Survival Among Incident Peritoneal Dialysis Versus Hemodialysis Patients Who Initiate With an Arteriovenous Fistula

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Rationale & Objective: Comparisons of outcomes between in-center hemodialysis (HD) and peritoneal dialysis (PD) are confounded by selection bias because PD patients are typically younger and healthier and may have received longer predialysis care. We compared first-year survival between what we hypothesized were clinically equivalent groups; namely, patients who initiate maintenance HD using an arteriovenous fistula (AVF) and those selecting PD as their initial modality.

Study Design: Observational, registry-based, retrospective cohort study.

Setting & Participants: US Renal Data System data for 5 annual cohorts (2010-2014; n = 130,324) of incident HD with an AVF and incident PD patients.

Exposures and Predictors: Exposure was more than 1 day receiving PD or more than 1 day receiving HD with an AVF. Time at risk for both cohorts was determined for 12 consecutive 30-day segments, censoring for transplantation, loss to follow-up, or end of time. Predictors included patient-level characteristics obtained from Centers for Medicare & Medicaid Services 2728 Form and other data sources.

Outcomes: Patient survival.

Analytical Approach: Unadjusted and multivariable risk–adjusted HRs for death of HD versus PD patients, averaged over 2010 to 2014, were calculated.

Results: The HD cohort's average unadjusted mortality rate was consistently higher than for the PD cohort. The HR of HD versus PD was 1.25 (95% CI, 1.20-1.30) in the unadjusted model and 0.84 (95% CI, 0.80-0.87) in the adjusted model. However, multivariable risk–adjusted analyses showed the HR of HD versus PD for the first 90 days was 1.06 (95% CI, 0.98-1.14), decreasing to 0.74 (95% CI, 0.68-0.80) in the 270- to 360-day period.

Limitations: Residual confounding due to selection bias inherent in dialysis modality choice and the observational study design. Form 2728 provides baseline data at dialysis incidence alone, but not over time.

Conclusions: US patients receiving HD with an AVF appear to have a survival advantage over PD patients after 90 days of dialysis initiation after accounting for patient characteristics. These findings have implications in the choice of initial dialysis modality and vascular access for patients.

Visual Abstract included

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The impact of initial dialysis modality on survival and quality of life of patients remains controversial. Comparisons of outcomes between in-center hemodialysis (HD) and peritoneal dialysis (PD) are subject to selection bias, based on patient and provider preferences and local resources,[1] with HD most often being the default initial modality. Conducting randomized trials of one dialysis modality versus another are therefore challenging. A randomized controlled trial initiated in the Netherlands was stopped prematurely because of low enrollment.[2] Hence, evidence in this regard is mostly derived from comparing survival rates of HD and PD patients in observational studies that are methodologically complex and have produced conflicting inferences.[3-6] This variability can be attributed at least in part to differences in statistical methodologies, eligibility criteria, covariate adjustment, residual selection bias, confounding, and length of follow-up.[7] To compare outcomes between 2 groups, it is most important to make the 2 groups as clinically similar as possible, simulating the randomized clinical trial. Patients self-selecting to initiate end-stage renal disease (ESRD) therapy with PD are on average younger, healthier, more likely to be employed, etc.

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We hypothesized that patients who initiate thrice-weekly in-center HD using an arteriovenous fistula (AVF) are more clinically equivalent to those selecting PD as their initial modality because both types of patients typically represent planned elective dialysis initiation requiring substantial patient and provider engagement. Shared characteristics may include a comparable period of pre-ESRD planning, education, and care; greater likelihood of elective initiation of dialysis; and willingness to make decisions regarding dialysis modality and vascular access choice.

Analysis of Canadian registry data[8] (2001-2008) showed that first-year mortality for patients receiving PD was similar to that of patients initiating HD with an AVF or arteriovenous graft (AVG). Based on the mentioned

PLAIN-LANGUAGE SUMMARY

Comparisons of outcomes between in-center hemodialysis (HD) and peritoneal dialysis (PD) are difficult because the groups are often different in terms of patient characteristics because they are based on patient and nephrologist preference and availability of local resources. We compared first-year survival between what we considered as clinically equivalent groups; namely, patients who initiate maintenance HD using an arteriovenous fistula (AVF) and those selecting PD as their initial modality. We calculated crude and adjusted hazard ratios for death of HD with an AVF versus PD patients, averaged over a 5-year period (2010-2014). Patients receiving HD with an AVF appear to have a survival advantage over PD patients after 90 days of dialysis initiation, after accounting for patient characteristics. These findings have implications for the selection of dialysis modality and choice of initial vascular access in those selecting in-center HD.

considerations, we compared first-year survival between what we hypothesized were clinically equivalent groups; patients who initiate maintenance HD using an AVF and those selecting PD as their initial modality.

METHODS

Study Population

The study population included all dialysis patients in the US Renal Data System (USRDS) who were incident to ESRD between January 1, 2010, and December 31, 2014. Our primary source of dialysis patient data was the ESRD Medical Evidence Form (Centers for Medicare & Medicaid Services [CMS] Form 2728), which is submitted for all individuals newly diagnosed with ESRD in the United States. This form includes data reported at ESRD incidence for patient demographics (date of birth, sex, race, and ethnicity), ESRD first service date, prior transplant date, initial treatment modality, primary cause of ESRD, comorbid conditions, prior nephrology care, multiple indicators of functional status, employment status, Medical coverage information, ESRD network, smoking, and drug and alcohol dependence.

We obtained information for patients' changes in modality and death from the treatment history file maintained by the USRDS.[9] We restricted our analyses to 2 groups of incident patients with ESRD: those whose initial kidney replacement therapy (KRT) was HD with an AVF or PD. Here, HD patients are thrice-weekly in-center HD patients. Patients who reported "hemodialysis" to the "primary type of dialysis" question, "dialysis facility/center" to the "primary dialysis setting" question, and "AVF" to the "what access was used on first outpatient dialysis" question

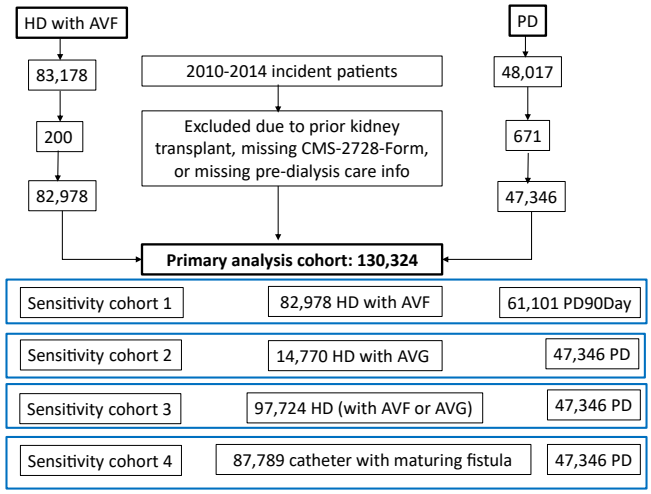

Figure 1. Flow chart describes the study population. Abbreviations: AVF, arteriovenous fistula; AVG, arteriovenous graft; CMS, Centers for Medicare & Medicaid Services; HD, hemodialysis; PD, peritoneal dialysis; PD90Day, patients who switched to PD for more than 1 day within 90 days of dialysis initiation.

on CMS Form 2728 were included in the HD with AVF cohort. Patients who answered "CAPD" (continuous ambulatory PD) or "CCPD" (continuous cycling PD) to the "primary type of dialysis" question were included in the PD cohort. These questions provided information on whether HD patients initiated dialysis with a functioning graft (reported "AVG" to the access question) or a catheter with a maturing fistula (reported "Catheter" to the access question and "yes" to "if maturing AVF present" question). Patients with a history of prior kidney transplant, missing prior nephrology care, or missing CMS Form 2728 were excluded from the study cohort.

The final study population consisted of 5 annual cohorts (2010-2014) of new patients with ESRD grouped into 2 subgroups: incident patients using HD with an AVF and incident patients using PD as their initial modality, as defined (Fig 1). Patients in each cohort were followed up for up to 360 days from a patient's date of ESRD onset for the outcome of death. This study envisaged an intent-to-treat analysis. The 1-year risk period was divided into 12 consecutive 30-day segments. For each time segment, we determined death and time at risk, censoring only for transplantation, loss to follow-up, or end of the follow-up period.

As a preliminary analysis, we calculated unadjusted death rates, expressed as deaths per 100 patient-years (PYs) at risk (Fig 2). We compared patient characteristics between 2 cohorts by fitting univariate logistic regressions for each covariate with HD with an AVF versus PD as the response (Table 1).

Statistical Model

To test for an association between mortality rate and treatment cohort (HD with an AVF vs PD), we fit a Cox

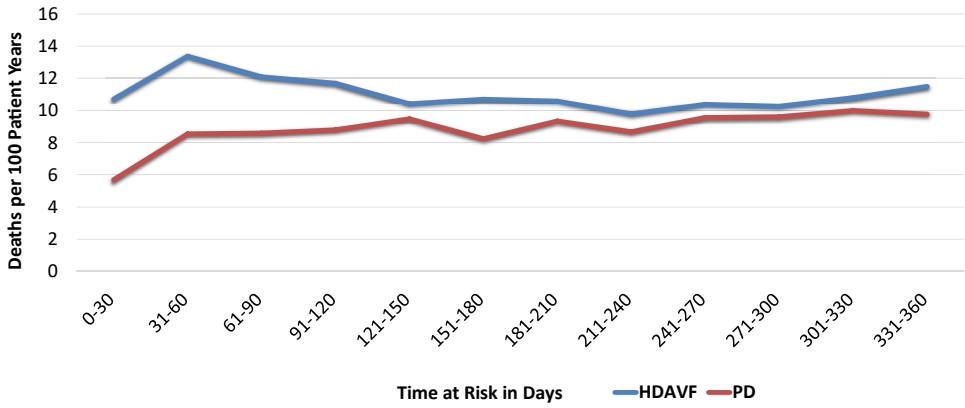

Figure 2. Unadjusted mortality rates of incident hemodialysis with an arteriovenous fistula (HDAVF) versus incident peritoneal dialysis (PD) patients, 2010 to 2014.

regression model adjusting for patient demographics, comorbid conditions, and functional status indicators. The main exposure variable was a binary indicator variable (HD with an AVF vs PD), which represented the treatment group each patient was classified into at ESRD incidence. The PD cohort served as the reference category. The model included the indicator variable (HD with an AVF = 1 vs PD = 0), along with adjustment covariates (age, race, sex, ethnicity, primary cause of ESRD, 9 comorbid conditions, 5 functional status indicators, employment status, 6 medical coverage [insurance] indicators, smoking, drug dependence, alcohol dependence, and ESRD network [Table 1]). Models were stratified by cohort year (2010-2014).

We evaluated follow-up time-dependent patterns in the HD with an AVF versus PD mortality contrast by fitting a Cox model with time-by-treatment interactions (ie, the so-called Cox nonproportional hazards model). This model shows HD with an AVF versus PD hazard ratios (HRs) specific to 90-day follow-up periods. We calculated unadjusted and risk-adjusted HRs of mortality for the same follow-up time windows and the entire 360-day period (Table 2; Fig 3).

Sensitivity Analyses

To test the robustness of our findings, we conducted sensitivity analyses, which accommodated early PD transfers. We included all patients who switched to PD for more than 1 day within 90 days of dialysis initiation. We called this the PD90Day cohort and compared its mortality rate with that of the HD with AVF cohort by following up these PD90Day patients for 360 days from their ESRD start date for the outcome of death. We treated patients who switched to PD within 90 days as being PD patients, even at ESRD start date, which meant less credit to HD with AVF for these patients. We carried out this analysis, knowing it would introduce a minor degree of immortal time bias, for the purposes of evaluating the impact on our results of slight changes to our main analysis.

We conducted 3 additional sensitivity analyses, featuring 3 different variants of the group to which PD patients were compared. We compared first-year survival of the incident PD cohort with: (1) HD patients initiating with a functioning AVG (HD with AVG), (2) HD patients initiating dialysis with a functioning AVF or AVG (HD with AVF or AVG), and (3) HD patients initiating dialysis with a catheter with a maturing fistula (HD with catheter). We calculated risk-adjusted HRs of mortality for these 4 pairs of cohorts.

All analyses were conducted using SAS software, version 9.4 (SAS Institute, Inc). The study was conducted under the USRDS Coordinating Center's Contract with the National Institutes of Health, and the protocol was approved by the University of Michigan's Institutional Review Board (IRB #HUM00086162).

RESULTS

Descriptive Statistics

The study population included 130,324 incident dialysis patients from 2010 to 2014, with 82,978 in the HD with AVF cohort and 47,346 in the PD cohort. As shown in Figure 1, a total of 0.7% of all incident patients with ESRD in 2010 to 2014 were excluded due to history of prior kidney transplant, missing prior nephrology care, or missing CMS Form 2728. Follow-up time was censored for transplantation or loss to follow-up for 2.8% of HD with AVF patients and 5.9% of PD patients. Patients starting ESRD with HD with an AVF were on average older (64 vs 57 years), more likely to be men (63.4% vs 56.8%) and Black (26% vs 22.5%), and slightly more likely to have received prior ESRD nephrology care (88.9% vs 85.7%) compared with those starting with PD as initial modality (Table 1). Among those who had received prior ESRD care, HD with AVF patients were more likely to have been on longer nephrology care (>12 months) than PD patients (52.4% vs 44.3%). HD with AVF patients had a higher comorbid condition burden, as reflected by a greater

Table 1. Patient Characteristics at ESRD Incidence

	HD With AVF (N = 82,978)	PD (N = 47,346)	*P*
Mean age, y	64.37 (13.8)	56.72 (17.6)	<0.001
Male sex	52,573 (63.4%)	26,912 (56.8%)	<0.001
Race			
White	55,872 (67.3%)	33,105 (69.9%)	<0.001
Black/African American	21,603 (26.0%)	10,633 (22.5%)	<0.001
Asian	3,537 (4.3%)	2,668 (5.6%)	<0.001
Other	1,966 (2.4%)	940 (2.0%)	<0.001
Hispanic ethnicity	10,197 (12.3%)	6,425 (13.6%)	<0.001
Primary cause of kidney failure			
Diabetes	40,896 (49.3%)	20,023 (42.3%)	<0.001
Hypertension	25,702 (31.0%)	12,576 (26.6%)	<0.001
Glomerulonephritis	6,451 (7.8%)	6,968 (14.7%)	<0.001
Cystic kidney	3,239 (3.9%)	2,398 (5.1%)	<0.001
Other and unknown causes	6,690 (8.1%)	5,381 (11.4%)	<0.001
Nephrology care (yes)	73,733 (88.9%)	40,552 (85.7%)	<0.001
Nephrology care range[a]			
<6 mo	10,553 (12.7%)	7,825 (16.5%)	<0.001
6-12 mo	19,691 (23.7%)	11,735 (24.8%)	<0.001
>12 mo	43,471 (52.4%)	20,989 (44.3%)	<0.001
Comorbid conditions			
Alcohol dependence	693 (0.8%)	238 (0.5%)	<0.001
Amputation	2,050 (2.5%)	868 (1.8%)	<0.001
ASHD	15,349 (18.6%)	5,548 (11.8%)	<0.001
Cancer	5,856 (7.1%)	2,323 (4.9%)	<0.001
Congestive heart failure	21,033 (25.5%)	7,407 (15.8%)	<0.001
COPD	6,671 (8.1%)	1,995 (4.2%)	<0.001
Cerebrovascular disease	6,931 (8.4%)	2,510 (5.3%)	<0.001
Diabetes	50,825 (61.3%)	24,748 (52.3%)	<0.001
Drug dependence	650 (0.8%)	181 (0.4%)	<0.001
History of hypertension	75,145 (91.0%)	41,292 (87.9%)	<0.001
Inability to ambulate	2,568 (3.1%)	690 (1.5%)	<0.001
Institutionalized	3,348 (4.1%)	291 (0.6%)	<0.001
Inability to transfer	1,052 (1.3%)	273 (0.6%)	<0.001
Needs assistance with daily activities	6,202 (7.5%)	2,158 (4.6%)	<0.001
Other cardiac disease	13,477 (16.3%)	5,497 (11.7%)	<0.001
Peripheral vascular disease	9,481 (11.5%)	3,566 (7.6%)	<0.001
Tobacco use (current smoker)	4,905 (5.9%)	2,730 (5.8%)	0.34
Toxic nephropathy	311 (0.4%)	147 (0.3%)	0.06
Insurance[b]			
DVA	2,768 (3.3%)	711 (1.5%)	<0.001
Medicare coverage	51,214 (61.7%)	21,410 (45.2%)	<0.001
Medicaid coverage	19,363 (23.3%)	7,886 (16.7%)	<0.001
Employer group health insurance	18,859 (22.7%)	17,902 (37.8%)	<0.001
No medical insurance	2,564 (3.1%)	3,452 (7.3%)	<0.001
Other medical insurance	18,067 (21.8%)	8,210 (17.3%)	<0.001
Employed full-/part-time	9,467 (11.4%)	11,882 (25.1%)	<0.001
ESRD Network			
(01 CT) Network of New England	3,712 (4.5%)	1,597 (3.4%)	<0.001
(02 NY) Network of NY	5,927 (7.1%)	1,537 (3.2%)	<0.001
(03 NJ) Trans-Atlantic R.C.	3,257 (3.9%)	1,366 (2.9%)	<0.001
(04 PA) ESRD Network Org #4	3,987 (4.8%)	1,786 (3.8%)	<0.001
(05 VA) Mid-Atlantic R.C.	4,338 (5.2%)	2,355 (5.0%)	0.05
(06 NC) Southeastern Kidney Council	7,390 (8.9%)	4,841 (10.2%)	<0.001
(07 FL) ESRD Network of Florida	4,156 (5.0%)	2,970 (6.3%)	<0.001
(08 MS) Network 8	4,495 (5.4%)	3,069 (6.5%)	<0.001

(Continued)

Table 1 (Cont'd). Patient Characteristics at ESRD Incidence

	HD With AVF (N = 82,978)	PD (N = 47,346)	*P*
(09 IN) Tri-State R.N.	6,609 (8.0%)	3,671 (7.8%)	0.18
(10 IL) Renal Network of Illinois	3,089 (3.7%)	2,117 (4.5%)	<0.001
(11 MN) Renal Network of Upper Midwest	5,504 (6.6%)	2,523 (5.3%)	<0.001
(12 MO) ESRD Network #12	2,918 (3.5%)	2,151 (4.5%)	<0.001
(13 OK) ESRD Network #13	3,265 (3.9%)	2,091 (4.4%)	<0.001
(14 TX) Network of Texas	5,889 (7.1%)	4,003 (8.5%)	<0.001
(15 CO) Inter-Mountain ESRD Network	4,477 (5.4%)	2,529 (5.3%)	0.68
(16 WA) Northwest Renal Network	3,613 (4.4%)	1,868 (3.9%)	<0.001
(17 N-CA) Trans-Pacific ESRD Network	4,433 (5.3%)	3,107 (6.6%)	<0.001
(18 S-CA) Southern California Network	5,919 (7.1%)	3,765 (8.0%)	<0.001

Note: Values expressed as mean (standard deviation) or number (percent).
Abbreviations: ASHD, atherosclerotic heart disease; COPD, chronic obstructive pulmonary disease; DVA, Department of Veterans' Affairs; ESRD, end-stage renal disease; HD with AVF, hemodialysis with arteriovenous fistula; PD, peritoneal dialysis.
[a]Counts and percentages for nephrology care range add up to the total count and percentage of patients in the cohort who had pre-ESRD nephrology care (response = yes), which is <100%.
[b]Insurance categories can add up to >100% because patients can have more than 1 type of insurance.

prevalence of each of the following conditions: diabetes, atherosclerotic heart disease, congestive heart failure, other cardiac disease, cerebrovascular disease, peripheral vascular disease, chronic obstructive pulmonary disease, and cancer. In contrast, patients receiving PD were more likely to ambulate and transfer and less likely to be institutionalized (0.6% vs 4.0%) or need assistance with daily activities (4.6% vs 7.5%) compared with patients starting with HD with an AVF. HD with AVF patients were more likely to receive Medicare insurance (61.7% vs 45.2%) and less likely to be employed full or part time (11.4% vs 25.1%).

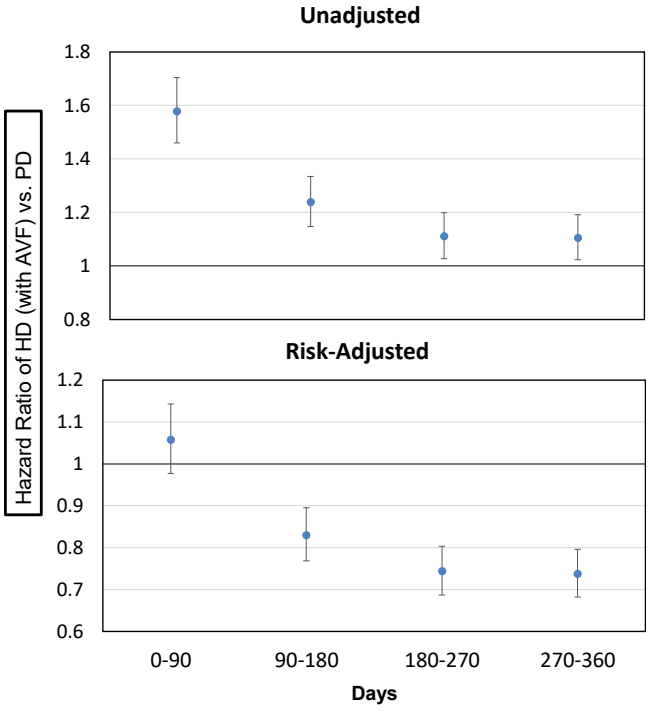

Figure 3. Hazard ratio of mortality for incident hemodialysis (HD) with an arteriovenous fistula (AVF) versus incident peritoneal dialysis (PD) patients in unadjusted and risk-adjusted models, 2010 to 2014.

Unadjusted Mortality Rates

The average unadjusted mortality rate during the first 360 days of dialysis for the HD with AVF cohort was higher than that of the PD cohort (11.0 [95% CI, 10.8-11.3] vs 8.8 [95% CI, 8.5-9.1] deaths per 100 PYs), with a rate in the first 30 days of 10.7 (95% CI, 9.9-11.5) and 5.7 (95% CI, 5.6-5.8) deaths per 100 PYs for HD with AVF and PD patients, respectively (Fig 2). Notably, we observed an early peak in mortality during the 31- to 60-day period in the HD with AVF cohort, which then declined during the rest of the first year receiving dialysis. The mortality rate was highest at 13.4 (95% CI, 12.5-14.3) deaths per 100 PYs in the 31- to 60-day period, declining to 9.8 (95% CI, 9.0-10.6) deaths per 100 PYs in month 8 (211-240 days), before increasing

Table 2. Results From the Multivariable Regression Model for the Outcome of Death

HD With AVF vs PD	HR	LCL	UCL	*P*
Unadjusted				
0- to 12-mo overall model	1.25	1.2	1.3	<0.001
3 mo	1.58	1.46	1.71	<0.001
6 mo	1.24	1.15	1.34	<0.001
9 mo	1.11	1.03	1.20	0.008
12 mo	1.10	1.02	1.19	0.011
Risk-Adjusted				
0- to 12 mo overall model	0.84	0.8	0.87	<0.001
3 mo	1.06	0.98	1.14	0.166
6 mo	0.83	0.77	0.90	<0.001
9 mo	0.74	0.69	0.80	<0.001
12 mo	0.74	0.68	0.80	<0.001

Abbreviations: HD with AVF, hemodialysis with arteriovenous fistula; HR, hazard ratio; LCL, lower confidence limit; PD, peritoneal dialysis; UCL, upper confidence limit.

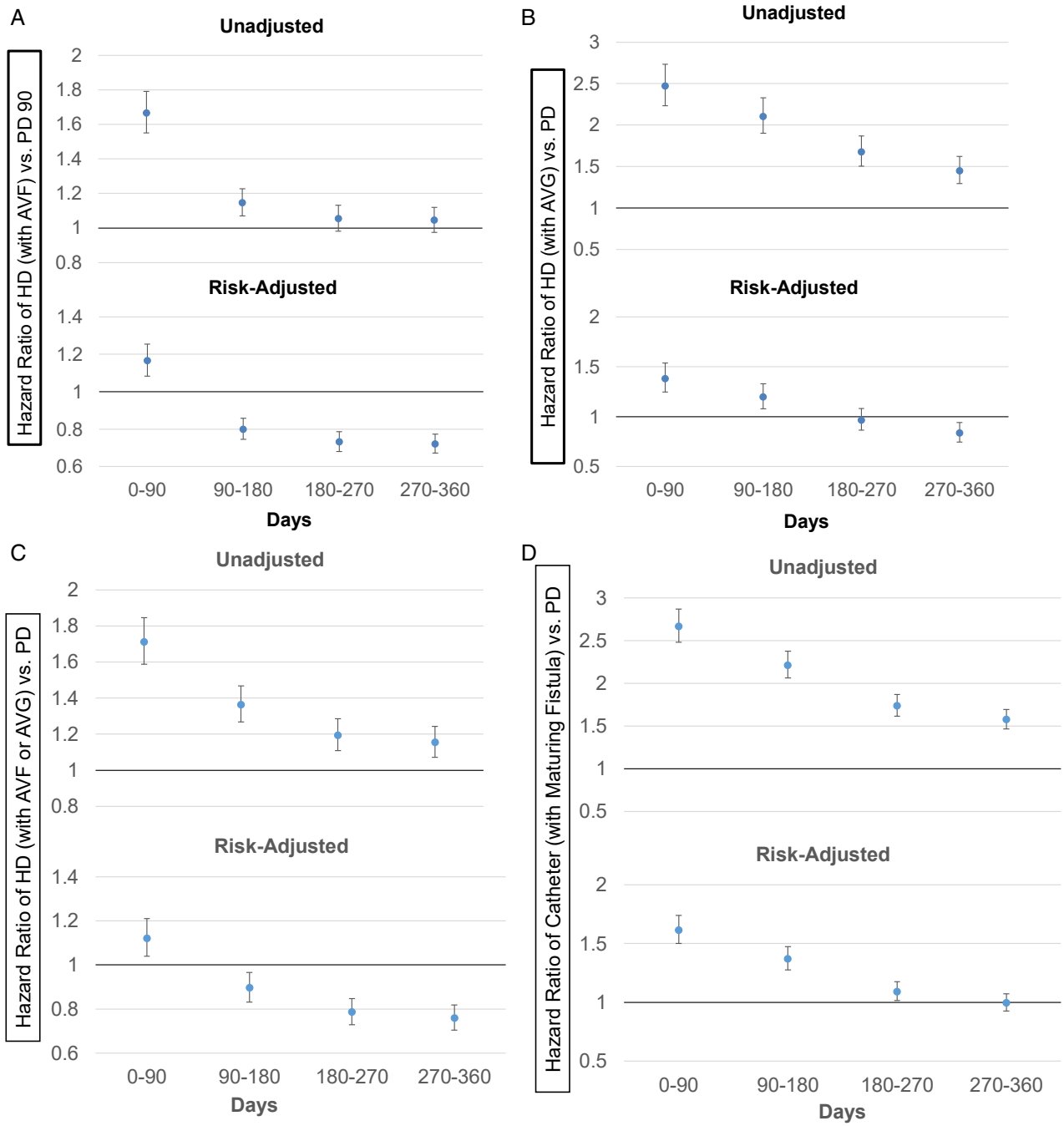

Figure 4. Hazard ratio of mortality in unadjusted and risk-adjusted models, 2010 to 2014 for: (A) incident hemodialysis (HD) with an arteriovenous fistula (AVF) versus incident peritoneal dialysis (PD) patients who switched to PD for more than 1 day within 90 days of dialysis initiation (PD90) patients; (B) incident HD with AVG versus incident PD patients; (C) incident HD (with AVF or arteriovenous graft [AVG]) versus incident PD patients; and (D) for incident HD with catheter (with maturing fistula) versus incident PD patients.

again to 11.5 (95% CI, 10.6-12.4) deaths per 100 PYs for the final 30 days of the follow-up period. In contrast, in PD patients, mortality rates showed an increase in the 31- to 60-day period followed by continued mortality rate increase during much of the rest of the first year receiving dialysis. PD patients exhibited an upward trend in mortality rates, with rates increasing from 5.7 (95% CI, 5.6-5.8) deaths per 100 PYs in the first 30-day period to 9.8 (95% CI, 9.7-9.9) deaths per 100 PYs in the last 30-day time segment (331-360 days).

Covariate-Adjusted Mortality Comparisons

Applying the described intent-to-treat study analysis, Cox regression models, stratified by cohort year, were

used to determine the unadjusted HR of first-year mortality for HD with AVF versus PD patients and the multivariable model additionally adjusted for many covariates listed in Table 1. In the unadjusted model, the HR of first-year mortality was 1.25 (95% CI, 1.20-1.30) for HD with AVF versus PD, which indicated higher overall mortality during the first year for patients who initiated KRT with HD with an AVF compared with initiating KRT with PD. In contrast, in multivariable analyses that account for numerous differences in patient characteristics, the overall HR of first-year mortality was seen to be lower for patients who initiated KRT with HD with an AVF (HR of first-year mortality, 0.84; 95% CI, 0.80-0.87 for HD with AVF vs PD; Table 2).

In additional Cox regression, we explored the HR of mortality for HD with AVF versus PD patients in 90-day time segments during the first 360-day period following a patient's ESRD start date (Table 2). In the unadjusted model, HRs of HD with AVF versus PD were consistently higher than 1.0 across all four 90-day segments (Table 2; Fig 3). The HR of HD with AVF versus PD was 1.58 (95% CI, 1.46-1.71) in the 0- to 90-day period, and 1.11 (95% CI, 1.03-1.20) in the 180- to 270-day time segment in the unadjusted model. In contrast, multivariable risk–adjusted analyses indicated only slightly elevated mortality rates for HD with AVF versus PD patients during the first 90 days receiving dialysis (HR, 1.06, 95% CI, 0.98-1.14), with HRs for mortality then declining substantially after 90 days to an HR of 0.83 (95% CI, 0.77-0.90) in the 90- to 180-day period and HR of 0.74 (95% CI, 0.68-0.80) in the last quarter (270-360 days; Table 2; Fig 3). Detailed results from the multivariable regression model are included as Table S1.

We conducted sequential testing and explored which covariates were crucial for inclusion in the model for HD with AVF patients to have lower mortality risk than patients receiving PD after 90 days. Our results showed that age, race, sex, ethnicity, cause of ESRD, cancer, congestive heart failure, chronic obstructive pulmonary disease, inability to ambulate, inability to transfer, and institutionalized and needs assistance with daily activities were the 12 risk factors that reversed HR for mortality from >1 in 0 to 90 days to <1 after 90 days. Adjustment for additional covariates had minimal impact on the risk-adjusted HR of HD with AVF versus PD (Table S2).

Our sensitivity analyses showed that even after allowing for early PD transfers in the PD cohort, HD with AVF patients exhibited a survival advantage over PD patients after 90 days (Fig 4A). The HR for mortality for HD with AVF versus PD90Day was 0.72 (95% CI, 0.67-0.77) in the last quarter (270-360 days), which is lower than what we observed for the HD with AVF versus PD cohort for the same period (Table 2). Risk-adjusted HRs for mortality of HD with an AVG versus PD patients were >1 and statistically significant for 0 to 180 days, declining to 0.84 (95% CI, 0.75-0.94) only in the 270- to 360-day segment (Fig 4B). When we combined HD with AVG and HD with AVF cohorts, results mimicked those of HD with AVF versus PD model results (Fig 4C). Patients starting out on a catheter with a maturing fistula failed to exhibit any survival advantage over PD patients in the 360-day follow-up period (Fig 4D).

DISCUSSION

Patients in the United States who initiated in-center HD with an AVF between 2010 and 2014 displayed a survival advantage compared with patients starting KRT with PD after the first 90 days receiving dialysis after adjusting for patient characteristics. Patients receiving HD with an AVF were on average older with greater comorbid condition burden and required more assistance with ambulation and daily activities, with a greater proportion being institutionalized. We had hypothesized that patients who initiate HD with an AVF would be the most directly comparable to those initiating KRT with PD as their initial choice of dialysis modality because these groups have similar needs for pre-ESRD planning, modality education, access preparation, possible motivation, access to health care, etc. Not unexpectedly, we found that the crude (unadjusted) first-year mortality rates for HD patients with a functioning fistula were consistently higher than those of PD patients throughout the first year receiving dialysis. However, to our surprise, in adjusted survival analyses beyond the initial 90 days, patients receiving HD with an AVF demonstrated a consistently lower HR for mortality compared with those starting out with PD.

We observed an early peak in mortality when examining monthly death rates of patients in the HD with AVF cohort during the first year. These results are consistent with prior studies[10,11] highlighting this phenomenon. In the case of PD patients, mortality rates were seen to increase continually throughout the first year receiving dialysis. This is also consistent with the continual increase in PD mortality rates, with longer dialysis vintage reported by the USRDS[12] observed over many PD cohorts dating back to 1997.

Our finding of higher first-year mortality risk with PD compared with HD with an AVF is consistent with Chan et al,[13] who showed that from 1997 to 2009, PD patients displayed lower mortality compared with HD with AVF patients only in the initial period, but with HD with AVF patients thereafter having lower mortality than PD patients from 91 to 365 days post-ESRD start. However, our study is based on more contemporary USRDS data during a 5-year period (2010-2014). The approach of comparing 2 selected cohorts (HD with AVF and PD) that are more clinically comparable, for the reasons stated, along with covariate adjustments, reduced the magnitude of confounding by indication bias, to which such comparisons are susceptible.

Our findings are consistent with previous studies from Australasia and Korea,[14–18] as well as Canada.[8,13] Thus, including the present study, longer overall case-mix–adjusted first-year survival has been seen for HD with AVF patients versus PD patients in 5 well-conducted studies.[14–18] A key reason for carrying out the current study was that survival receiving PD has improved substantially during the last 20 years in the United States, with mortality rates declining >40%, while mortality rates for HD patients have declined ~25%.

Thus, a key question was to understand whether patient survival continues to differ for PD versus HD with an AVF, and if so, to what extent. Our results suggest that despite the large improvement in PD survival over the last 2 decades, HD patients with a functioning AVF display greater first-year survival after adjusting for patient covariates. This survival advantage for HD with AVF patients was seen despite a baseline comorbid condition imbalance between the HD with AVF and PD cohorts, with greater comorbid condition burden and prevalence of institutionalized and nonambulatory patients among HD with AVF patients, suggesting greater potential for residual selection bias.

Despite these imbalances, adjusted analyses revealed lower mortality for HD with AVF versus PD patients after 90 days. Conceivably, HD with AVF survival may be even greater than that observed for PD patients if the comorbid condition adjustments did not fully represent the severity and extent of greater comorbidity for HD with AVF cohort patients. In an earlier version of the present study,[19] we had performed the same analysis with an as-treated cohort in which time at risk was censored for transplantation, modality switch, recovery of kidney function, loss to follow-up, or end of study, and the inferences were similar.

Our findings and those of similar prior studies raise the key question of why case-mix–adjusted survival is worse for PD versus HD with AVF patients. The precise answer to this important question is unclear. We speculate that a functioning AVF at HD start is a surrogate for relatively preserved vascular health,[20,21] in addition to avoiding the presence of a foreign body (ie, a peritoneal catheter) that can cause peritonitis or tunnel infection. Our findings are relevant in the context of the recently announced Advancing American Kidney Health initiative,[22] which envisions as one of its goals greater use of home dialysis therapies. Although not specifically tested in the current study, superior first-year survival was seen for patients initiating dialysis with PD compared with HD through a central venous catheter.[13] In view of greater case-mix–adjusted survival of HD with AVF versus PD patients seen in this present work, a better strategy may be to incentivize greater pre-ESRD care to substantially increase the fraction of patients who initiate dialysis with HD with an AVF (treated in-center or at home), while greatly decreasing HD starts with a central venous catheter. Many in the community have been voicing this approach as being needed for many years. Some countries have been very successful in having most of their patients with ESRD initiating KRT with PD, HD with AVF, or kidney transplant.[23] In view of our current results and those of the prior studies cited that indicate better first-year survival with HD with AVF, caution should be applied in promoting PD over HD with AVF use at ESRD start. The observed increase in mortality risk with increasing time on PD therapy points to the great need to understand the prime reasons for the increase in PD mortality with PD vintage and steps to improve on this.

This study has limitations. It is a retrospective observational cohort study dependent on administrative billing data, with all the limitations that such an approach brings. We obtained information for patient characteristics and other demographics (which are used as risk factors in the multivariable model) from CMS Form 2728, which provides information for patients at dialysis incidence but not at follow-up. We did not use claims data after initiation to further adjust for comorbid conditions developing over time because the analysis was done as an intent-to-treat analysis. Another limitation is the potential for residual confounding. However, given the comparator group being HD with AVF, such residual bias is likely lower than in prior studies. Data for residual kidney function, which can affect long-term outcomes, were not available. In addition, the cohort may include a small number of urgent-start PD patients, although this number was likely small and therefore inconsequential. Finally, there are issues such as health system, patient, and provider preferences that go into the complex decision to pursue HD versus PD that cannot fully be addressed by statistical adjustment.

To evaluate the robustness of our findings, we conducted 4 sensitivity analyses (Fig 4A-D). Results of these sensitivity analyses continue to show clear superiority of the AVF at HD start paradigm compared with AVG or catheter as the access of choice at the start of HD. Moreover, whether we consider PD at start versus PD starts that allow for conversion to PD by day 90, results were unchanged.

In conclusion, despite improvements in quality of care of PD patients during the past 2 decades, with declining peritonitis, hospital days, and mortality for PD patients in the United States,[12,24] our analyses using contemporary US data suggest that when compared with a clinically equivalent group of patients such as those who commence KRT using an AVF at the start of HD, the survival advantage among PD patients is restricted to the initial 3 months of the first year, after which those who started with HD with an AVF have a clear survival advantage. Although the quality of life–related issues and patient preferences are often primary considerations in decisions regarding the choice of initial dialysis modality, our findings should help guide providers in advising and informing patients in this regard. Future prospective studies are needed to

understand the underlying mechanisms of observed survival differences between the 2 modalities, as well as to enhance patient experience and quality of life with both.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Table S1: Detailed results from the multivariable regression model for the outcome of death for incident HD with AVF vs incident PD patients

Table S2: Results from the multivariable regression model that adjusts for a select group of factors** for the outcome of death

ARTICLE INFORMATION

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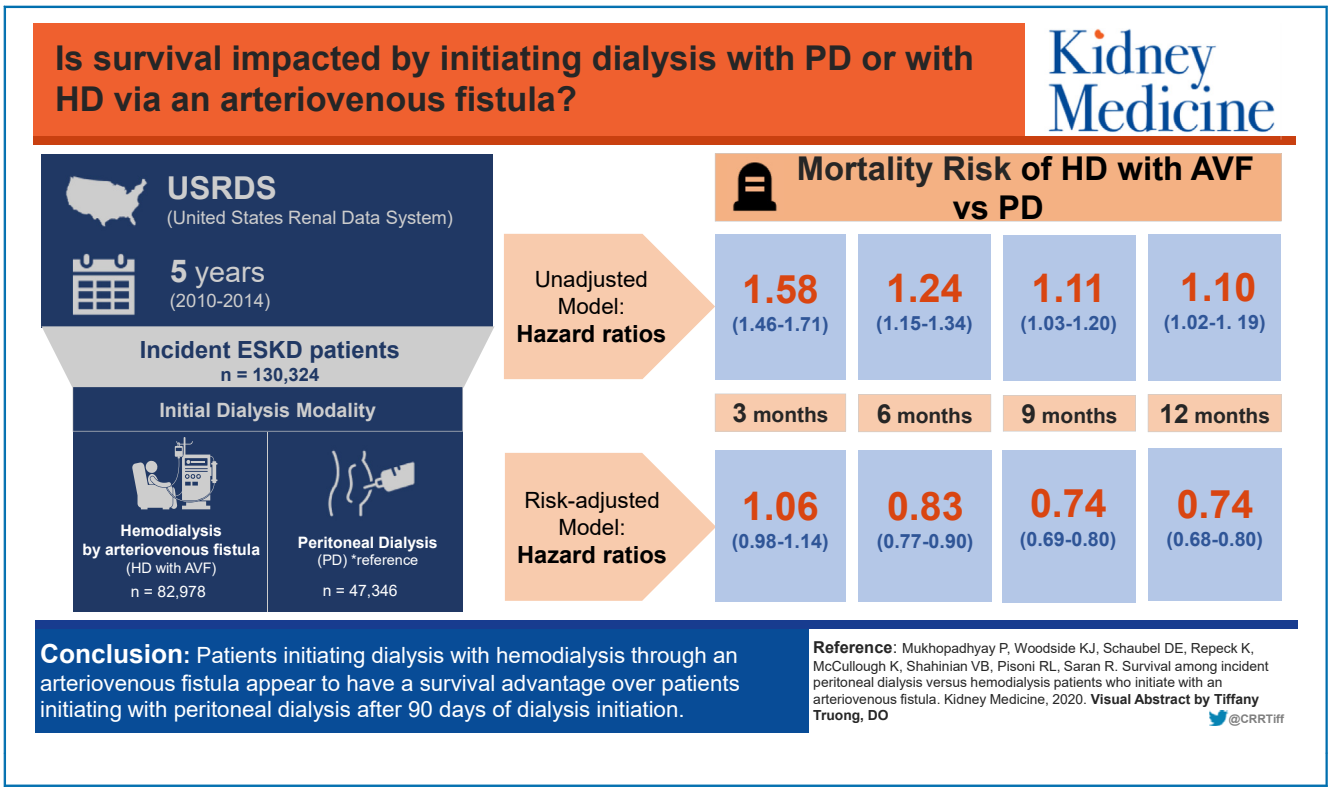
Is survival impacted by initiating dialysis with PD or with HD via an arteriovenous fistula?
Kidney Medicine
USRDS
(United States Renal Data System)
5 years
(2010-2014)
Incident ESKD patients
n = 130,324
Initial Dialysis Modality
Hemodialysis by arteriovenous fistula
(HD with AVF)
n = 82,978
Peritoneal Dialysis
(PD) *reference
n = 47,346
Mortality Risk of HD with AVF vs PD
Unadjusted Model: Hazard ratios
1.58 (1.46-1.71)
1.24 (1.15-1.34)
1.11 (1.03-1.20)
1.10 (1.02-1. 19)
3 months
6 months
9 months
12 months
Risk-adjusted Model: Hazard ratios
1.06 (0.98-1.14)
0.83 (0.77-0.90)
0.74 (0.69-0.80)
0.74 (0.68-0.80)
Conclusion: Patients initiating dialysis with hemodialysis through an arteriovenous fistula appear to have a survival advantage over patients initiating with peritoneal dialysis after 90 days of dialysis initiation.
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