Title

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Permalink

https://escholarship.org/uc/item/4643k299

Journal

Clinical Kidney Journal, 14(12)

ISSN

2048-8505

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Publication Date

2021-12-21

DOI

10.1093/ckj/sfab097

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Peer reviewed

ORIGINAL ARTICLE

Depression screening and clinical outcomes among adults initiating maintenance hemodialysis

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ABSTRACT

Background. Transitioning to maintenance hemodialysis (HD) is a vulnerable period for persons with end-stage renal disease (ESRD), punctuated by high rates of depression, hospitalizations and death. Screening for depression during this time may help to improve patient outcomes but formal inquiry has yet to be conducted. Among a national Veteran cohort, we examined whether depression screening in the year prior to HD initiation led to improved outcomes in the year thereafter.

Methods. Associations between pre-ESRD depression screening and post-ESRD outcomes were examined with Cox proportional hazards models (mortality) and Poisson regression models (hospitalization). Hierarchal adjustment models accounted for sociodemographic, clinical, pre-ESRD care and dialysis characteristics.

Results. The final analytic cohort of the study was 30 013 Veterans of whom 64% underwent pre-ESRD depression screening. During the 12 months post-transition, the crude all-cause mortality rate was 0.32 person-year for those screened and 0.35 person-year for those not screened, while the median (interquartile range) hospitalizations were 2 (2, 2) per year for both groups. In fully adjusted models, pre-ESRD depression screening was associated with a lower risk of mortality [hazard ratio (95% confidence interval): 0.94 (0.90–0.99)] and hospitalization [incidence rate ratio (95% confidence interval): 0.97 (0.9–0.99)].

Conclusion. Depression screening among adults prior to maintenance HD transition may be associated with better outcomes during the following year.

INTRODUCTION

Up to 40% of adults with end-stage renal disease (ESRD) requiring maintenance dialysis have depression, which is 5-fold greater than the general population [1]. Concomitant depression is associated with worse dialysis treatment, dietary and medication adherence, as well as lower quality of life, increased hospitalizations and higher mortality [2–6]. While some outcomes for maintenance dialysis patients have improved, the transition period around the initiation of maintenance dialysis remains an especially vulnerable time for them because of a very high risk of hospitalization and death [7]. To ameliorate this transition, substantial resources have been directed to improve pre-dialysis education, informed dialysis modality decision-making and timely placement of dialysis access. Importantly, the decline in mental health due to the lifestyle changes and demands necessitated by this dialysis transition has received less attention despite formidable negative consequences [6, 8]. Depression among adults prior to initiating maintenance dialysis is associated with higher all-cause mortality during the 12 months afterward compared with their counterparts without depression [9, 10].

Screening for depression among adults with kidney disease has been recommended by systematic reviews and consensus guidelines [11–13]. Moreover, the Centers for Medicare and Medicaid Services (CMS) have included depression screening and follow-up as a clinical performance measure for all maintenance dialysis patients in its pay-for-performance Quality Incentive Program [14]. However, a recent Veterans Affairs (VA) Evidence Synthesis Program review noted that no studies to date have examined the impact of depression screening on outcomes in adults with kidney disease [15]. While depression screening may intuitively seem to confer benefits as it is an essential first step in diagnosis and treatment of a comorbid condition associated with adverse outcomes, this conclusion is not preordained. Depression screening may pose an additional burden on staff that detracts from other aspects of patient care and may be perceived negatively by patients, and its treatments may be unacceptable to patients. Therefore, it is essential to further evaluate the effect of depression screening on patient outcomes.

The prevalence of ESRD among Veterans is approximately double that of non-Veterans, owing in part to high rates of predisposing comorbid illnesses, older age and other sociodemographic risk factors [16]. Veterans also experience major depressive disorder at more than twice the rate of the general US population (13.5% versus 7.1%) [11], and those Veterans with chronic kidney disease (CKD) have even a higher rate of depression (30%) [10]. In 2014, the US Renal Data System (USRDS) Special Study Center, 'Transition of Care in CKD' (TC-CKD), was created to examine outcomes among a national cohort of adults who transition to kidney replacement therapy, with a specific emphasis on Veterans, starting from the fiscal year 2007 [9]. Using data from this study, we examined the relationship between screening for depression among Veterans in the year prior to maintenance hemodialysis (HD) initiation and mortality and hospitalization in the year thereafter. We hypothesized that depression screening would be associated with reductions in mortality and hospitalization.

MATERIALS AND METHODS

Study population and data sources

The analytical cohort for this study was derived from the USRDS TC-CKD study, which focused on 102 477 US Veterans with incident ESRD who transitioned to dialysis treatment between 1 October 2007 and 30 March 2015 [9]. In the current study, we restricted participants to those with an available date of birth and who had a nephrology or primary care outpatient visit in VA within 1 year prior to transition. We identified the earliest nephrology or primary care outpatient visit in this 1 year prior to transition as the index outpatient visit. We excluded Veterans with a diagnosis of depression, bipolar disorder or dementia, or any antidepressant medication prescriptions within 1 year prior to this index outpatient visit date. Finally, we excluded patients for errors in estimates of follow-up time or treated with an initial dialysis modality other than in-center HD. Our final analytical cohort included 30 013 patients (Figure 1). In subgroup analyses, we restricted the cohort to Veterans without a diagnosis of post-traumatic stress disorder (PTSD) or anxiety within 1 year prior to the index outpatient visit date ($n = 28\,929$), who initiated dialysis within a VA facility ($n = 4903$), were alive and on dialysis 90 days after dialysis initiation ($n = 26\,787$), who initiated dialysis before year 2011 ($n = 13\,517$) or who initiated dialysis after year 2011 ($n = 16\,496$), because 2011 was the midpoint during the overall TC-CKD observation period. Given the nonintrusive nature, Veteran anonymity and large sample size, the requirement for written informed consent was waived and the study was approved by the Memphis and Long Beach Veterans Affairs Medical Centers Institutional Review Boards.

Demographic, clinical and laboratory measurements

Baseline patient characteristics of this study cohort include date of birth, sex, race and ethnicity, marital status, primary
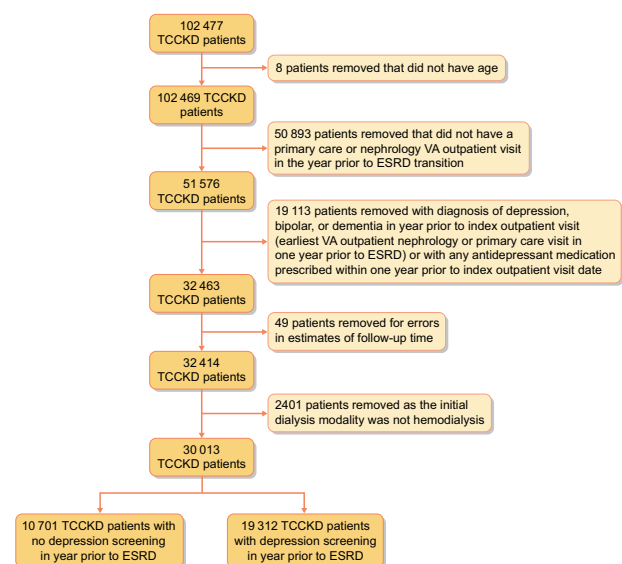

FIGURE 1: Cohort identification.

cause of ESRD, vascular access type, preexisting comorbidity status, homelessness and Charlson comorbidity index (CCI), tobacco usage, alcohol dependency, drug dependency, patient income, body mass index (BMI), laboratory measurements and baseline dialysis provider [17]. Methods on extracting these data were described previously [7, 18]. Information on service connectedness, which is defined as a Veteran who receives financial aid for a disability incurred or exacerbated during military service, was obtained from the VA data provider [17].

Exposure measurement

The main exposure was completion of a Patient Health Questionnaire-2 (PHQ-2) or Questionnaire-9 (PHQ-9) depression screening questionnaire in the year prior to ESRD transition. We defined depression screening by completion of these instruments because they were mandated for depression screening by VA during the study period [11, 19].

Outcome assessment

The main outcomes were all-cause mortality and hospitalization during the 12 months after maintenance HD initiation. Information on all outcomes and censoring events were obtained from VA, CMS and USRDS records. Patients were followed from the date of initiation of ESRD until death, renal transplantation, loss to follow-up or the date of final follow-up for all patients (12-month post-ESRD transition or 1 September 2015 for all-cause mortality and hospitalization rate). Loss to follow-up was determined as the last date of use of VA or CMS services.

Statistical analysis

Baseline patient characteristics are presented as means ± standard deviation (SD), median [interquartile range (IQR)] or percent as appropriate for the total cohort and stratified by patient's depression screening status. Screened versus non-screened patients were compared using standardized differences [20], where an absolute difference of 0.2 or larger was considered meaningful.

Cox proportional hazards models were used to evaluate the association of pre-ESRD depression screening status with post-ESRD all-cause mortality over the 12-month follow-up. The proportionality assumption was checked using plots of log [−log(survival rate)] against log(survival time). The number needed to treat (NNT) at 1 year was calculated by taking the difference of the Kaplan–Meier estimated survival at 1 year between the screened and unscreened, and taking 1 over this value. Poisson regression models were used to evaluate the relationship of pre-ESRD depression screening status with post-ESRD 12-month hospitalization rate. We counted the total number of hospitalizations during follow up.

For each outcome, four hierarchal models of adjustment were used: (i) Model 1, unadjusted; (ii) Model 2, adjusted for age, gender, race, ethnicity, marital status and income level; (iii) Model 3, Model 2 + primary cause of ESRD, CCI, PTSD, anxiety, tobacco use, drug dependence, alcohol dependence, BMI and baseline laboratory measures of albumin, hemoglobin and estimated glomerular filtration rate (eGFR); and (iv) Model 4, Model 3 + pre-ESRD VA visit intensity for primary care or geriatric, and nephrology, in the year prior to transition, dialysis provider (VA versus non-VA) and HD vascular access type at dialysis initiation (central venous catheter, arteriovenous fistula or graft, other). We defined Model 4 as the primary model of interest.

Associations were also examined in substrata as described above, where tests for interaction were evaluated using a Wald's test. Missing marital status data were <0.1% and were categorized as non-married. Missing income (<3% of the total cohort) and dialysis initiation access type (<2.5% of the total cohort) were handled by creating missing categories. Missing service connected (61%) were categorized as not having service connected. Patients with missing CCI score, PTSD and anxiety data (<0.01% of the total cohort), and missing tobacco use, alcohol dependency and drug dependency data (<2.5% of the total cohort) were categorized as absence of condition for each comorbidity. Missing values for BMI (5% of the total cohort) and laboratory measurements (including 27% of patients for albumin, 14% for hemoglobin and 4% for eGFR) were imputed using multiple imputation.

To examine potential biases from nonrandom assignment of patients to screening groups, we conducted a series of propensity score and facility experience analyses. For the facility experience analyses, we calculated each VA facility's depression screening percentage as the number of patients screening out of the total number of patients. The median facility screening proportion was 65%. We then conducted subgroup analyses stratified by facilities screening proportion <65% and ≥65%. For propensity score analyses, we calculated propensity scores from a logistic regression model that predicted the probability of membership in the screened versus the non-screened group with Model 4 adjustment + facilities screening proportion aiming to reduce differences between groups. We then used the propensity score for both mortality and hospitalization analyses in three complementary ways (matching, adjustment and inverse probability weighting) and assessed outcomes. Matching procedures were completed by SAS macro *Gmatch* based on the Greedy Algorithm created by Bergstralh et al. [21].

All analyses were conducted using SAS Enterprise Guide, version 7.1 (Cary, NC, USA).

RESULTS

Baseline cohort characteristics

The final analytic cohort included 30 013 US Veterans transitioning to ESRD with an average age of 71.54 ± 11.23 years (mean ± SD), 1% females, 26% African-American, 43% with diabetes as primary cause of ESRD, 36% with service connected and a median of three Veteran Healthcare Administration (VHA) primary care or geriatric visits before transition to ESRD (Table 1). Sixty-four percent of patients underwent depression screening in the year prior to transition to ESRD (18 263 patients had PHQ-2 screening and 1049 patients had PHQ-9 screening). Patient baseline characteristics were similar between those with and without pre-ESRD depression screening. Compared with patients without pre-ESRD depression screening, patients with screening had a higher number of primary care or geriatric outpatient visits in the year prior to transition (Table 1). Across the years of dialysis initiation, the percentage of VA patients completing a depression screening in the year prior to transition incrementally increased until 2011, where it became 84% of patients per year, and then plateaued thereafter (Supplementary data, Table S1).

Pre-ESRD depression screening and post-ESRD mortality

During the first 12 months of ESRD, 8070 patients died with a crude rate of 33 (32–34) deaths per 100 person-years, and

Table 1. Baseline characteristics of Veterans transitioning to maintenance HD categorized by pre-ESRD depression screening status

Variable	Total	Screened	Not screened	Standard differences
N (%)	30 013	19 312 (64.35)	10 701 (35.65)	
Age (years)	71.54 ± 11.23	71.45 ± 11.19	71.71 ± 11.31	−0.0234
Female (%)	1.36	1.28	1.50	−0.0185
Race (%)				
White	70.44	69.81	71.57	−0.0388
Black	26.42	26.82	25.69	0.0258
Other	3.15	3.37	2.74	0.0368
Ethnicity (%)				
Hispanic	6.26	6.55	5.74	0.0338
Marital status (%)				
Single	7.44	7.52	7.31	0.0080
Married	58.50	58.56	58.39	0.0036
Divorced	22.36	22.76	21.63	0.0274
Widowed	11.7	11.16	12.68	−0.0470
Employment (%)				
Full or part time	4.78	4.70	4.93	−0.0111
Income (%)				
SES level 1, <$35 000	17.02	17.00	17.07	−0.0016
SES level 2, $35 000 to <$55 000	50.35	50.18	50.66	−0.0085
SES level 3, ≥$55 000	32.62	32.82	32.26	0.0123
Homelessness (%)	7.10	7.22	6.88	0.0132
Service connected—Yes (%)	35.7	37.1	33.4	0.0188
ESRD cause (%)				
Diabetes mellitus	43.4	43.98	42.37	0.0325
Hypertension	31.74	31.53	32.13	−0.0128
GN/cystic kidney disease	6.85	6.53	7.42	−0.0347
Other or unknown	18	17.96	18.08	−0.0032
BMI at initiation (kg/m^2)	28.23 ± 6.03	28.37 ± 6.05	28.00 ± 6.00	0.0658
Charlson comorbidity index	5 (3–7)	5 (3–7)	5 (3–7)	0.0215
Comorbidities at baseline (%)				
Diabetes mellitus	68.55	69.18	67.41	0.0382
Hypertension	97.64	97.92	97.15	0.0496
Heart disease	81.54	81.32	81.93	−0.0157
Chronic obstructive pulmonary disease	41.24	41.75	40.32	0.0292
Liver disease	11.39	11.70	10.82	0.0278
Cancer	25.18	25.15	25.25	−0.0023
Anemia	76.87	77.33	76.04	0.0304
Current tobacco use	6.67	6.91	6.25	−0.0032
Alcohol dependence	2.09	2.14	2.01	−0.0032
Drug dependence	1.18	1.09	1.34	−0.0032
Anxiety	8.2	8.57	7.54	0.0377
Post-traumatic stress disorder	3.25	3.55	2.70	0.0489
Lab tests at initiation of dialysis				
eGFR	9.23 (6.80–12.33)	9.13 (6.75–12.22)	9.41 (6.91–12.59)	−0.0676
Serum albumin	3.16 ± 0.62	3.16 ± 0.61	3.16 ± 0.63	0.0066
Hemoglobin	9.80 ± 1.47	9.72 ± 1.47	9.94 ± 1.46	−0.1560
VHA usage in year before ESRD (number of outpatient encounters)				
PCP/geriatrics	3 (1–5)	3 (2–6)	2 (1–5)	0.2546
Nephrology	0 (0–4)	0 (0–5)	0 (0–4)	0.1456
Mental health	0 (0–0)	0 (0–0)	0 (0–0)	0.0435
Dialysis provider at initiation (%)				
VA	16.34	16.60	15.86	0.0201
Non-VA	83.66	83.40	84.14	0.0201
Year of dialysis initiation (%)				
2007–10	45.04	28.29	75.26	−1.0651
2011–15	54.96	71.71	24.74	1.0651
Dialysis access type at initiation (%)				
Catheter	73.51	72.49	75.36	−0.0654
AV fistula or AV graft	23.48	24.29	22.01	0.0542
Missing or other	0.51	0.36	0.78	−0.0560

AV, arteriovenous; GN, glomerulonephritis; PCP, primary care physician; SES, socioeconomic status. Data presented as mean ± SD, median (IQR) or proportion, where appropriate.
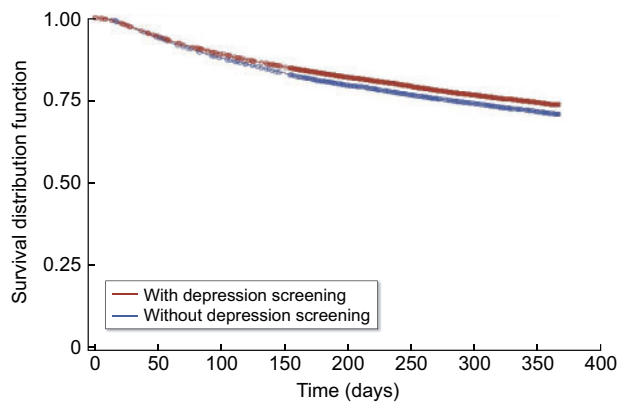
FIGURE 2: Pre-ESRD depression screening and 12-month post-ESRD survival.

patients with depression screening had a lower crude mortality rate than those without screening, 32 (31–32) and 35 (34–37) deaths per 100 person-years, respectively (Figure 2 and Supplementary data, Table S2). The calculated NNT according to the Kaplan–Meier survival rate at 1 year was 35. In unadjusted analysis, patients with depression screening before dialysis initiation had a lower rate of 12-month all-cause mortality after dialysis initiation {hazard ratio (HR) [95% confidence interval (CI)]: 0.89 (0.85–0.93)}. After adjustment for demographics characteristics, patients with depression screening continued to have a lower post-ESRD 12-month all-cause mortality risk [HR (95% CI): 0.91 (0.87–0.95)]. After adjustment for comorbidities and laboratory parameters in Model 3 and additional variables in Model 4, depression screening was associated with significantly lower, albeit attenuated, 12-month mortality [HR (95% CI): 0.92 (0.88–0.96) and 0.94 (0.90–0.99), respectively] (Figure 3 and Supplementary data, Table S2).

In subgroup analyses, results were consistent with the overall cohorts in showing a lower mortality risk in patients
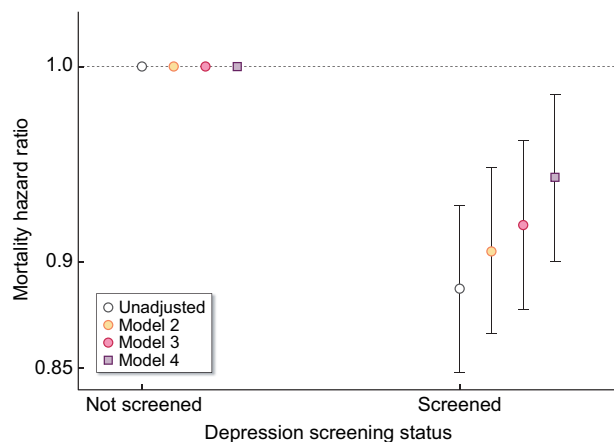
screened for depression: without a pre-diagnosis of PTSD or anxiety [Model 4 HR (95% CI): 0.94 (0.90–0.99)]; who initiated dialysis within the VA facilities [Model 4 HR (95% CI): 0.77 (0.68–0.89)]; on dialysis at least 90 days after dialysis initiation [Model 4 HR (95% Cl): 0.93 (0.88–0.99)]; and who initiated dialysis after year 2011 [Model 4 HR (95% CI): 0.90 (0.83–0.98)] (Supplementary data, Table S3). Depression screening was also associated with a lower mortality risk in patients who initiated dialysis prior to 2011, and there was no significant interaction by year group (P for interaction: 0.0849). Patients who initiated dialysis within VA facilities had a significantly lower mortality risk associated with depression screening, compared with patients who initiated dialysis at a non-VA facility (P for interaction: 0.00071). In facility subgroup and propensity score analyses, the results were not significantly changed (Supplementary data, Tables S4 and S5).

Pre-ESRD depression screening and post-ESRD hospitalization rate

Overall, patients had a median (IQR) of 1 (1–2) hospitalizations in the first 12 months after ESRD initiation. Patients with depression screening before dialysis initiation had a lower 12-month hospitalization rate after dialysis initiation [incidence rate ratio (IRR) (95% CI): 0.97 (0.95–0.98)] (Figure 4 and Supplementary data, Table S6). The association between pre-ESRD depression screening status and 12-month hospitalization persisted after all levels of adjustment [IRR (95% Cl): 0.97 (0.95–0.99) (Model 2), 0.97 (0.95–0.99) (Model 3) and 0.97 (0.95–0.99) (Model 4)].

In substrata analysis, depression screening was associated with lower hospitalization rates in patients without a pre-diagnosis of PTSD or anxiety [Model 4 IRR (95% CI): 0.97 (0.95–0.99)] and patients on dialysis 90 days after dialysis initiation [Model 4 IRR (95% CI): 0.98 (0.96–1.00)] (Supplementary data, Table S7). The relationship between depression screening status and 12-month hospitalization was not significant but trended
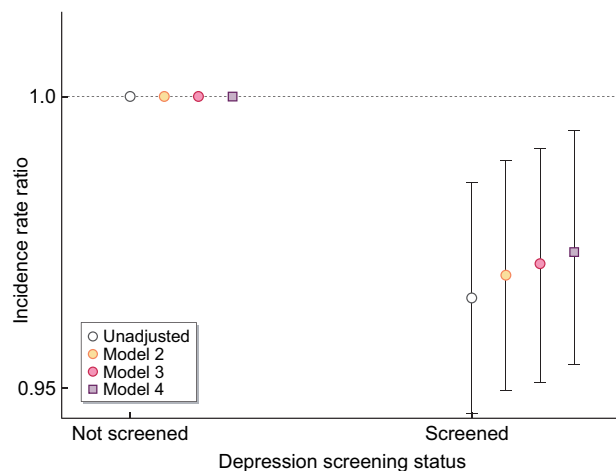

FIGURE 3: Association of pre-ESRD depression screening with 12-month post-ESRD all-cause mortality. Model 2, adjusted for age, gender, race, ethnicity, marital status (married versus non-married) and income level (<$35 000, $35 000 to <$55 000 and ≥$55 000); Model 3, adjusted for variables in Model 2 + primary cause of ESRD, CCI, PTSD, anxiety, tobacco use, drug dependence, alcohol dependence, BMI and baseline laboratory measures of albumin, hemoglobin and eGFR; and Model 4, adjusted for variables in Model 3 + pre-ESRD VA visit intensity for primary care or geriatric, nephrology and mental health outpatient visits in year prior to transition, dialysis provider (VA versus non-VA) and HD vascular access type at dialysis initiation (central venous catheter, arteriovenous fistula or graft, other).

FIGURE 4: Association of pre-ESRD depression screening and 12-month post-ESRD hospitalization rate. Model 2, adjusted for age, gender, race, ethnicity, marital status (married versus non-married) and income level (<$35 000, $35 000 to <$55 000 and ≥$55 000); Model 3, adjusted for variables in Model 2 + primary cause of ESRD, CCI, PTSD, anxiety, tobacco use, drug dependence, alcohol dependence, BMI and baseline laboratory measures of albumin, hemoglobin, eGFR; and Model 4, adjusted for variables in Model 3 + pre-ESRD VA visit intensity for primary care or geriatric, nephrology and mental health outpatient visits in year prior to transition, dialysis provider (VA versus non-VA) and HD vascular access type at dialysis initiation (central venous catheter, arteriovenous fistula or graft, other).

toward lower hospitalization rates in patients who initiated dialysis within VA facilities [Model 4 IRR (95% CI): 0.96 (0.91–1.01)]. When stratified according to dialysis year initiation (before 2011 or 2011 and after), associations between depression screening and hospitalization incidence rates were not significant in either strata [before 2011 IRR (95% CI): 0.99 (0.96–1.02); 2011 and after IRR (95% CI): 0.98 (0.95–1.02)], with a respective P for interaction: 0.4591. In facility level and propensity score analyses, the results were not significantly changed (Supplementary data, Tables S8 and S9).

DISCUSSION

In a large national cohort of Veterans transitioning to maintenance HD, depression screening was significantly associated with improvement in important clinical outcomes. Specifically, screening for depression during the 12 months prior to HD initiation was associated with a significant, albeit modest reduction in all-cause mortality and hospitalization during the following year after accounting for a broad array of important contributing factors. This relationship between depression screening and improved outcomes appeared robust as it was consistently observed in complementary analytic frameworks and across numerous subcohorts.

Our findings provide the first data to suggest that screening for depression in adults transitioning to HD confers benefits in important health outcomes. While depression screening has been mandated by both CMS and VA for adults with ESRD [12, 14], it is not without controversy because of a lack of empirical evidence to support its benefits. The techniques, quality, completeness and impacts of depression screening among large adult populations with kidney disease have not previously been reported [15]. Adults with ESRD transitioning to maintenance dialysis appear to be especially susceptible to depression, which is likely because of the many mental, physical and lifestyle losses associated with this transition [22]. Up to one-half of incident dialysis patients may experience depression, which is even higher than that in maintenance dialysis patients [8, 23]. Therefore, patients at this point in the trajectory of their progressive kidney disease may derive the most benefit from depression screening.

A variety of reasons may explain the positive association of depression screening with the studied outcomes. First, regardless of the results of the screening test or follow-up testing, patients who participate in depression screening are perhaps more likely to participate in other disease screening, and be more adherent to disease treatment and more engaged with their healthcare provider to all aspects of their health (e.g. more frequent primary care follow-up visits). Second, for those who have a positive screening test, depression screening will lead to further detailed assessment to confirm a depression diagnosis and the receipt of appropriate treatment if the diagnosis of depression is confirmed. Several clinical trials have demonstrated the efficacy of non-pharmacologic and pharmacologic treatments to improve depressive symptoms in ESRD [15, 24, 25]. Moreover, depression may negatively impact health outcomes through a variety of mechanisms including altering immunologic and stress responses, compromising nutritional status and reducing adherence to prescribed dialysis and medical regimens [22]. Therefore, in addition to alleviating the symptom burden, efficacious treatments should also ameliorate these factors. Third, for those who have a positive screening test, depression screening may prompt additional investigation, ascertainment and resolution as to the reason(s) for the depressive symptoms.

For example, a patient's unstable angina, a condition that often provokes anxiety and depression, may be identified and receive appropriate treatment. Similarly, a patient who has encountered financial difficulties may receive assistance from a social worker. Similar to our subgroup findings where the mortality benefit of depression screening was relatively greater for Veterans initiating dialysis within VA, prior work has shown that Veterans initiating dialysis in VA had lower mortality than those who did in the community [26, 27]. In contrast to Veterans initiating dialysis in the community, those initiating dialysis in VA may benefit from streamlined access to healthcare services and care coordination including those for mental health [26, 27]. The chief focus of this report was to characterize the effects of the process of depression screening; therefore, potential reasons described here should be considered speculative. Additional studies are needed to examine the consequences of such screening and the pathways that underpin these observations.

Our findings support policies advocating screening for depression in adults who are transitioning to maintenance dialysis. It is important to consider the elements required for a depression screening program to be successful, namely that depression is highly prevalent and underdiagnosed, accurate instruments for depression screening exist and effective treatments for depression are available [28]. A depression screening program in adults with ESRD, therefore, seems exceptionally deserved. Unfortunately, delivery of mental health care for adults with ESRD is quite poor. As noted in recent cross-sectional study in Canada [29], nearly 75% of maintenance HD patients have at least one barrier preventing them from participating in a depression screening program, which include primarily concerns about additional medications and treatments as well as lack of concern for the negative effects of depression. Moreover, patients with depressive symptoms were more likely to have perceived barriers to such a screening program than those without depressive symptoms [29]. Additional observational studies and clinical trials of maintenance dialysis patients with depression have similarly found that patients are often unaware of their depressive symptoms and their importance or are not interested in starting or modifying antidepressant treatments [25, 29–32]. To realize the benefits of a depression screening program, concerted multipronged efforts are required to overcome barriers not only at the patient-level (e.g. educating patients about the importance of depression, changing illness perceptions), but also at the provider-level (e.g. recognition of depression symptoms, understanding treatment options) and system-level (e.g. easing visits to mental health providers, normalizing approaches to depression) [29].

While this study has several notable strengths including its large national sample of Veterans, comprehensive data collection and extensive subgroup and sensitivity analyses, it does have limitations. First, it is possible that participants who were not screened for depression in VA could have been screened outside the VA. This scenario is unlikely since our cohort purposely included adults who relied chiefly on VA for important healthcare services in the year prior to dialysis transition, which provided ample opportunity for depression screening in VA. Second, cause–effect relationships cannot be inferred from our observational study findings. Despite risk adjustment, our observations may be subject to residual bias and confounding, especially selection bias (e.g. why patients screened/not screened). However, these concerns are minimized by the propensity score analysis findings as well as numerous subgroup and sensitivity analyses that found consistent results. A

randomized controlled trial to examine the impact of depression screening is unlikely to ever be conducted. Additionally, our analyses may be susceptible to survival bias since our cohort only included patients who survived to dialysis initiation. Third, while the PHQ-2 and PHQ-9 are validated instruments for depression screening in the general population [33, 34], their performance characteristics have not been extensively studied in populations with kidney disease [35]. Fourth, low doses of antidepressants may have been prescribed to patients for reasons other than depression; therefore, it is possible some patients excluded from our analyses because of receipt of antidepressants were in fact not receiving pharmacologic treatment for preexisting depression. Fifth, our cohort was comprised of Veterans transitioning to ESRD over a 9-year period; therefore, our results could be impacted by other clinical developments that affected the outcomes. However, this possibility is unlikely as our findings per each year were similar. Lastly, because our cohort accurately represented US Veterans, there were few civilian or female participants; therefore, our findings may not be generalizable to these groups.

In summary, among a large cohort of adults with ESRD transitioning to maintenance dialysis, we observed a modestly lower rate of mortality and hospitalization among those who received depression screening. Considering the unacceptably poor outcomes for adults with ESRD who are initiating maintenance dialysis, screening for depression presents the nephrology community with an opportunity to improve the outcomes of these patients. To fully realize the gains from a depression screening program, much more collaborative work is needed to improve the current infrastructure for the mental health care delivery system in the USA.

ACKNOWLEDGEMENTS

FUNDING

AUTHORS' CONTRIBUTIONS

M.J.F. and W.M.K. carried out study design, data analyses, contribution of drafting the manuscript, approval of the final version of the manuscript. E.S. and J.-T.H. performed study design, data collection, data analyses, contribution of drafting the manuscript and approval of the final version of the manuscript. S.T.C., C.P.K. and K.K.-Z. were responsible for study design, contribution of drafting the manuscript and approval of the final version of the manuscript.

SUPPLEMENTARY DATA

Supplementary data are available at *ckj* online.

CONFLICT OF INTEREST STATEMENT

K.K.-Z. has received honoraria and/or support from Abbott, Abbvie, ACI Clinical (Cara Therapeutics), Akebia, Alexion, Amgen, Ardelyx, American Society of Nephrology (ASN), AstraZeneca, AVEO, BBraun, Chugai, Cytokinetics, Daiichi, DaVita, Fresenius, Genentech, Haymarket Media, Hofstra Medical School, International Federation of Kidney Foundations (IFKF), International Society of Hemodialysis (ISH), International Society of Renal Nutrition and Metabolism (ISRNM), Japanese Society of Dialysis Therapy (JSDT), Hospira, Kabi, Keryx, Kissei, Novartis, OPKO, National Institutes of Health (NIH), National Kidney Foundation (NKF), Pfizer, Regulus, Relypsa, Resverlogix, Dr Schaer, Sandoz, Sanofi, Shire, Veterans Affairs (VA), Vifor, UpToDate and ZS-Pharma.

DATA AVAILABILITY STATEMENT

Restrictions apply to the availability of data generated or analyzed during this study to preserve patient confidentiality or because they were used under special permissions. The corresponding author will on request detail the restrictions and any conditions under which access to some data may be provided.

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