 70.0% were Caucasian. The median duration of ESRD before initiating HHD was 2.1 years. The primary cause of ESRD was diabetes in 32.0% of patients, and 34.4% were listed for kidney transplant at the time of initiation of HHD. The vast majority of patients lived in an urban region, with only 10.6% living in a region classified as rural. The cohort included patients from 48 states as well as the District of Columbia and the states with the greatest number of HHD patients were California, Florida, and Pennsylvania.

HHD Discontinuation

Cumulative incidence estimates for discontinuation, death and transplantation are shown in Figure 1. The proportion of patients who discontinued at 1 year was 24.9%, which corresponds to 29.4 discontinuations per 100 patient years. The proportion of patients who had died and undergone transplantation at 1 year were 7.6% and 7%, respectively, which corresponds to 10.2 deaths and 9.3 transplants per 100 patient years. Event proportions for discontinuation at 3 months, 6 months, and 2 years are 9%, 16%, and 35%, respectively. The only characteristic that differed between patients who discontinued within 3 months ($n=239$), between 3 and 12 months ($n=353$), or > 12 months ($n=137$) after HHD initiation was age (Table 2). Patients with early discontinuation, discontinuation between 3 and 12 months, and late discontinuation had mean ages of 54.3, 52.2, and 50.8 years, respectively (p

= 0.05). Results from the competing risk Cox regression model (Table 3) show that being listed for kidney transplant at the time of HHD initiation was associated with a 27% decrease in risk of discontinuation (HR, 0.73; 95% confidence interval [CI], 0.61–0.87) and living in a rural environment trended toward protection against discontinuation (HR, 0.78; 95% CI, 0.59–1.02), although this was not statistically significant. Diabetes and smoking/alcohol/drug use were associated with increased risk of HHD discontinuation (HRs of 1.34 [95% CI, 1.07–1.68] and 1.34 [95% CI, 1.01–1.78], respectively). In sensitivity analyses with discontinuation defined as 30 days (rather than 60 days) with no HHD sessions, the results were similar except that RUCA score was not as suggestive a predictor (Table S1, available as online supplementary material).

Facility level variables as predictors of HHD discontinuation were examined in the subset of patients for whom facility data were available. This subset included 2055 patients receiving care at 323 facilities. Baseline characteristics by facility as well univariate analysis using facility factors as predictors of HHD discontinuation are shown in Table 4. Discontinuation of HHD was not associated with HHD program size, any of the indicators of dialysis facility size, or duration of facility Medicare certification. Total number of HHD patients and total number of facility patients were analyzed both as categorical and continuous variables with no difference in results.

Discussion

We used a large, nationally representative sample of patients treated with HHD and found that the proportion of patients who discontinued HHD at 1 year was 24.9%, which approximates to 29.4 events per 100 patient-years. Our analysis did not include the period of patient and caregiver training for HHD. It is likely that the discontinuation rate would be even higher if patients who do not complete HHD training were considered. This discontinuation rate is similar to rates reported in other multicenter studies of HHD in the United States but prior studies had not focused on identifying predictors of HHD discontinuation.^{4,9,12} We found that patients who discontinue are more likely to have diabetes or use tobacco, alcohol or recreational drugs and are less likely to be listed for kidney transplantation or live in a rural area.

The HHD patients in this cohort differ in several respects from the overall US dialysis population as reported by the USRDS.²⁹ The HHD patients in our cohort are younger than prevalent US dialysis patients (mean age, 52 versus 60.9 years). Compared with the US dialysis population, the HHD cohort has a greater proportion of white patients (70.0% versus 55.7%), fewer black patients (26.3% versus 37.1%), more male patients (66.1% versus 55.0%) and a lower proportion with diabetes (38.4% versus 43.5%).²⁹ The annual mortality rate for the HHD cohort is about half that reported by the USRDS (10.2 versus 22 deaths per 100 patient-years). The annual rate of kidney transplantation among the HHD patients is greater than in a general dialysis population – 7% versus a crude estimate from USRDS of 4.8% annually. Given that our cohort is large, geographically diverse, and included all of the HHD patients from a large dialysis provider, it is likely that the differences we observed between the HHD cohort and the USRDS reflect the types of patients who initiate HHD.

Rates of HHD discontinuation similar to that found in our study have been reported previously. In a study comparing hospitalization rates between 3,400 HHD patients using NxStage System One and in-center HD patients taken from USRDS, Weinhandl, et al noted 21.3 discontinuation events per 100 patient-years.⁹ In another study, Weinhandl, et al reported 26.4% of 1,873 HHD patients discontinued because of change in dialysis modality over a mean follow-up time of 1.8 years.⁴ In their most recent study, also with NxStage data from 2007–2010, Weinhandl and colleagues observed that 18% discontinued at 1 year of follow-up.³⁰ In an interim analysis of 239 HHD patients from the ongoing FREEDOM (Following Rehabilitation, Economics and Everyday-Dialysis Outcome Measurements) observational study, 22% of patients returned to in-center hemodialysis at 12 months.¹² Other studies reported lower rates of HHD discontinuation. Among 116 HHD patients from the Northwest Kidney Center program, 10.3% returned to in-center hemodialysis over 19 months³¹, and one year discontinuation rates of 3%–15% were reported in smaller observational studies from Canada and the United Kingdom.^{23,32–34} Compared with the United States, Australia and New Zealand have historically had high utilization of home modalities, with 11% of dialysis patients in Australia and 27% in New Zealand using HHD. Based on national registry data, over 75% of Australia and New Zealand HHD patients continue with this modality for > 2 years.³⁵ There are a number of differences between practices in Australia and New Zealand and in the United States that might account for the differences. In Australia and New Zealand, nocturnal HHD is used more often than short daily dialysis, which is the converse of US practice. Additionally, in Australia and New Zealand, education in home modalities is emphasized during nephrology training, a high proportion of dialysis centers offer HHD, and financial incentives favor home modalities, all of which increase access and interest for patients and physicians.^{36,37,38} Outside of the United States, HHD is usually performed with conventional hemodialysis machines rather than with the low-flow NxStage system. These key differences make comparing outcomes and discontinuation rates challenging. As HHD use increases in the United States it will be interesting to see if discontinuation rates decrease.

We stratified patients based on time to discontinuation (early discontinuation, defined as <3 months on HHD; discontinuation between 3 and 12 months; or late discontinuation, defined as >12 months on HHD) and found that patients who discontinue earlier tend to be older. No other statistically significant differences between those with early and late discontinuation were identified; however, the power to detect differences was limited due to the small number of patients in these subgroups. We hypothesized that the underlying reasons for discontinuation may be different for early versus late events, but we cannot explain this with the available data.

In competing risk analysis, we found that patients with diabetes and those who use alcohol, drugs or tobacco products have an increased risk of HHD discontinuation. Both diabetes and substance use may be indicators of worse overall health status and resultant difficulty with a home modality. Being listed for kidney transplant, an indicator of a relatively healthy status, was associated with a decreased risk of HHD discontinuation. Having a rural residence location trended toward a decreased risk of discontinuation as well. This relationship was not statistically significant in multivariable analysis, most likely because of small sample size (only 10.6% of the HHD population had rural residence). This association is also logical

if one assumes that patients in rural areas may live farther from an in-center dialysis unit and thus have greater motivation to succeed with HHD to avoid the inconvenience of travelling a distance thrice weekly for dialysis treatments. Overall, we found no association between HHD discontinuation and age, gender, race, ESRD duration prior to initiation of HHD, or median income. This finding is in contrast to the statistically significant relationships reported by Weinhandl, et al between modality change from HHD and both ESRD duration and low income (defined by dual Medicare/Medicaid eligibility).⁴ In our study we defined median household income by zip code of residence rather than dual Medicare/Medicaid eligibility and this difference might underlie the different results between the studies. In contrast to our study, Australia and New Zealand data suggest a higher rate of HHD discontinuation with increasing age.³⁵

We hypothesized that facility factors may also be determinants of HHD discontinuation and that larger and more experienced facilities would have better modality retention because of better infrastructure for supporting HHD patients. We were able to identify HHD facilities for a large proportion of patients in our cohort and found no associations between facility variables and HHD discontinuation. However, facility data are collected by USRDS via surveys completed by each dialysis facility annually. Since the majority of our patients received HHD services at a facility which had fewer than 10 HHD patients (mean, 3.9 patients/facility), small fluctuations in facility size can lead to a large proportional change in the size of the facility and thus can have a large impact on the detection of associations. Unfortunately, there are no variables on the facility survey that represent facility experience with HHD.

There are inherent limitations to using administrative data to evaluate HHD discontinuation. While we were able to detect several predictors of HHD discontinuation, we were unable to evaluate psychosocial factors for both patients and caregivers, comorbid conditions that developed after HHD initiation, and technical aspects of the dialysis procedure such as training approach, prescription, adequacy and vascular access complications.^{39,40} Our power was limited for the analyses of facility factors since only a subset of patients could be linked to the facility. A qualitative study of patients and facility personnel could provide important insights about the reasons patients discontinue HHD and would complement the findings from our study.

There are several strengths of this study. Given that the total number of patients in the United States in 2007–2009 performing HHD is 5000–6000, our cohort is large and representative of the national HHD population. By using dialysis provider data, we had accurate dates of HHD service and thus could describe the rate and timing of discontinuation in this cohort. Our inclusion of additional datasets linked via zip code to characterize income level and place of residence allowed us to find associations that would not have been evident with just the dialysis provider and USRDS data sets.

In conclusion, we found that nearly 25% of patients discontinue HHD within one year of initiation of the modality, and we identified several associated patient characteristics. The high rate of discontinuation, while not surprising given the complexity of performing hemodialysis in the home setting, suggests that increasing HHD utilization requires efforts

directed not only at uptake of the modality but also at retention. While additional work is required to identify contributing facility factors as well as the specific reasons patients discontinue HHD, targeting high-risk patients for increased support from clinical teams is a potential strategy for reducing HHD discontinuation and increasing the overall use of this modality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Some of the data reported here have been supplied by the USRDS. The interpretation and reporting of these data are the responsibility of the authors and in no way should be seen as official policy or interpretation of the US government. The authors are grateful to DaVita Clinical Research and the USRDS for providing the data for this research.

Support: This research was supported by grants from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK; F32-DK101156-01 to Dr Seshasai and T32-DK07006 to Drs Seshasai and Chaknos) The NIDDK did not participate in the study design, data collection, analysis, interpretation, writing of the manuscript or decision to submit the manuscript for publication.

Dr Glickman was previously a member of the NxStage Scientific Advisory Board and currently serves as a consultant to DaVita Inc. Dr Negoianu is on the speaker bureau for DaVita Inc.

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Fig. 1. Cumulative incidence of home hemodialysis discontinuation among incident home hemodialysis patients, treating death and kidney transplantation as competing risks of discontinuation.

Table 1

Baseline Characteristics

Characteristic	All Patients (N = 2,840)	Discontinued HHD (n = 729 [*])
Age at HHD initiation, years	52 ± 14.5	53 ± 14.5
Race		
White	1,989 (70.0)	500 (68.6)
Black	748 (26.3)	203 (27.9)
Other	103 (3.6)	26 (3.6)
Hispanic Ethnicity	140 (5.0)	37 (5.2)
Sex		
Female	964 (33.9)	259 (35.5)
Male	1,876 (66.1)	470 (64.5)
Primary ESRD cause		
Diabetes	908 (32.0)	263 (36.1)
Hypertension	596 (21.0)	159 (21.8)
Glomerulonephritis	550 (19.4)	124 (17)
Cystic	185 (6.5)	36 (4.9)
Other	513 (18.1)	126 (17.3)
Unknown	86 (3.0)	21 (2.9)
ESRD duration at HHD initiation (years)	2.1 [0.6–5.6]	2.2 [0.78–5.3]
Median household income (\$)	51,746 [41,083–67,713]	51,748 [41,109 – 67,651]
Current Smoking/Alcohol/Drug use	189 (6.8)	58 (8.2)
Comorbid Conditions ^{**}		
Diabetes	1,066 (38.4)	319 (44.8)
Inability to ambulate or transfer	68 (2.5)	21 (3.0)
No. of other comorbid conditions ^{**}		
0	312 (11)	86 (11.8)
1	1,628 (57)	391 (53.6)
2	900 (32)	252 (34.6)
Listed for transplant at HHD initiation	977 (34.4)	200 (27.4)
Top Five States represented ^{***}		
California	227 (8)	49 (6.7)
Florida	208 (7.3)	46 (6.3)
Pennsylvania	192 (6.8)	39 (5.4)
Illinois	152 (5.4)	45 (6.2)
Texas	151 (5.3)	36 (4.9)

Characteristic	All Patients (N = 2,840)	Discontinued HHD (n = 729 [*])
Rural residence: RUCA score 7	300 (10.6)	64 (8.9)

Note: Values for categorical variables are given as number (percentage); values for continuous variables, as mean $\pm$ standard deviation or median [interquartile range].

^{**} Other comorbid conditions include hypertension, peripheral vascular disease, heart disease, cerebrovascular disease, congestive heart failure, cancer, and chronic obstructive pulmonary disease

^{***} Patients resided in 48 states + Washington D.C.

Abbreviations: HHD, home hemodialysis; ESRD, end-stage renal disease; RUCA, rural- urban commuting area

^{*} Switched modality; not counting discontinuation due to kidney transplantation or death.

Table 2

Baseline Characteristics by Time to Discontinuation

Characteristic	< 3 mos (n=239)	3–12 months (n=353)	> 12 months (n=137)	P
Age (at HHD initiation, years)	54.3 ±14.58	52.2±14.77	50.8 ±13.43	0.05
Race				0.8
White	167 (69.9)	242 (68.6)	91 (66.4)	
Black	66 (27.6)	96 (27.2)	41 (29.9)	
Other	6 (2.5)	15 (4.3)	5 (3.7)	
Hispanic Ethnicity	12 (5.19)	22(6.34)	3 (2.26)	0.2
Sex				0.8
Women	84 (35.2)	129 (36.5)	46 (33.6)	
Men	155 (64.9)	224 (63.5)	91 (66.4)	
Primary ESRD cause				0.6
Diabetes	86 (37.6)	134 (38.6)	43 (32.6)	
Hypertension	54 (23.6)	81 (23.3)	24 (18.2)	
Glomerulonephritis	41 (17.9)	54 (15.6)	29 (21.9)	
Cystic	11 (4.8)	16 (4.6)	9 (6.8)	
Other	37 (16.2)	62 (17.9)	27 (20.5)	
ESRD duration at HHD initiation (years)	2.48 [0.86 – 5.50]	1.8 [0.76, 4.90]	2.41 [0.89 – 6.57]	0.1
Median household income (\$)	51,974 [40,399 – 67,281]	51,237 [41,212 – 67,793]	51,994 [41,149 – 70,455]	0.8
Current Smoking/Alcohol/Drug use	24 (10.4)	24 (6.9)	10 (7.5)	0.4
Comorbid Conditions				
Diabetes	102 (44.2)	162 (46.7)	55 (41.0)	0.5
Inability to ambulate or transfer	6 (2.6)	11 (3.2)	4 (2.9)	0.9
No. of other comorbid conditions*				0.6
0	23 (9.6)	48 (13.6)	15 (10.9)	
1	127 (53.1)	189 (53.5)	75 (54.7)	
2	89 (37.2)	116 (32.9)	47 (34.3)	
Listed for transplant % (at HHD initiation)	73 (30.5)	91 (25.8)	36 (26.3)	0.4
Rural residence: RUCA score 7	22 (9.3)	28 (8.1)	14 (10.3)	0.7

Note: Values for categorical variables are given as number (percentage); values for continuous variables, as mean ± standard deviation or median [interquartile range].

* Other comorbid conditions include hypertension, peripheral vascular disease, heart disease, cerebrovascular disease, congestive heart failure, cancer, and chronic obstructive pulmonary disease.

Abbreviations: HHD, home hemodialysis; GN, glomerulonephritis; ESRD, End Stage Renal Disease; RUCA, rural-urban commuting area

Table 3

Patient Factors and Discontinuation

Covariate	Univariate analysis (N = 2,840)		Multivariable analysis (n = 2,628)	
	HR (95% CI)	P	HR (95% CI)	P
Age, per 1-year older	1.04 (0.99, 1.10)	0.9	0.98 (0.93, 1.05)	0.6
Race				
White	1.00 (reference)		1.00 (reference)	
Black	1.13 (0.96, 1.32)	0.2	1.10 (0.92, 1.33)	0.3
Other	1.02 (0.69, 1.51)	0.9	1.07 (0.70, 1.64)	0.8
Ethnicity				
Non-Hispanic	1.00 (reference)		1.00 (reference)	
Hispanic	1.04 (0.74, 1.44)	0.8	1.11 (0.78, 1.57)	0.6
Sex				
Women	1.00 (reference)		1.00 (reference)	
Men	0.90 (0.78, 1.05)	0.2	0.97 (0.74, 1.02)	0.09
Primary ESRD cause				
Diabetes	1.00 (reference)		1.00 (reference)	
Hypertension	0.95 (0.78, 1.15)	0.6	1.25 (0.96, 1.62)	0.09
Glomerulonephritis	0.73 (0.59, 0.90)	0.004	0.91 (0.68, 1.22)	0.5
Cystic	0.63 (0.45, 0.89)	0.009	0.88 (0.59, 1.31)	0.5
Other	0.82 (0.66, 1.01)	0.06	0.99 (0.76, 1.30)	0.9
ESRD duration, per 1-year greater	0.99 (0.98, 1.01)	0.1	0.99 (0.98, 1.01)	0.8
Median household income				
Quartile 1	1.00 (reference)		1.00 (reference)	
Quartile 2	0.99 (0.81, 1.22)	0.9	0.96 (0.77, 1.20)	0.7
Quartile 3	1.01 (0.83, 1.25)	0.9	0.99 (0.80, 1.25)	0.9
Quartile 4	1.00 (0.81, 1.23)	0.9	1.02 (0.81, 1.29)	0.9
Current Smoking/Alcohol/Drug use	1.40 (0.80, 1.86)	0.04	1.34 (1.01, 1.78)	0.04
Comorbid Conditions				
Diabetes	1.35 (0.78, 1.16)	<0.001	1.34 (1.07, 1.68)	0.01
Inability to ambulate or transfer	1.22 (1.16, 1.56)	0.4	1.10 (0.71, 1.69)	0.7
No. of other comorbid conditions*				
0	1.00 (reference)		1.00 (reference)	
1	0.84 (0.66, 1.06)	0.1	0.84 (0.65, 1.08)	0.2
2	0.97 (0.76, 1.24)	0.8	0.88 (0.66, 1.16)	0.4
Listed for transplant at HHD initiation	0.69 (0.58, 0.81)	<0.001	0.73 (0.61, 0.87)	0.001

Covariate	Univariate analysis (N = 2,840)		Multivariable analysis (n = 2,628)	
	HR (95% CI)	P	HR (95% CI)	P
Rural residence: RUCA score 7	0.73 (0.57, 0.95)	0.02	0.78 (0.59, 1.02)	0.08

* Other comorbid conditions includes hypertension, peripheral vascular disease, heart disease, cerebrovascular disease, congestive heart failure, cancer, and chronic obstructive pulmonary disease

Abbreviations: CI, confidence interval; HHD, home hemodialysis; HR, hazard ratio; ESRD, End Stage Renal Disease; RUCA, rural-urban commuting area

Table 4

Baseline Facility Characteristics and Patient HHD Discontinuation By Facility Factors

Covariate	Baseline facility characteristics* (N = 323)	Univariate analysis, by patient (n = 2055)	
		HR (95% CI)	P
Years Medicare Certified	12.0 ± 9.9	1.00 (0.99, 1.01)	0.5
No. of HHD patients	3.9 ± 7.1	1.00 (0.99, 1.01)	0.9
Total no. of patients in facility: home + in-center	84.4 ± 60.8	1.00 (0.99, 1.00)	0.5
Proportion of HHD patients within total facility patients	8.6% ± 19.4%	0.74 (0.53, 1.25)	0.3
Total home dialysis patients: HHD + PD	16.3 ± 18.7	1.00 (0.99, 1.00)	0.6
Proportion of HHD patients within total home dialysis patients	35.9% ± 35.7%	0.84 (0.66, 1.08)	0.2
No. of in-center dialysis stations	18.7 ± 9.9	1.00 (0.99, 1.01)	0.4

Note: HRs are given per 1-unit increase in covariate, eg, 1-greater year of Medicare certification.

* Values are given as mean ± standard deviation

Abbreviations: CI, confidence interval; HHD, home hemodialysis; HR, hazard ratio; PD, peritoneal dialysis