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Journal
Journal of Nephrology, 32(3)

ISSN
1121-8428

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Publication Date
2019-06-01

DOI
10.1007/s40620-018-00572-0

Peer reviewed

HHS Public Access
Author manuscript
J Nephrol. Author manuscript; available in PMC 2019 June 01.

Published in final edited form as:
J Nephrol. 2019 June ; 32(3): 477–485. doi:10.1007/s40620-018-00572-0.

Transplant Waitlisting Attenuates the Association between Hemodialysis Access Type and Mortality

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Abstract

Prior studies have shown that beginning hemodialysis (HD) with a hemodialysis catheter (HC) is associated with worse mortality than with an arteriovenous fistula (AVF) or arteriovenous graft (AVG). We hypothesized that transplant waitlisting would modify the effect of HD access on mortality, given waitlist candidates' more robust health status. Using the US Renal Data System, we studied patients with incident ESRD who initiated HD between 2010–2015 with an AVF, AVG, or HC. We used Cox regression including an interaction term for HD access and waitlist status. There were 587,607 patients that initiated HD, of whom 82,379 (14.0%) were waitlisted for transplantation. Only 26,264 (4.5%) were transplanted. Among patients not listed, those with an AVF had a 34% lower mortality compared to HC (adjusted hazard ratio [aHR] 0.66, 95% confidence interval [CI] 0.65–0.67) while those with an AVG had a 21% lower mortality compared to HC (aHR 0.79, 95% CI 0.77–0.81). Transplant waitlisting attenuated the association between hemodialysis access type and mortality (interaction $p<0.001$ for both AVF and AVG vs HC). Among patients on the waitlist, those with an AVF had a 12% lower mortality compared to HC (aHR 0.88, 95% CI 0.84–0.93), while those with an AVG had no difference in mortality (aHR 0.95, 95% CI 0.84–1.08). While all patients benefit from AVF or AVG over HC, the benefit was attenuated in waitlisted patients. Efforts to improve health status and access to healthcare for non-waitlisted ESRD patients might decrease HD-associated mortality and improve rates of AVF and AVG placement.

Keywords

hemodialysis access; end-stage renal disease; kidney transplantation; transplant waitlisting

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COMPLIANCE WITH ETHICAL STANDARDS
The authors of this manuscript have no conflicts of interest to disclose. This study was considered exempt non-human subject research by the Johns Hopkins Medicine Institutional Review Board.

This study was presented as a poster at the Society for Vascular Surgery 2018 Vascular Annual Meeting.

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INTRODUCTION

Nearly 100,000 people in the US initiate hemodialysis (HD) each year, with 30 million adults additionally at risk for developing end-stage renal disease (ESRD) [1]. Prior studies have shown that beginning HD with a hemodialysis catheter (HC) is associated with significantly higher mortality than with an arteriovenous fistula (AVF) or arteriovenous graft (AVG) [2–5]. The association between worse mortality and HD access type has been demonstrated even in the elderly [3]. Whether the association between mortality and HD access type holds for ESRD patients who are waitlisted for kidney transplantation, and thus might not have a need for long term HD access, is not clear.

Historically, healthier ESRD patients were placed on the waitlist for kidney transplantation because they had the most survival benefit from transplantation [6]. However, socioeconomic and geographic factors also impact whether a patient becomes waitlisted, so in many ways transplant waitlisting might be considered a proxy for access to care as well [7–12]. In this sense, ESRD patients who are waitlisted for transplantation might be considered the healthiest subset of ESRD patients who have the most ability to access healthcare when needed. This subset of ESRD patients might therefore benefit less from AVF or AVG as compared to HC.

The goal of this study was to determine whether the association between HD access and mortality would vary by transplant waitlist status, given transplant candidates' shorter need for HD access and more robust health status. We used data from the United States Renal Data System (USRDS) to study this interaction. We hypothesized that transplant waitlisting would modify the effect of HD access on mortality, given waitlist candidates' more robust health status.

METHODS

Data source

We studied patients with incident ESRD 2010–2015 in the United States Renal Data System (USRDS). The USRDS includes demographic, clinical, treatment, and survival data for nearly all patients with ESRD in the US [13]. The USRDS is linked with claims data from the Centers for Medicare and Medicaid Services (CMS) and with transplantation data from the Organ Procurement and Transplantation Network/United Network for Organ Sharing (OPTN/UNOS). This study was acknowledged as exempt non-human subjects research by the Johns Hopkins Institutional Review Board.

Study population

We included all patients with incident ESRD, who initiated HD between 1/1/2010–12/31/2015 with an AVF, AVG, or HC. Demographic characteristics, clinical comorbidities, and initial HD access type were taken from CMS Form 2728. We excluded patients who had been on HD prior to 1/1/2010 and patients who did not have CMS Form 2728 data available. Transplant waitlisting was ascertained through linkage to OPTN/UNOS data. Patients who were waitlisted at any time during the study period were considered to have been waitlisted.

Descriptive characteristics of patients who were waitlisted were compared to those who were not waitlisted using t-tests or chi-square tests, as appropriate.

Mortality

Mortality was ascertained through linkage to CMS data. We used Cox proportional hazards models to study the association between HD access and mortality, including an interaction term to examine effect modification of HD access on mortality by waitlist status. We censored at transplantation or on 12/31/2015. We adjusted for subject age, gender, African American race, Hispanic ethnicity, insurance prior to Medicare enrollment, body mass index (BMI), etiology of ESRD, being in the care of a nephrologist, and comorbid conditions of congestive heart failure (CHF), atherosclerotic heart disease (ASHD), cerebrovascular disease (CVD), peripheral vascular disease (PVD), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), current tobacco smoking, history of cancer, alcohol dependence, drug dependence, and inability to ambulate.

Sensitivity analyses

As a sensitivity analysis, we used doubly robust Cox proportional hazards models with matching by propensity to be waitlisted to examine effect modification of HD access type on mortality by waitlist status, separately for AVG vs. HC and AVF vs. HC. The sensitivity analysis was limited to patients with no missing data. The MatchIt package for R was used to create propensity scores and match using 1:1 nearest-neighbor matching [14]. Covariates included in creation of propensity scores were the same as those included in the primary analysis regression model: age, gender, African American race, Hispanic ethnicity, insurance prior to Medicare enrollment, BMI, cause of ESRD, being in the care of a nephrologist, and comorbid conditions of CHF, ASHD, CVD, PVD, DM, COPD, current tobacco smoking, history of cancer, alcohol dependence, drug dependence, and inability to ambulate. Covariate balance was assessed through the standardized differences between the means of waitlisted and not waitlisted matched subcohorts, with good balance considered standardized differences less than 0.25 [15,16]. Data from the matched subcohorts do not generalize to all patients with ESRD, as they represent a non-random minority subcohort selected for their high likelihood to be waitlisted for transplantation.

As an additional sensitivity analysis, we used a competing risk regression in the method of Fine and Gray to study a 10% random sample of the study population. This analysis confirmed effect modification of the association between mortality and HD access by transplant waitlisting (interaction $p<0.001$) and direction of the associations between HD access and mortality within waitlisted and not waitlisted groups, thus full results of the model are not included.

Statistical analysis

An α of 0.05 was considered significant. Analyses were performed using Stata 14.2/SE for Windows (College Station, Texas) and R (Vienna, Austria).

RESULTS

Study population

Of 587,607 subjects, 82,379 (14.0%) were ever waitlisted for kidney transplantation. Only 26,264 (4.5%) were transplanted. Subjects who were not waitlisted had a median of 1.6 years with maximum 6 years follow-up, while subjects who were waitlisted had a median of 2.6 years with maximum 6 years follow-up. Although the majority of subjects had an HC for HD access (80.7%), transplant waitlisted subjects were more likely to have an AVF at ESRD registration than those who were never waitlisted (26.6% vs. 14.7%, p<0.001) (Table 1). Subjects who were waitlisted were younger, less frequently female, more frequently African American or Hispanic, and more frequently under the care of a nephrologist than those who were not waitlisted (Table 1). Waitlisted subjects more frequently had private insurance prior to Medicare coverage (38.8% vs 15.2%, p<0.001). Waitlisted subjects were less likely to have comorbid conditions including CHF, ASHD, CVD, PVD, DM, COPD, current tobacco smoking, a history of cancer, alcohol or drug dependence, and inability to ambulate compared to those who were not waitlisted (Table 1).

AVF vs. HC

Among those with an AVF at ESRD registration, 5-year mortality for waitlisted subjects was 25.6% compared to 58.2% in those not waitlisted. Transplant waitlisting attenuated the association between access with an AVF vs. HC and mortality (interaction p<0.001). Among patients who were on the waitlist, those with an AVF had a 12% lower risk of mortality compared to HC (adjusted hazard ratio [aHR] 0.88, 95% confidence interval [CI] 0.84–0.93, p<0.001) (Table 2, Figure 1). Among patients not on the waitlist, those with an AVF had a 34% lower risk of mortality compared to HC (aHR 0.66, 95% CI 0.65–0.67, p<0.001).

AVG vs. HC

Among those with an AVG at ESRD registration, 5-year mortality for waitlisted subjects was 25.2% compared to 62.6% in those not waitlisted. Transplant waitlisting attenuated the association between access with an AVG vs. HC and mortality (interaction p<0.001). Among patients who were on the waitlist, those with an AVG had no difference in mortality (aHR 0.95, 95% CI 0.84–1.08, p=0.5) (Table 2, Figure 1). Among patients not on the waitlist, those with an AVG had a 21% lower risk of mortality compared to HC (aHR 0.79, 95% CI 0.77–0.81, p<0.001).

Sensitivity analyses

AVF vs. HC sensitivity analysis—The matched subset comparing AVF to HC (n=142,860) demonstrated good balance in matched covariates in the standardized difference in means between the waitlisted and not waitlisted groups (Table 3). The modification of the effect of AVF on mortality by transplant waitlisting was confirmed (p<0.001). For those not transplant waitlisted, AVF was associated with a 32% lower risk of mortality (aHR 0.68, 95% CI 0.66–0.71), while for waitlisted patients AVF was associated with an 11% lower risk of mortality (aHR 0.89, 95% CI 0.85–0.93).

AVG vs. HC sensitivity analysis—The matched subset comparing AVG to HC (n=105,998) demonstrated good balance in matched covariates in the standardized difference in means between the waitlisted and not waitlisted groups (Table 4). There was not significant modification of the effect of AVG on mortality by transplant waitlisting (p=0.09). For those not transplant waitlisted, AVG was associated with 15% lower risk of mortality (aHR 0.85, 95% CI 0.78–0.92), while for waitlisted patients AVG was not statistically significantly associated with risk of mortality (aHR 1.06, 95% CI 0.95–1.19) (Figure 2).

DISCUSSION

In this national study of patients registering for ESRD benefits, over 80% of patients were initiating HD with an HC. Only 14.0% were waitlisted for kidney transplantation, and only 4.5% received a kidney transplant during the study period. Although the majority of waitlisted patients did not receive a kidney transplant, they had a significantly lower burden of comorbid disease and were more likely to have private insurance, a marker of socioeconomic status. Among waitlisted patients, those with an AVF had a 12% lower risk of mortality compared to those with an HC, and there was no difference between AVG and HC in mortality. Among patients not waitlisted, those with an AVF had a 34% lower risk of mortality compared to those with an HC, and those with an AVG had a 21% lower risk of mortality compared to those with an HC.

Our finding that over 80% of patients initiated HD with an HC at a decade after Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations to begin HD with an AVF is concerning, but reaffirms the findings of others. Slinin et al. found that survival at one year after HD initiation was associated with the number of evidence-based KDOQI guidelines met, and also found that 81% of incident HD patients began HD with an HC, despite more than 57% being in the care of a nephrologist prior to initiation of HD [17]. Indeed, Zarkowsky et al. found that there is marked regional variation in AVF placement [18] and that a third of ESRD patients initiating HD with an HC had been in the care of a nephrologist for over six months [19]. This has led to the creation of simulation models to help nephrologists predict when to refer for AVF placement [20], however we found that initiating HD with an HC remained common.

Interestingly, despite the low likelihood of receiving a kidney transplant, waitlisted patients do not have meaningfully worse mortality with an HC as compared to an AVF or AVG. This suggests that the differences in outcomes with these HD access types might be due to socioeconomic differences and differences in ability to access healthcare. Our propensity score matched analysis demonstrated this concept: these matched subcohorts are all highly likely to have become transplant waitlisted. In these subcohorts, despite having similar age, gender, race, ethnicity, insurance, and comorbid conditions, those who were waitlisted had lower mortality. Many groups have reported similar disparities in HD access type [2,3], access to the transplant waitlist [21,7–9], and more broadly, disparities in access to healthcare [22–24,11,25]. Importantly, this suggests that in order to impact the HD-associated mortality rate, we must improve rates of AVF placement, improve access to the transplant waitlist, and address and modify comorbid conditions in ESRD patients. A counterintuitive finding is that for waitlisted patients, being in the care of a nephrologist was associated with a 14% higher risk of mortality; this may be because patients who were more physiologically ill were more likely to be in the care of a nephrologist prior to HD initiation.

Our study has several limitations worth discussion. First, we are limited by our use of administrative data. This introduces the potential for unmeasured confounders not captured in USRDS data, which cannot be accounted for through regression analysis or propensity score matching. Still, USRDS is a near complete sample of the population on HD in the US [13], and limitations in granularity of data are balanced by the generalizability of our conclusions to the US ESRD population. Second, our comparison of transplant waitlisted to not waitlisted subjects is limited by overlap of characteristics of these populations. That is, patients on HD who become waitlisted are very different than those who are not waitlisted, and regression analysis using the full population might extrapolate the effect of HD access type across waitlisted and not waitlisted groups. However, our sensitivity analyses which used a subcohort matched by propensity to be waitlisted confirmed our findings. Finally, our inferences might not be generalizable beyond the US population we studied.

In conclusion, in this national study of how the association between HD access type and mortality varies by transplant waitlisting, we found that for ESRD patients who are waitlisted for kidney transplant, the benefit of AVF is attenuated compared to those patients not waitlisted, but still associated with a lower mortality risk than initiating HD with an HC. For ESRD patients who are not waitlisted, initiating HD with an HC is associated with markedly higher mortality than AVF or AVG. To address the impact of HD access type on mortality, efforts must focus on those patients who are least linked in to the healthcare system, and thus at highest risk for poor outcomes. Still, even for patients with the most access to healthcare, AVF is associated with lower mortality.

ACKNOWLEDGEMENTS

This work was supported by grants number F32DK109662 and K24DK101828 from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), F32AG053025 from the National Institute on Aging (NIA), and an American College of Surgeons Resident Research Scholarship. The analyses described here are the responsibility of the authors alone and do not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products or organizations imply endorsement by the U.S. Government.

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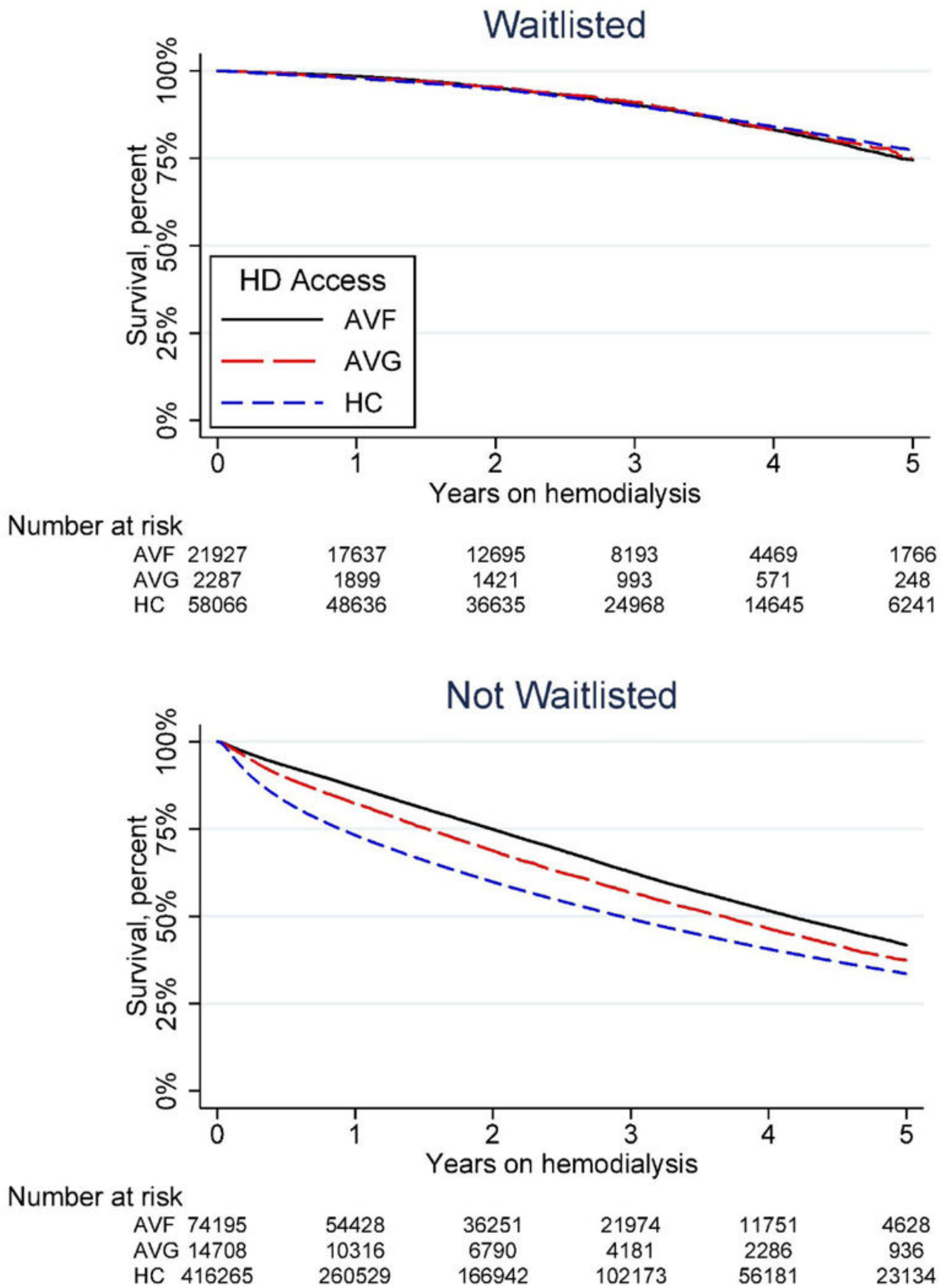

Figure 1. Mortality by hemodialysis access, stratified by waitlist status.

Among patients who were on the waitlist, those with an AVF had a 12% lower risk of mortality (aHR 0.88, 95% CI 0.84–0.93, p<0.001) and those with an AVG had no difference in mortality (aHR 0.95, 95% CI 0.84–1.08, p=0.5) compared to HC. Among patients not on the waitlist, those with an AVF had a 34% lower risk of mortality (aHR 0.66, 95% CI 0.65–0.67, p<0.001) and those with an AVG had a 21% lower risk of mortality (aHR 0.79, 95% CI 0.77–0.81, p<0.001) compared to HC.

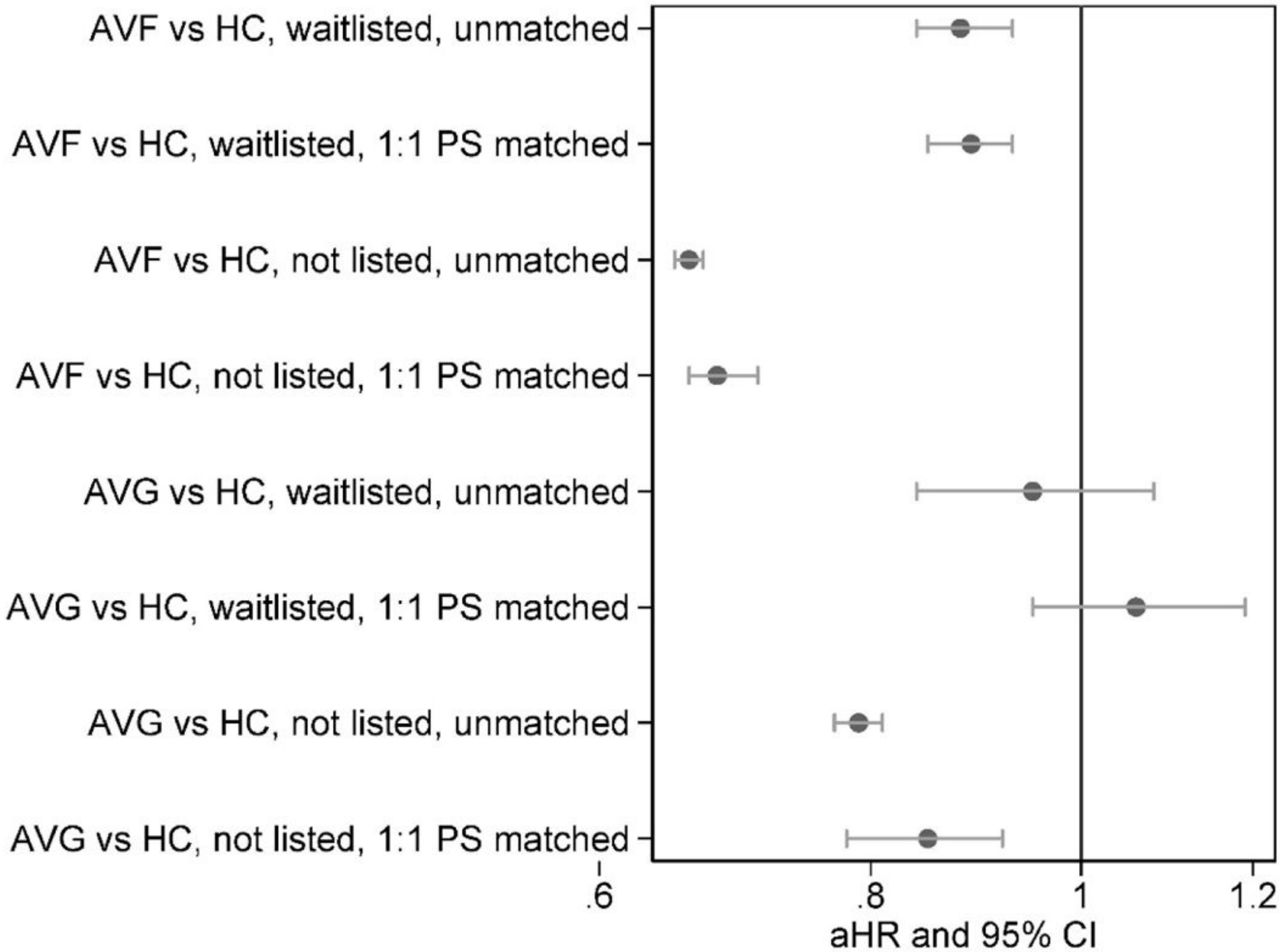

Figure 2. Adjusted hazard ratios and 95% confidence intervals for the association of HD access type with mortality.

Unmatched and matched cohorts demonstrated similar findings.

Table 1.

Characteristics of study population, stratified by transplant waitlisting.

	Waitlisted n=82,379	Not Waitlisted n=505,228	p-value
Hemodialysis access			<0.001
AVF	26.6%	14.7%	
AVG	2.8%	2.9%	
HC	70.6%	82.4%	
Age, median (IQR) years	53 (42–62)	67 (57–76)	<0.001
Female sex	35.9%	43.5%	<0.001
BMI, median (IQR)	28 (24–33)	28 (24–34)	<0.001
African American race	28.9%	27.3%	<0.001
Hispanic ethnicity	20.0%	14.5%	<0.001
Cause of ESRD			<0.001
Diabetes	42.0%	47.6%	
Hypertension	24.9%	30.9%	
Glomerulonephritis	12.4%	4.0%	
Secondary glomerulonephritis	3.8%	1.6%	
Interstitial nephritis	2.7%	2.6%	
Cystic/hereditary/congenital	7.0%	1.3%	
Neoplasms	1.4%	2.5%	
Other	6.0%	9.4%	
Under the care of a nephrologist	74.8%	65.7%	<0.001
Insurance prior to ESRD			<0.001
Medicare	14.0%	32.0%	
Medicaid	21.5%	26.7%	
Private	38.8%	15.2%	
Other	15.9%	20.0%	
Uninsured	9.8%	5.9%	
Comorbid disease			
CHF	14.2%	34.4%	<0.001
ASHD	9.2%	19.2%	<0.001
CVD	4.2%	10.0%	<0.001
PVD	5.4%	13.5%	<0.001
DM			<0.001
On no medication	4.8%	5.9%	
On oral medication(s)	9.7%	11.0%	
On insulin	33.8%	41.4%	
COPD	2.4%	11.2%	<0.001
Current tobacco smoker	3.9%	6.7%	<0.001
History of cancer	2.8%	8.3%	<0.001
Alcohol dependence	1.1%	1.8%	<0.001

	Waitlisted n=82,379	Not Waitlisted n=505,228	p-value
Drug dependence	0.6%	1.4%	<0.001
Inability to ambulate	0.9%	8.7%	<0.001

Table 2.

Mortality risk of transplant waitlisted vs. non-waitlisted patients.

	Waitlisted*	Not Waitlisted
Hemodialysis access		
HC	Ref	Ref
AVG	0.95 (0.84–1.08), p=0.5	0.79 (0.77–0.81), p<0.001
AVF	0.88 (0.84–0.93), p<0.001	0.66 (0.65–0.67), p<0.001
Age, per 5 years	1.14 (1.13–1.16), p<0.001	1.14 (1.14–1.14), p<0.001
Female sex	0.98 (0.94–1.03), p=0.5	0.96 (0.95–0.97), p<0.001
BMI, per 5 units	0.91 (0.90–0.93), p<0.001	0.94 (0.94–0.94), p<0.001
African American race	0.57 (0.54–0.60), p<0.001	0.74 (0.73–0.75), p<0.001
Hispanic ethnicity	1.74 (1.63–1.85), p<0.001	1.40 (1.38–1.42), p<0.001
Cause of ESRD		
Diabetes	Ref	Ref
Hypertension	0.90 (0.84–0.96), p=0.003	0.99 (0.98–1.01), p=0.3
Glomerulonephritis	0.70 (0.63–0.78), p<0.001	0.84 (0.81–0.86), p<0.001
Secondary glomerulonephritis	0.83 (0.71–0.97), p=0.02	1.03 (0.99–1.07), p=0.2
Interstitial nephritis	0.87 (0.75–1.01), p=0.06	0.91 (0.89–0.94), p<0.001
Cystic/hereditary/congenital	0.76 (0.66–0.86), p<0.001	0.72 (0.69–0.76), p<0.001
Neoplasms	1.63 (1.41–1.88), p<0.001	1.53 (1.49–1.57), p<0.001
Other	1.55 (1.41–1.70), p<0.001	1.16 (1.14–1.18), p<0.001
Under the care of a nephrologist	1.14 (1.08–1.21), p<0.001	0.93 (0.92–0.94), p<0.001
Insurance prior to ESRD		
Medicare	Ref	Ref
Medicaid	0.93 (0.86–1.00), p=0.06	1.00 (0.99–1.02), p=0.6
Private	0.91 (0.86–0.97), p=0.005	0.89 (0.88–0.91), p<0.001
Other	0.97 (0.90–1.04), p=0.4	0.98 (0.97–0.99), p<0.001
Uninsured	0.65 (0.59–0.72), p<0.001	0.71 (0.69–0.73), p<0.001
Comorbid disease		
CHF	1.21 (1.14–1.28), p<0.001	1.31 (1.30–1.33), p<0.001
ASHD	1.12 (1.05–1.20), p<0.001	1.05 (1.03–1.06), p<0.001
CVD	1.04 (0.94–1.14), p=0.5	1.05 (1.04–1.07), p<0.001
PVD	1.19 (1.10–1.29), p<0.001	1.11 (1.10–1.12), p<0.001
DM		
None	Ref	Ref
On no medication	1.00 (0.90–1.12), p=0.9	0.95 (0.93–0.97), p<0.001
On oral medication(s)	1.04 (0.96–1.14), p=0.3	0.96 (0.94–0.97), p<0.001
On insulin	1.40 (1.31–1.50), p<0.001	1.09 (1.08–1.11), p<0.001
COPD	1.21 (1.09–1.35), p<0.001	1.24 (1.22–1.26), p<0.001
Current tobacco smoker	1.12 (1.01–1.24), p=0.04	1.07 (1.05–1.09), p<0.001
History of cancer	1.11 (1.00–1.24), p=0.04	1.27 (1.25–1.29), p<0.001
Alcohol dependence	1.94 (1.64–2.29), p<0.001	1.27 (1.23–1.32), p<0.001

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	Waitlisted*	**Not Waitlisted**
Drug dependence	1.10 (0.84–1.44), p=0.5	1.12 (1.08–1.17), p<0.001
Inability to ambulate	1.44 (1.23–1.69), p<0.001	1.64 (1.62–1.66), p<0.001

*Adjusted hazard ratios with 95% confidence intervals shown.

Table 3.

Characteristics of population with AVF versus HC for HD access, before and after propensity score matching by propensity to be waitlisted.

	Unmatched			Matched		
	Wait-listed n= 71,430	Not listed n= 412,744	Std. mean diff.*	Wait-listed n= 71,430	Not listed n= 71,430	Std. mean diff.
AVF, %	28.8	16.5	0.2718	28.8	27.7	0.0241
Age, mean years	51	65	−1.0233	51	52	−0.0647
Female, %	35.3	42.9	−0.1593	35.3	35.0	0.0063
BMI, mean units	29	30	−0.0782	29	30	−0.0635
African American, %	28.2	26.4	0.0401	28.2	30.1	−0.0436
Hispanic, %	19.5	14.2	0.1329	19.5	19.5	−0.0018
Cause of ESRD, %						
Diabetes	41.9	47.7	−0.1169	41.9	46.0	−0.0838
Hypertension	24.0	30.1	−0.1421	24.0	25.4	−0.0321
Glomerulonephritis	13.0	4.3	0.2574	13.0	10.0	0.0892
Secondary glomerulonephritis	3.8	1.7	0.1130	3.8	3.5	0.0158
Interstitial nephritis	2.7	2.8	−0.0005	2.7	2.8	−0.0040
Cystic/hereditary/ congenital	7.3	1.4	0.2268	7.3	4.5	0.1071
Neoplasms	1.4	2.7	−0.1019	1.4	1.6	−0.0095
Other	5.8	9.4	−0.1553	5.8	6.2	−0.0167
Under the care of a nephrologist, %	74.4	65.1	0.2127	74.4	73.2	0.0287
Insurance prior to ESRD registration, %						
Medicare	14.0	32.2	−0.5243	14.0	14.1	−0.0039
Medicaid	20.7	25.8	−0.1263	20.7	21.9	−0.0296
Private insurance	39.8	16.0	0.4870	39.8	37.1	0.0562
Other insurance	15.8	20.2	−0.1207	15.8	15.7	0.0025
Uninsured	9.7	5.8	0.1305	9.7	11.2	−0.0511
Comorbid disease, %						
CHF	14.4	35.0	−0.5886	14.4	14.5	−0.0044
ASHD	9.6	20.5	−0.3711	9.6	9.6	−0.0010
CVD	4.2	10.1	−0.2950	4.2	4.3	−0.0068
PVD	5.6	14.1	−0.3726	5.6	5.7	−0.0052
DM	48.4	58.5	−0.2024	48.4	52.8	−0.0878
COPD	2.5	11.4	−0.5746	2.5	2.2	0.0197
Current tobacco smoker	4.1	7.0	−0.1497	4.1	4.4	−0.0181
History of cancer	2.9	8.7	−0.3394	2.9	3.0	−0.0015
Alcohol dependence	1.0	1.8	−0.0797	1.0	1.1	−0.0108
Drug dependence	0.6	1.4	−0.1199	0.6	0.6	−0.0023
Inability to ambulate	0.9	8.4	−0.8068	0.9	0.6	0.0243

* Std. mean diff.: standardized mean difference between treated and untreated.

Table 4.

Characteristics of population with AVG versus HC for HD access, before and after propensity score matching by propensity to be waitlisted.

	Unmatched			Matched		
	Wait-listed n= 52,999	Not listed n= 357,969	Std. mean diff.*	Wait-listed n= 52,999	Not listed n= 52,999	Std. mean diff.
AVG, %	4.0	3.7	0.0160	4.0	4.2	−0.0105
Age, mean years	50	65	−1.0850	50	50	−0.0582
Female, %	37.6	44.4	−0.1413	37.6	37.0	0.0117
BMI, mean units	29	30	−0.1021	29	29	−0.0674
African American, %	29.8	27.2	0.0547	29.8	31.5	−0.0376
Hispanic, %	20.6	14.5	0.1516	20.6	20.6	0.0021
Cause of ESRD, %						
Diabetes	41.6	47.1	−0.1127	41.6	45.5	−0.0809
Hypertension	24.1	29.8	−0.1317	24.1	25.0	−0.0210
Glomerulonephritis	12.9	4.1	0.2625	12.9	10.0	0.0861
Secondary glomerulonephritis	4.6	1.8	0.1322	4.6	4.1	0.0207
Interstitial nephritis	2.7	2.8	−0.0069	2.7	2.6	0.0011
Cystic/hereditary/ congenital	5.7	1.1	0.1964	5.7	3.8	0.0835
Neoplasms	1.6	2.9	−0.1050	1.6	1.7	−0.0114
Other	6.9	10.4	−0.1385	6.9	7.2	−0.0097
Under the care of a nephrologist, %	66.4	60.2	0.1315	66.4	65.8	0.0133
Insurance prior to ESRD registration, %						
Medicare	12.7	31.7	−0.5718	12.7	12.4	0.0067
Medicaid	21.5	26.6	−0.1233	21.5	22.4	−0.0214
Private insurance	39.0	15.7	0.4777	39.0	37.2	0.0385
Other insurance	14.9	19.7	−0.1351	14.9	14.7	0.0064
Uninsured	11.9	6.3	0.1725	11.9	13.4	−0.0447
Comorbid disease, %						
CHF	14.9	36.1	−0.5948	14.9	14.7	0.0045
ASHD	9.0	20.4	−0.3970	9.0	8.9	0.0037
CVD	4.2	10.3	−0.3062	4.2	4.2	−0.0019
PVD	5.4	14.3	−0.3895	5.4	5.5	−0.0028
DM	48.3	58.5	−0.2025	48.3	52.8	−0.0893
COPD	2.4	11.7	−0.6098	2.4	2.0	0.0233
Current tobacco smoker	4.1	7.1	−0.1509	4.1	4.4	−0.0127
History of cancer	2.6	8.7	−0.3770	2.6	2.6	0.0038
Alcohol dependence	1.2	2.0	−0.0682	1.2	1.4	−0.0114
Drug dependence	0.6	1.6	−0.1199	0.6	0.6	0.0024
Inability to ambulate	1.0	9.2	−0.8034	1.0	0.8	0.0257

*Std. mean diff.: standardized mean difference between treated and untreated.