Dialysis Provider and Outcomes among United States Veterans Who Transition to Dialysis

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Abstract

Background and objectives Veterans with ESKD initiate dialysis under the Veterans Health Administration (VHA), an integrated health system, or are outsourced to non-VHA providers. It is unknown whether outcomes differ according to their dialysis provider at initiation. We sought to evaluate the association between dialysis provider and mortality and hospitalization among United States veterans initiating dialysis.

Design, setting, participants, & measurements Among 68,727 United States veterans who initiated dialysis in 2007–2014, we examined the association of dialysis provider (VHA versus non-VHA) at initiation with mortality and hospitalization rates in the first 12 months post-initiation. Associations were examined across adjusted models, accounting for demographics and comorbidities.

Results Patients were 72±11 years, 5% were women, 24% were black, and 10% (n=7584) initiated at VHA dialysis centers. VHA dialysis center patients were younger, more likely to be black, had fewer cardiovascular comorbidities, and lower eGFR at dialysis initiation. VHA provider patients were more likely to be hospitalized in the first 12 months (adjusted incidence rate ratio, 1.10; 95% confidence interval, 1.07 to 1.14), but had lower all-cause mortality risk (adjusted hazard ratio, 0.87; 95% confidence interval, 0.83 to 0.93) in fully adjusted models.

Conclusions Veteran patients initiating dialysis with a VHA dialysis provider appear to have a lower mortality risk but higher hospitalization rates than veterans initiating dialysis at non-VHA dialysis units.

Clin J Am Soc Nephrol 13: 1055–1062, 2018. doi: https://doi.org/10.2215/CJN.12951117

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Introduction

There are approximately 22 million veterans in the United States. Among these, 9 million are enrolled in the Veterans Health Administration (VHA), including nearly 6 million veterans who receive their health care in one of the VHA facilities (1–3). Each year, approximately 120,000 Americans, including 13,000 veterans, transition from CKD to ESKD requiring kidney replacement therapy (dialysis or kidney transplant). Given the 1973 ESKD legislation (4), ESKD patients are eligible for Medicare coverage after a 90-day waiting period irrespective of age. Therefore, some veterans with ESKD may be afforded a choice in selecting a dialysis provider in either the private sector or from a VHA facility. However, VHA patients cannot receive dialysis benefits from both the VHA and Medicare simultaneously (5). When a VHA facility has capacity limitations or is not located in a proximate distance to a veteran's residence, the VHA can outsource dialysis treatments to the private sector on a fee-for-service basis. The VHA operates 73 VHA dialysis units, including 69 hospital-based units, two stand-alone outpatient hemodialysis clinics, and two units with both a hospital-based clinic and a stand-alone clinic (6).

According to the 2015 US Renal Data System (USRDS) annual data report, only 10% of veteran ESKD patients initiate dialysis with a VHA dialysis provider (7). The majority of the veterans with ESKD receive dialysis treatment through non-VHA dialysis providers which are mostly for-profit large dialysis organizations. In 2014, the USRDS Special Study Center, "Transition of Care in CKD," was created to examine patients who transition to kidney replacement therapy, with a specific emphasis on veterans, starting from the fiscal year 2007. Using data prepared from the Transition of Care in CKD study center, we herein sought to examine differences in mortality and hospitalizations among veterans on the basis of dialysis provider at dialysis initiation. Given the VHA's dedication to continuously improving patient care (8–10), we hypothesize that veteran patients have better outcomes when initiating dialysis with a VHA dialysis provider.

Materials and Methods

Study Population

The Transition of Care in CKD study cohort has been previously described (11–16). Briefly, a retrospective

cohort study was performed examining United States veterans with incident ESKD who transitioned to kidney replacement therapy from October 1, 2007 to March 30, 2014. The Veterans Information Resource Center internally identified 85,505 veterans transitioning to ESKD by linking the USRDS datasets (7) to files of veterans eligible for VHA services, either those who obtained health care or were eligible for VHA benefits or compensation. The algorithm for the cohort definition is shown in Supplemental Figure 1. We excluded 1701 veterans who did not have a dialysis provider assigned according to USRDS data, including 1133 who received preemptive transplants. We also removed three patients with missing data on age, and 15,074 veteran patients who were not enrolled in either the VHA or Centers for Medicare and Medicaid Services (CMS) for at least 1 year before ESKD. The final analytical cohort consisted of 68,727 veterans.

Exposure Variable

The exposure of interest was baseline VHA dialysis provider assignment (versus non-VHA) at time of ESKD start, ascertained from USRDS facility file data.

Covariates

Data from the USRDS Patient and Medical Evidence files were combined with data from VHA and CMS databases to determine patients' baseline demographic characteristics. Information on comorbidities at the time of transition to ESKD was extracted from VHA Inpatient and Outpatient Medical SAS datasets (17), and CMS data using International Classification of Diseases, Ninth Revision, Clinical Modification diagnostic and Current Procedural Terminology codes. Comorbidities were assigned if patients had two outpatient visits or one inpatient visit with the relevant diagnostic code before dialysis initiation. Heart disease included atrial fibrillation, ischemic heart disease, myocardial infarction, congestive heart failure, peripheral vascular disease, and cerebrovascular disease. Information on vascular access type, dialysis modality, cause of ESKD, body mass index (BMI), eGFR, hemoglobin and albumin at initiation, tobacco use (current smoker), alcohol and drug dependence, and patient zip code, were obtained from USRDS files. Information on whether a patient was service connected was obtained from VHA sources only. The VHA defines service connected as the occurrence or aggravation of an injury or illness during active military service. Patients who are service connected are eligible for disability compensation or have less financial responsibility for VHA services. Information on socioeconomic status (SES) was created by linking patient zip codes to the median household income provided by the 2010 United States Census (18). Information on whether provider facilities were hospital-based or for-profit versus nonprofit were obtained from the USRDS facility files.

Outcome Assessment

The primary outcome of interest was 12-month mortality after dialysis initiation. Mortality data, censoring events, and associated dates were obtained from VHA, CMS, and USRDS data sources. The start of the follow-up period was the date of dialysis initiation, and patients were followed up until death or other censoring events, including kidney transplantation, loss to follow-up, or end of follow-up period (12 months after dialysis initiation or September 2, 2014) (11,13). Lost to follow-up was determined as the last date of use of CMS or VHA services. Frequency of hospital admissions and emergency room encounters in the first year after initiation were also examined. Information on these encounters was obtained from USRDS, CMS, VHA, and VHA Fee Basis claims files, the latter including services from non-VHA providers but funded by VHA resources.

Statistical Analyses

Baseline patient characteristics were summarized according to VHA versus non-VHA baseline provider, and are presented as mean±SD or median (interquartile range) for continuous variables and number and percentages for categorical variables.

The survival probabilities between VHA versus non-VHA baseline providers and the association between the provider and mortality were estimated using the Kaplan–Meier method and Cox proportional hazards models, respectively. Associations of VHA versus non-VHA baseline dialysis provider with hospitalization rates were examined with negative binomial regression. Models were incrementally adjusted for the following potential confounders, on the basis of theoretical considerations: model one, unadjusted; model two (case–mix), adjusted for age, sex, race, ethnicity, marital status, geographic region, year of dialysis initiation, and service-connected status; model three (fully adjusted), additionally adjusted for comorbidities (heart disease, liver disease, chronic obstructive pulmonary disease, diabetes, cancer, depression, post-traumatic stress disorder, and homelessness), Charlson Comorbidity Index, socioeconomic status income category, tobacco use, drug and alcohol dependence, BMI (measured in kilograms per meter squared) and eGFR at dialysis initiation, distance from patient to dialysis provider zip code, and dialysis access type.

Associations were also examined and tested for interactions across *a priori* selected subgroups of demographics, metrics related to VHA health care utilization, and proxies of predialysis initiation care in fully adjusted models. We additionally used restricted cubic splines with three knots to examine the continuous effect of distance and year of dialysis initiation on the association of provider with mortality outcomes. Associations of provider with rates of emergency room admissions and emergency room encounters resulting in a hospitalization within the first year post-initiation were also examined with negative binomial regression. We conducted several sensitivity analyses to evaluate the robustness of our main findings. We examined associations restricted to hospital-based dialysis providers (four VHA stand-alone clinics were removed). We also compared patients receiving care from VHA providers with for-profit and other nonprofit providers. In addition, in order to account for the effect of continuity of care, we restricted analyses to veteran patients with at least one outpatient nephrology visit to a VHA clinic in the year before initiation. Although our main analysis used models focusing on the baseline provider and its cumulative effect, we also conducted sensitivity analysis in which patients were additionally censored when transferring off their baseline

provider between a VHA and non-VHA facility and vice versa, and an analysis removing patients that were censored (including those who switched providers) within the first 30 days after dialysis initiation.

Information on marital status was missing in 5% of patients, information on socioeconomic status was missing in 3% of patients, and information on tobacco use and drug and alcohol dependence was missing in 2% of patients; all other covariate data in multivariable models, including eGFR, BMI, and zip code for distance, each had <1% missing data. For categorical data, a missing category was created, and for continuous variables, missing information was imputed by means according to baseline provider. All analyses were conducted using SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary, NC) and STATA/MP version 14 (Stata Corp., College Station, TX). The study was approved by the Institutional Review Boards of the Memphis and Long Beach Veterans Affairs Medical Centers, with exemption from informed consent given the large sample size, patient anonymity and nonintrusive nature of this study.

Results

Compared with other non-VHA baseline dialysis providers, veterans initiating dialysis within the VHA were more likely to be younger, men, Black, Hispanic, unmarried, in a lower socioeconomic status income category, and live a greater distance from their dialysis provider (Table 1). However, they were more likely to have diabetes and liver disease and had a lower prevalence of other comorbidities. They were also more likely to have current tobacco use and alcohol or drug dependence, and have a history of homelessness, depression, and post-traumatic stress disorder. Veterans initiating dialysis within the VHA were more likely to be service connected and have used the VHA for pharmacy prescriptions or outpatient visits in the year before initiation. They were also more likely to have a lower eGFR at the time of initiation, have an arteriovenous fistula as their primary access type, and initiate dialysis during a hospital admission. Over the years, the proportion of veteran patients initiating dialysis in a VHA facility declined (P for trend <0.001; 12% in 2008 versus 9% in 2013, see Supplemental Table 1).

Mortality Risk and Hospitalizations

In the cohort, there were 19,456 (28%) veterans who died over the first year of dialysis, with a median follow-up of 366 (interquartile range, 218–366) days and a mortality rate of 36 (95% confidence interval [95% CI], 35 to 36) deaths per 100 person years. There were 504 patients transplanted and 6215 (9%) were lost to follow-up in the first year after dialysis initiation. Figure 1A presents crude, annualized monthly mortality rates over the first post-initiation year, with patients who initiated in a VHA facility experiencing lower mortality rates. This was also observed in the Kaplan–Meier analysis (Figure 1B; log-rank P<0.001). In unadjusted analyses, compared with veterans initiating dialysis with a non-VHA provider, veterans using the VHA as their baseline provider had a 44% lower mortality risk (hazard ratio [HR], 0.56; 95% CI, 0.53 to 0.59). After further adjustment for demographics and comorbidities, associations still showed that VHA provider patients had a lower mortality risk compared with patients served by non-VHA dialysis providers (case–mix HR, 0.80; 95% CI, 0.75 to 0.84 and fully adjusted HR, 0.87; 95% CI, 0.83 to 0.93) (Table 2).

In fully adjusted analyses comparing mortality risk of VHA with non-VHA provider patients across multiple subgroups (Figure 2A), associations similarly showed VHA patients having a lower mortality risk. There was significant effect modification by race on the association of baseline dialysis provider with mortality, whereas HR estimates showed a lower mortality risk for black compared with white veteran patients (P for interaction =0.007). In addition, the effect of initiating dialysis during a hospitalization modified the VHA provider–mortality association (P for interaction <0.001), whereas no association was observed for patients who initiated dialysis during a hospital admission. Across strata of distance from dialysis provider, the lower risk of death when initiating with a VHA versus non-VHA provider was modestly weakened for patients who lived >10 miles away from their dialysis provider; however, this association was not significantly different across strata (P for interaction =0.07). Although most patients lived in the same zip code as their dialysis provider, in restricted cubic spline models examining the continuous effect of distance on the association between VHA provider and all-cause mortality, the lower risk of death observed for those initiating with a VHA provider appeared to be attenuated for patients traveling ≥30 miles to their dialysis provider (Supplemental Figure 2). However, this lack of association may be attributed to small numbers. Lastly, the risk of death observed for those initiating with a VHA provider progressively decreased over the years between 2007 and 2014 (P for trend =0.003) (Supplemental Figure 3).

Hospitalization rates in the first patient year after dialysis initiation were 2.15 per patient year (95% CI, 2.14 to 2.16) and were higher for patients with a VHA baseline provider (Table 2). Across all models of adjustments, veterans receiving care from VHA (versus non-VHA) dialysis providers had higher rates of first year hospitalizations (unadjusted incidence rate ratio (IRR), 1.03; 95% CI, 1.00 to 1.07; case–mix IRR, 1.10; 95% CI, 1.06 to 1.13; fully adjusted IRR, 1.10; 95% CI, 1.07 to 1.14). VHA baseline provider patients also had more frequent emergency room encounters that resulted in hospitalizations, despite having less emergency room encounters overall (Supplemental Figure 4). In analyses comparing first year hospitalization rates of VHA with non-VHA provider patients across multiple subgroups (Figure 2B), associations showed VHA patients having greater hospitalization rates for most subgroups. However, there was an effect modification on the basis of race and hospitalization during transition where hospitalization rate ratios comparing VHA with non-VHA baseline dialysis providers were lower in black patients and patients hospitalized during initiation (P for interaction <0.001 for both). In addition, no difference in hospitalization rates were observed according to baseline providers for patients having a history of homelessness (P for interaction <0.001) or post-traumatic stress disorder (P for interaction <0.001). Of note, hospitalization rate ratios for VHA versus non-VHA patients were significantly

Table 1. Baseline characteristics of 68,727 veterans who initiated dialysis between October of 2007 and March of 2014, according to dialysis provider at initiation

Variables	VHA	Non-VHA	All Patients
N	7584	61,143	68,727
Age, yr (mean±SD)	65±11	72±11	72±11
Women, %	184 (2)	3546 (6)	3730 (5)
Race, %			
White	3983 (53)	45,184 (74)	49,167 (71)
Black	3201 (42)	13,025 (21)	16,226 (24)
Other	400 (5)	2934 (5)	3334 (5)
Ethnicity, %			
Hispanic	668 (9)	3525 (6)	4193 (6)
Marital status, %			
Single	970 (13)	3621 (6)	4591 (7)
Married	3268 (43)	37,093 (61)	40,361 (59)
Divorced	2613 (34)	10,863 (18)	13,476 (20)
Widowed	722 (10)	6400 (10)	7122 (11)
Missing or other	11 (0.2)	3166 (5)	3177 (5)
Income, %			
SES level 1, <$35,000	1514 (21)	8947 (15)	10,461 (16)
SES level 2, $35,000 to <$55,000	3338 (45)	29,776 (50)	33,114 (50)
SES level 3, ≥$55,000	2490 (34)	20,575 (35)	23,065 (34)
Geographic region, %			
Northeast	1109 (15)	10,699 (18)	11,808 (17)
Midwest	1438 (19)	14,155 (23)	15,593 (23)
South	3163 (42)	25,694 (42)	28,857 (42)
West	1826 (24)	10,002 (17)	11,828 (17)
Zip code distance to provider, %			
<10 miles	3047 (41)	42,102 (69)	45,149 (66)
Cause of ESKD, %			
Diabetes	3651 (48)	25,956 (42)	29,607 (43)
Hypertension	1600 (21)	20,476 (33)	22,076 (32)
GN/cystic kidney disease	767 (10)	3910 (6)	4677 (8)
Other or unknown	1566 (21)	10,801 (17)	12,367 (18)
Charlson comorbidity index[a]	3 (2–5)	4 (2–6)	4 (2–6)
Comorbidity, %			
Heart disease	5404 (71)	49,358 (81)	54,762 (80)
Chronic obstructive pulmonary disease	2350 (31)	27,770 (45)	30,120 (44)
Liver disease	941 (12)	6383 (9)	7324 (11)
Diabetes	5255 (69)	40,929 (67)	46,184 (67)
Cancer	1522 (20)	15,820 (26)	17,342 (25)
Anemia	5148 (68)	44,383 (73)	49,531 (72)
Depression	2120 (28)	12,686 (21)	14,806 (22)
Post-traumatic stress disorder	1128 (15)	4192 (7)	5320 (8)
Homelessness	1817 (24)	4871 (8)	6688 (10)
Service connected	3680 (48)	18,566 (30)	22,246 (32)
Alcohol dependence	315 (4)	1042 (2)	1357 (2)
Current tobacco use	784 (11)	3753 (6)	4537 (7)
Drug dependence	347 (5)	545 (1)	892 (1)
Dialysis modality, %			
Hemodialysis	7255 (96)	57,366 (94)	64,621 (94)
Access type, %			
AV fistula or AV graft	2066 (27)	12,201 (20)	14,267 (21)
Central venous catheter	4886 (64)	43,917 (72)	48,803 (71)
Missing or other	632 (8)	5025 (8)	5657 (8)
eGFR at initiation, ml/min per 1.73 m^2	9.3±5.6	10.9±6.1	10.8±6.0
Body mass index at initiation, kg/m^2	28.8±7.1	28.4±6.8	28.4±6.9
Albumin at initiation, g/dl	3.2±0.7	3.2±0.7	3.2±0.7
Hemoglobin at initiation, g/dl	9.7±1.6	9.9±1.6	9.9±1.6
Initiated dialysis in the hospital, %	4216 (55)	32,272 (53)	36,488 (53)
VHA usage in year before ESKD			
VHA pharmacy usage, %	7486 (99)	35,564 (58)	43,050 (63)
VHA outpatient usage, %	7485 (99)	38,280 (63)	45,765 (67)
Frequency of VHA outpatient visits[a]	32 (20–48)	3 (0–16)	4 (0–22)

VHA, Veterans Health Administration; SES, socioeconomic status; AV, arteriovenous.
[a]Data presented as median (interquartile range).

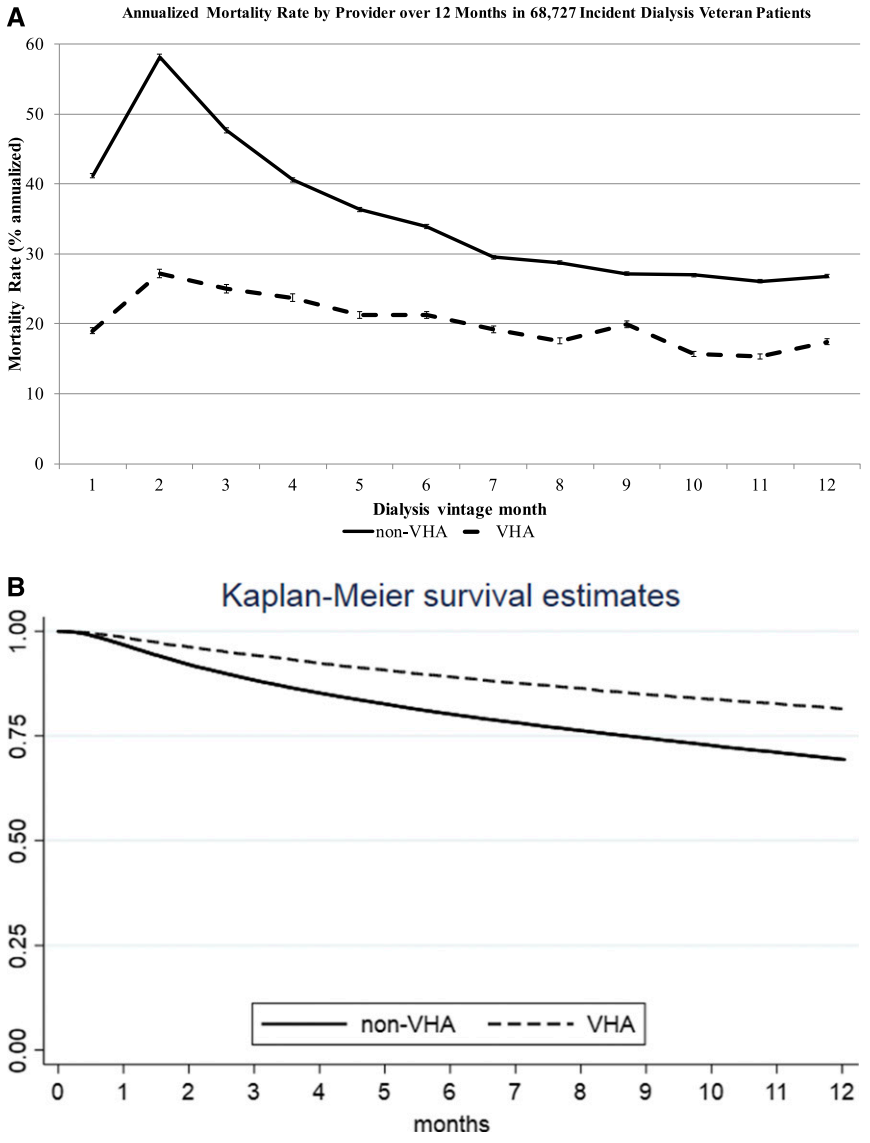

Figure 1. | Veterans with a VHA (versus non-VHA) baseline dialysis provider had lower mortality in 68,727 veterans who initiated dialysis between October of 2007 and March of 2014. (A) Annualized mortality rates showing lower mortality rates for VHA (B) Kaplan Meier showing a slower decrease in survival over time for VHA.

higher in patients whose cause of ESKD was GN or cystic disease (P for interaction <0.001). The top 20 causes of hospital admission did not differ in VHA versus non-VHA provider patients (Supplemental Table 2).

Sensitivity Analyses

We performed a number of sensitivity analyses to test the robustness of our mortality findings (Supplemental Table 3). In these subcohorts, compared with non-VHA baseline provider patients, patients who initiated dialysis within a VHA facility had a lower mortality risk in unadjusted models this large, contemporary, national cohort of United States veterans initiating dialysis, we found that patients initiating dialysis in a VHA dialysis center had a lower mortality risk even after comprehensively accounting for confounders. Results were mostly consistent across numerous sensitivity analyses. Our findings stand in contrast to a prior regional study by Wang *et al.* (19), who examined a smaller regional sample size of prevalent patients and found no difference in 1-year mortality between VHA and non-VHA provider patients. However, our study included a larger number of veteran patients, representative of the entire incident ESKD United States veteran population, and had both pre-ESKD data and available follow-up beginning at ESKD initiation. In addition, Wang *et al.* identified VHA or non-VHA provider from VHA treatment claims data, whereas in our study, we used the USRDS files to ascertain baseline provider. Consistent with other studies comparing VHA and non-VHA dialysis patients, VHA provider patients in our cohort also initiated at a lower eGFR (20); had a higher prevalence of diabetes, current tobacco use, and alcohol or drug dependence (20); and had a higher rate of arteriovenous fistula placement possibly indicative of more predialysis

Table 2. All-cause mortality hazard ratios and hospitalization rate ratios according to baseline VHA versus non-VHA dialysis provider over 12 months of follow-up in 68,727 veterans

Events	VHA	Non-VHA	*P* for Difference
Mortality, HR (95% CI)			
N event	1376	18,080	
Mortality rate per 100 person years	21 (20 to 22)	38 (37 to 38)	<0.001
Unadjusted	0.56 (0.53 to 0.59)	1-referent	<0.001
Case–mix	0.80 (0.75 to 0.84)	1-referent	<0.001
Fully adjusted	0.87 (0.83 to 0.93)	1-referent	<0.001
Hospitalization, IRR (95% CI)			
N event	15,277	102,368	
Hospitalization rate per 100 person years	231 (227 to 234)	213 (212 to 214)	<0.001
Unadjusted	1.03 (1.00 to 1.07)	1-referent	0.05
Case–mix	1.10 (1.06 to 1.13)	1-referent	<0.001
Fully adjusted	1.10 (1.07 to 1.14)	1-referent	<0.001

VHA, Veterans Health Administration; HR, hazard ratio; 95% CI, 95% confidence interval; IRR, incidence rate ratio.

nephrology care at the time of dialysis initiation (21). In contrast to previous studies (19,22), however, VHA provider patients in our cohort tended to have less comorbidity burden overall.

Although the true underlying reasons for retaining some patients on dialysis in the VHA versus outsourcing others to other providers is unknown, it may be that patients with a greater connection to VHA health care services are more likely to be selected for dialysis in a VHA facility, which may explain their particular case–mix characteristics. In models adjusted or stratified by these factors, VHA provider patients still had or trended toward a lower mortality risk. Patients who initiated dialysis during a hospital admission, however, had no differences in post-dialysis initiation mortality according to provider. This stratum may represent patients who are older and sicker

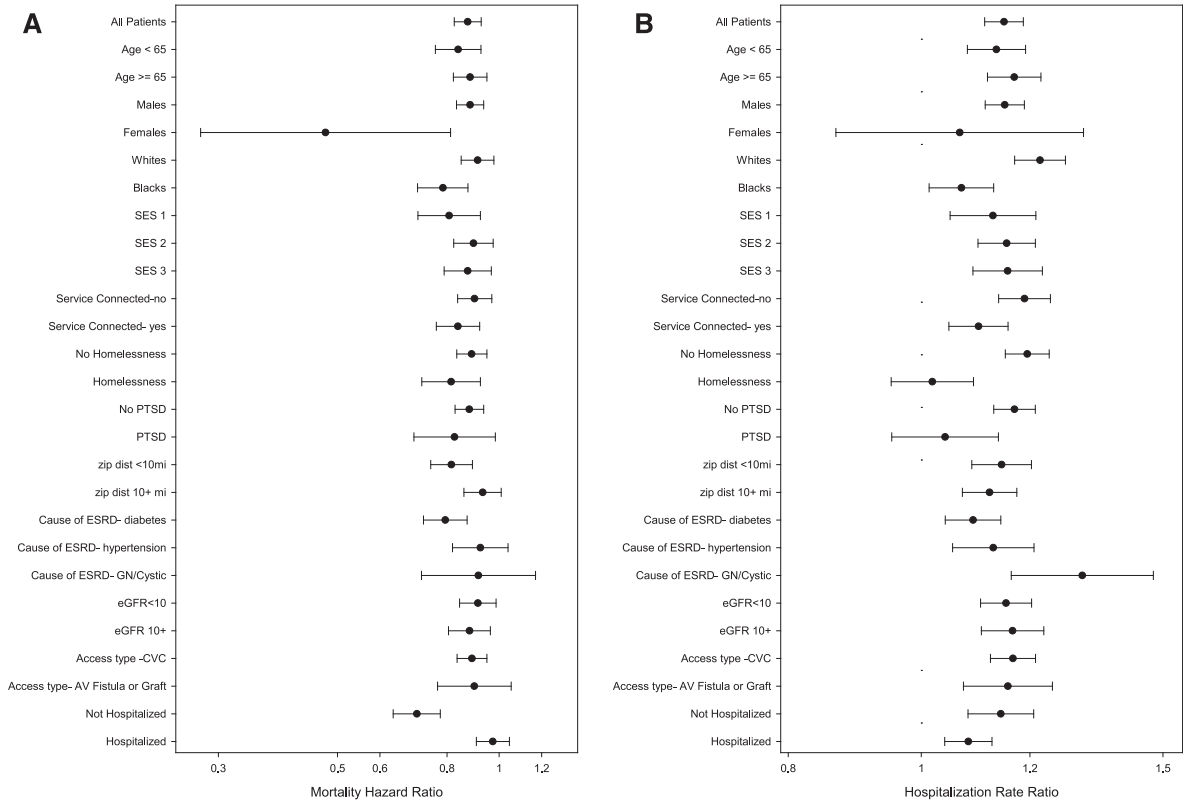

Figure 2. | Association of VHA (versus non-VHA) baseline dialysis provider over 12 months follow-up in *a priori* selected subgroups. Patients with VHA (versus non-VHA) baseline dialysis provider experienced lower all-cause mortality risk (A) yet higher hospitalization rates (B) over 12 months of follow-up across most examined a priori selected subgroups. AV, arteriovenous; CVC, central venous catheter; mi, miles; PTSD, post-traumatic stress disorder; SES, socioeconomic status; zip dist, zip code distance to provider.

and do not have predialysis care, leading to a higher mortality risk (23) independent of the factors related to VHA versus non-VHA provider care. Nonetheless, differences in mortality risk between non-VHA and VHA providers in general may be explained by advantages offered by a fully equipped acute care hospital setting (as most VHA dialysis units are hospital-based [24]), such as better facility staffing levels and more integrated care across primary care and specialty services, which may further explain mortality differences. However, in our sensitivity analysis comparing VHA with non-VHA hospital-based provider patients, VHA patients had lower mortality risk in unadjusted and case–mix adjusted models, and trended toward lower mortality in fully adjusted models. One of the reasons that may explain the better performance by the VHA system is the integrated health care system, which is supported by a comprehensive electronic medical record system and characterized by continuity of care across all aspects of a patient's ever changing health status (8). Moreover, in a study by Hynes *et al.* (22) reporting on dialysis health care costs between 170 VHA and 164 private sector dialysis patients, they speculated that the higher costs for VHA patients may be related to greater staffing ratios. We similarly found higher staffing ratios for VHA versus non-VHA dialysis centers in our own supplemental analysis (Supplemental Material). Higher staffing ratios and more full-time staff may lead to improved patient safety and better quality of care (25,26). In a systematic review by Trivedi *et al.* comparing VHA with non-VHA quality of nonsurgical care over nearly 20 years, the VHA performed better (9), although no differences in mortality risk were observed. Another study by Asch *et al.* (10) found that the VHA patients reported receiving a higher quality of care than non-VHA patients. Furthermore, a previous analysis has shown that after system-wide reengineering and improvements in the 1990s, the VHA outperformed Medicare fee-for-service programs on most indicators of quality of care (8). In our study, we also observed that the lower mortality risk associated with initiating dialysis with a VHA provider grew stronger across the years.

In our overall cohort and in most subgroups, VHA provider patients had a higher incidence of hospitalization and emergency room encounters resulting in hospitalization in the first year post-transition, compared with non-VHA dialysis provider patients, even after adjustment for comorbidities. The top causes of hospital admissions did not significantly differ for VHA versus non-VHA provider patients. Higher hospitalization rates in conjunction with lower mortality risk may suggest VHA provider patients are receiving more intense care addressing their health problems. Because of the integrated health care system, VHA patients may also have an easier transfer to hospital admission if they are already receiving dialysis care at a provider within the VHA system. VHA hospitals are also not subject to CMS Hospital Readmission Reduction Program financial penalties, which may contribute to higher hospitalization readmissions and thereby higher hospitalization rates for VHA provider patients (27). A previous study in veteran men also found VHA versus non-VHA hospitals had higher readmission rates, but lower standardized 30-day mortality rates (27). In addition, an integrated health care system may also provide better communication between the hospitalization care givers and dialysis providers, which may lead to a lower mortality risk (28).

Our study has several potential limitations that may confound the interpretation of our findings. Analyses were adjusted for available confounders, and we cannot exclude the possibility of residual confounding in our associations. The VHA may be selecting on a healthier cohort that is also more active in seeking care with the VHA system, which may lead to bias due to confounding by indication in our results. However, in fully adjusted models accounting for these factors, VHA patients still had a lower mortality risk. We also did not have time-updated information and comprehensive information on laboratory data for all patients. Lastly, because this was an observational study, cause–effect relationships cannot be confirmed. Despite these limitations, our study is notable for its large sample size representative of United States veterans initiating dialysis. To our knowledge, this is the largest study to assess the associations between baseline dialysis provider and all-cause mortality and hospitalization rate after dialysis initiation in veterans.

In conclusion, we found that veterans initiating dialysis in a VHA facility had a lower mortality risk but higher hospitalization incidence than those who initiated in a non-VHA facility. These associations were robust across multivariable adjustments and strata of clinically relevant subgroups. It is possible that the lower risk for death observed in VHA provider-based patients is the result of advantages provided by an integrated health care system. Further studies are warranted to identify methods of improving patient health and outcomes for all veterans receiving dialysis.

Acknowledgments

The data reported here have been supplied by the US Renal Data System (USRDS).

This study was supported by grant U01-DK102163 from the National Institutes of Health (NIH) to C.P.K. and K.K.-Z., and by resources from the US Department of Veterans Affairs. Support for Veterans Health Administration/CMS data are provided by the Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, Health Services Research and Development, Veterans Affairs Information Resource Center (project numbers SDR 02-237 and 98-004). K.K.-Z. has been supported by the NIH/ National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) midcareer award K24-DK091419. C.M.R. has been supported by the NIH/NIDDK early career award K23-DK102903. E.S. is supported by a career development award from the Office of Research and Development of the Department of Veterans Affairs (IK2- CX 001266-01).

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 Department of Veterans Affairs or the United States Government.

Disclosures

K.K.-Z. has received honoraria and/or support from Abbott, Abbvie, Alexion, Amgen, American Society of Nephrology, AstraZeneca, AVEO Oncology, Chugai, DaVita, Fresenius, Genentech, Haymarket Media, Hofstra Medical School, International Federation of Kidney Foundations, International Society of Hemodialysis, International Society of Renal Nutrition and Metabolism, Japanese

Society of Dialysis Therapy, Hospira, Kabi, Keryx, Novartis, National Institutes of Health, National Kidney Foundation, OPKO, Pfizer, Relypsa, Resverlogix, Sandoz, Sanofi, Shire, Vifor, UpToDate, and ZSPharma. E.S., C.P.K., J.L.T.C., and K.K.-Z. are employees of the Department of Veterans Affairs.

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Received: November 20, 2017 **Accepted:** April 19, 2018

Published online ahead of print. Publication date available at www.cjasn.org.

See related editorial, "Site of Care and Health Outcomes of Veterans Undergoing Maintenance Dialysis," on pages 979–981.

This article contains supplemental material online at http://cjasn.asnjournals.org/lookup/suppl/doi:10.2215/CJN.12951117/-/DCSupplemental.