Supplemental Appendix to:

"Provider Visit Frequency and Vascular Access Interventions in Hemodialysis"

Table of Contents:

Determining vascular access use by claims:

We used Medicare claims to identify vascular access use. Patients who had Medicare claims for vascular access procedures prior to starting dialysis were considered to begin dialysis with a catheter if a tunneled catheter was placed (and not removed) prior to dialysis. Alternatively, if a graft or fistula was placed prior to dialysis initiation, and no tunneled catheter was placed or a tunneled catheter was placed but subsequently removed, then we assumed patients began dialysis with the graft or fistula. Finally, we excluded the small number of patients in whom both a graft and fistula were placed prior to beginning dialysis since we could not, based on claims, determine what type of access was used in these cases.

A similar approach was used to identify initiation of dialysis with a graft or fistula among patients with vascular access claims only prior to initiation of hemodialysis. However, patients who had claims for placement of a graft or fistula, followed by a claim for tunneled catheter removal, but who did not have a prior claim for a tunneled catheter placement, were assumed to initiate dialysis with the graft or fistula at the time of tunneled catheter removal. This group represents patients for whom we did not identify the initial placement of the catheter via claims.

Data Validation:

To assess accuracy of our graft and fistula survival estimates, we first plotted survival stratified by graft versus fistula to demonstrate that patients with fistulas have improved survival than those with grafts. **(eFigure 1)** Next, we compared survival in our cohort to that in two previously published analyses documenting cumulative patency. We compared cumulative patency reported by a single center study[1] to that observed in our cohorts in **eTableIIa**. We compared cumulative patency in fistulas (both forearm and upper arm) published from 11 vascular access centers in the Netherlands[2] with our cohort **eTableIIb**.

Among patients whose first modality was in-center hemodialysis, we compared the vascular access that we ascertained at the start of hemodialysis using pre-ESRD Medicare claims to that reported in the CMS 2728 form in **eTableIIc**. Among patients who we identified as initiating dialysis with an AV fistula, 17.5% had "catheter" documented as the first vascular access from the CMS 2728 form. Among those who we identified as initiating dialysis with an AV graft, 14.5% had "catheter" documented as the first vascular access from the CMS 2728 form. Finally, among patients in our cohort who we identified as initiating dialysis with a catheter, 89% had a "catheter" documented in the CMS 2728 form. There was less consistency with the medical evidence form when comparing the type of permanent vascular access used (i.e. AV fistula vs. graft) among patients who we identified as starting dialysis with an AV fistula or graft.

For a large majority of patients, our method of ascertaining vascular access at dialysis initiation using Medicare claims agreed with the type of vascular access reported in the CMS 2728 form. However, there was a discrepancy in 11.0 to 17.5% of cases. There are several

possible explanations for this discrepancy. First, the type of vascular access used at dialysis initiation reported in the CMS medical evidence form may not be accurate. The medical evidence report has been demonstrated to be relatively unreliable in other areas such as comorbidities, and may be equally inaccurate in this measure.[3, 4] To our knowledge, an assessment of the accuracy of the Medical Evidence Report's documented vascular access, through an independent assessment of the actual vascular access used, has not been done.

A second explanation for the observed discrepancy may be that some patients initiate outpatient hemodialysis with a non-tunneled catheter. While the CMS 2728 Medical Evidence Report would document these patients as initiating hemodialysis with a catheter, our method of Medicare claims-based ascertainment would have categorized these patients as initiating with a permanent vascular access. We intentionally chose to ignore temporary catheters because they are only used for a brief period of time, and the focus of our study was long-term vascular access use. If a patient initiated hemodialysis with a temporary catheter, had a maturing AV fistula or graft, and no tunneled catheter was subsequently placed, they likely began using the AV fistula or graft soon after starting hemodialysis.

Sensitivity Analysis:

Sensitivity to visit frequency assumptions:

We tested the sensitivity of our results to the assumption that 2.5 visits were performed in months with 2-3 visits claimed. Results from these analyses are listed in **eTable III**. The results did not vary substantially from the findings in our main analysis, except that in a scenario where we assumed 2.5 visits was 3 visits, more visits were associated with an increased risk of vascular access failure. However, this increase was small (HR 1.02; 95% CI 1.00 to 1.04; p=0.01).

Additionally, we tested the sensitivity to exclusion of the most recent month when calculating visit frequency and hospitalization days. In this analysis we used the prior three months of visits, in addition to the current month, in our calculation of visit frequency. We did the same thing for calculating hospitalization days. In both the analysis of vascular access survival and vascular access interventions, the results did not change substantially; more frequent visits were not associated with vascular access survival (HR 1.01; 95% CI 1.00 to 1.02; p=0.17), while one additional visit was associated with a 13% increase in the odds of vascular access intervention in a given month (95% CI 12% to 14%).

Sensitivity to Hospitalizations as a mediator:

In a secondary analysis, we explored whether reduced hospitalizations mediate the causal pathway between more frequent provider visits and improved vascular access survival. We did

this by excluding hospitalizations as a covariate in the Cox and main logistic models. Additionally, we excluded months when a patient was hospitalized for more than two days when calculating the moving average of physician visits over the prior three months.

After excluding hospitalizations as a covariate, there continued to be no association between visit frequency and vascular access survival (HR 1.01; 95% CI 1.00 to 1.03; p=0.08) **(eTable IV)**. Additionally, the odds of vascular access repair in a month was only slightly less (OR 1.12; 95% CI 1.11 to 1.13) in this sensitivity analysis. **(eTable V)** This was consistent with our primary analysis, demonstrating no relation between visit frequency and the hazard of vascular access failure and a positive association between visit frequency and access preserving interventions. This suggests that reduction in hospitalizations is not a substantial mediator between visit frequency and these outcomes.

Sensitivity to exclusion of thrombus dissolution or removal:

We examined the sensitivity to exclusion of procedures involving thrombus dissolution or removal from our analysis of the association between visit frequency and vascular access preserving interventions. In this analysis, we included Medicare Claims submitted for procedures that involved thrombolysis and removal of thrombus from AV fistulas and grafts used for hemodialysis. Specifically, we included claims with the following Healthcare Common Procedure Coding System codes: 36831, 36833, and 36870. The results did not change noticeably when these procedures were included in the outcome. After including these procedures, one additional visit per month continued to be associated with a 13% increase in the odds of having a vascular access sparing intervention in a given month (95% CI 11 to 14%).

Sensitivity to differences in dialysis facility practices:

We were unable to observe different practices at the dialysis facility level that could modify the rates of vascular access interventions and vascular access survival. For example, we did not have data about different vascular access monitoring programs at dialysis facilities. If these practices led to differences in vascular access interventions or vascular access survival, and were systematically associated with differences in mean visit frequency at the dialysis facility level, this could confound our findings.

To examine the sensitivity of our findings to this possible source of bias, we conducted two analyses examining patients in the first year of follow-up. In these analyses, we excluded patients starting dialysis after January 1st, 2009 since they did not have a full year of follow-up. For each patient, we tabulated mean visit frequency in each full month during their first year of hemodialysis or until their vascular access failed. Additionally, we tabulated mean hospitalizations per month during this period. Then, we used linear probability models to estimate the association between mean visits per month and: 1) the probability of a patient receiving a vascular access preserving intervention in the first year of hemodialysis, and 2) the probability of graft failure in the first year of hemodialysis. In these analyses, we controlled for the same patient-level covariates included in our main analysis in addition to dialysis facility

fixed effects. By controlling for dialysis facility fixed effects, this analysis focused on within-facility differences in mean visits per month and outcomes of interest. This analysis controls for any differences in vascular access practices and visits frequency that occur at the level of individual dialysis facilities.

When examining the association between mean visits per month and vascular access repair in this analysis, we found that one additional visit per month was associated with a 4.1% increase in the absolute probability of receiving a vascular access repair in one year (95% CI 3.6 to 4.6%). When examining the association between mean visits per month and vascular access survival, we found no association between one additional visit per month and the absolute probability of AF fistula or graft failure (absolute probability 0.09%; 95% CI -0.3 to 0.5%). These findings are consistent with the findings from our primary analysis, suggesting that facility-level practices are not a major source of bias in our study.

Sensitivity to Assumptions about Timing of Initiation of AV Fistula and Graft Use

We tested the sensitivity of our vascular access survival and vascular access repair analyses to our assumptions about when, following surgical placement of an AV fistula or graft, patients began receiving dialysis through AV fistula or graft. To do this, we conducted both analyses under the assumption that patients began using vascular access earlier – at 14 days following surgical placement for AV grafts and 40 days following surgical creation for AV fistulas. Additionally, we conducted both analyses under the assumption that patients began using vascular access later – at 28 days following surgical placement for AV grafts and 180 days following surgical creation of AV fistulas. Our findings did not change noticeably under these alternative scenarios **(eTable XII).**

Methods for Creating Figure 2:

When calculating the annual probability of receiving a "vascular access sparing" intervention or hospitalization for vascular access infection, we used logistic regression results from our primary analyses. **(Tables III and eTable IX)** We calculated the annual probabilities in the following steps:

1) After running the initial logistic regression, for each patient we set the 3-month moving average of visits equal to one, two, three, and four.
2) At each 3-month moving average of visits (i.e. one, two to three, and four) we set time-since-access-placement equal to one, two and three. We used these three values because they all represented ranges of time-since-access-placement within the first year of access function.

3) For each of the 12 scenarios created in steps 1) and 2) above, we generated for each patient-month a predicted probability of vascular access preserving intervention or hospitalization for vascular access infection.
4) For each of the 12 scenarios created in steps 1) and 2) above, we calculated the mean predicted probability of vascular access preserving intervention or hospitalization for vascular access infection for all patient months in the cohort.
5) Mean predicted probabilities of vascular access preserving intervention of hospitalization from step 4) were converted into daily rates of each outcomes using the following equation:

$$Daily\ rate = {-(\ln(1-p))}/{t}$$

Where p is the mean probability of each outcome occurring in a month and t was equal to 30.4375 (the average length of a month in days)

6) Daily rates were converted back into probabilities of each outcome occurring over the course of all three time-since-access-placement intervals using the following equation:

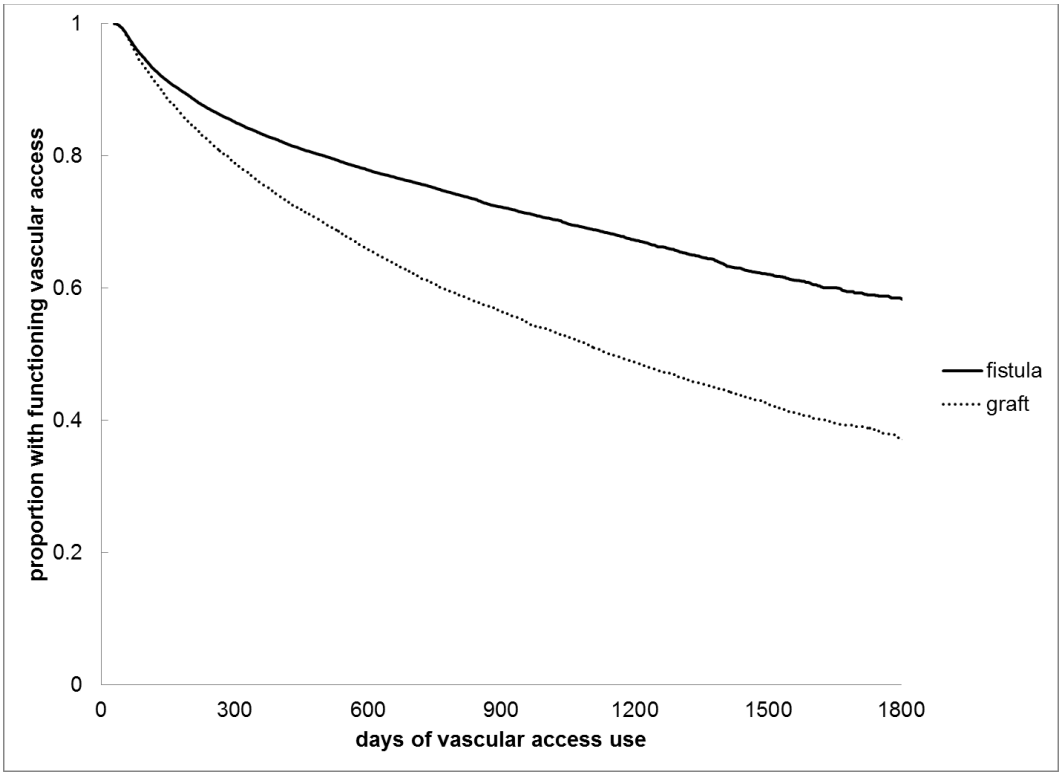
$$Probability = 1 - e^{-r*t}$$

Where r is the daily rate for each outcome occurring at a given visit frequency in a specified time-since-access-placement interval, and t is the duration (in days) of each time-since-access-placement interval up to one year.

7) Probabilities of each outcome occurring for each time-since-access-placement interval created in step 6) above were converted into probabilities of survival through each period.
8) Probabilities of survival for each period created in step 7) above were multiplied together for each outcome and visit frequency to generate a 1-year probability of survival without each outcome occurring.
9) 1-year probability of each outcome occurring in one year was created by subtracting the 1-year probability of survival created in step 8) from 1.

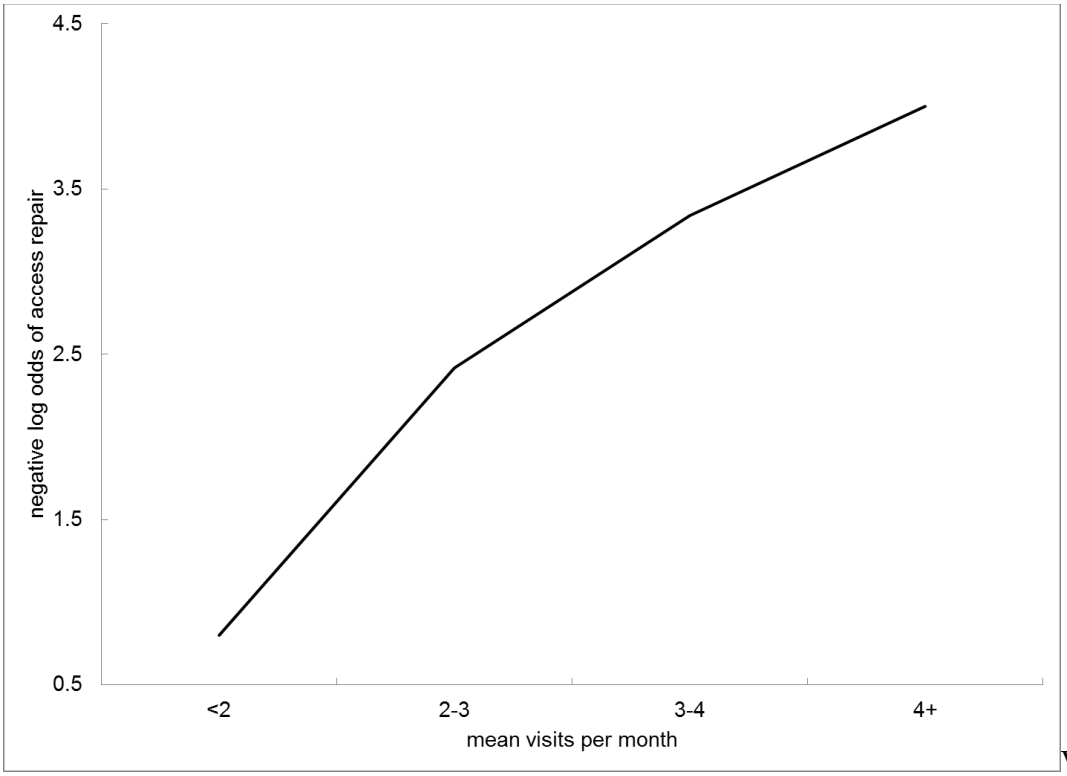
When calculating the annual probability of vascular access failure, we used a parametric survival model where we assumed an exponential survival function. This was slightly different from the Cox model used in our primary analysis, which makes no assumptions about the survival function, but was necessary to obtain predicted probabilities of survival. The results from the parametric survival regression model are included in **eTable XI**, while expected probabilities are reported in **eTable XII**. For each patient, the probability of vascular access survival at one year was the product of the expected probability of survival for each segment of the year, where each segment had different values for the three month moving average of hospital days.

eFigure 1: Survival of Arteriovenous Fistulas *versus* Grafts



As expected, patients in our cohort experienced improved vascular access survival with arteriovenous fistulas compared to grafts.

eFigure 2. Assessment of Linearity of Log Odds of Access Repair by Visit Frequency



Visit

eTable I: ICD 9 and HCPCS Codes for Obtaining Vascular Access and Visit Frequency Information

Vascular Access Placement (HCPCS Codes)				
36818	36819	36820		
36821	36825	36830		
Visit Frequency (HCPCS and G-codes)				
G0319	G0318	G0317		
90962	90961	90960		
Tunneled Catheter Placement (HCPCS Codes)				
36561	36558			
Renal Diagnosis (ICD9 Codes)				
38.95	39.43	39.93	39.94	
86.07	996.1	996.56	996.52	
996.68	996.73	V56.1	V56.2	
250.xx	403.xx	580	589	593.xx
Vascular Access Repair (renal-specific HCPCS codes)				
36832	01844	36145	90939	
G0392	G0393			
Require renal diagnosis				
35458	35460	35475	35476	36005
37205	37206	37207	37208	75820
75860	75960	75962	75978	90940
36834	37190	75790	01784	
Outpatient antibiotics (Given in dialysis along with ICD9 code 996.62)				
J3370	J0690	J0692	J0696	J1840

Note: We identified antibiotic use for treatment of vascular access infection through billing claims from outpatient dialysis facilities. Antibiotics for vascular access infection were identified in instances where a diagnosis of vascular access infection occurred in conjunction with codes for administration of the following commonly used antibiotics: vancomycin, cefazolin, broad spectrum cephalosporins, aminoglycosides and daptomycin. Hospitalization for vascular access infection was defined as either a hospitalization with the primary ICD 9 diagnosis of vascular access infection (996.62) or hospitalization with the primary ICD 9 diagnosis of sepsis or septicemia (995.91 or 995.92 or 038.xx) with 996.62 documented as a secondary diagnosis.

eTable IIa: Comparison of AV Graft and Fistula Survival from Our Cohort with Other Cohorts

Years	Single Center	Our Cohort	Single Center	Our Cohort	Single Center	Our Cohort
	AVG	AVG	UA AVF	UA AVF	FA AVF	FA AVF
1	.54	.76	.69	.83	.52	.83
2	.42	.61	.59	.75	.48	.76
3	.31	.51	.53	.68	.43	.69
5	.19	.36	.53	.57	.34	.58

.

eTable IIb: Comparison of Patency of All AV Fistulas from Our Cohort with Older Cohort.

	Vascular Access Centers	Our Cohort
3 months	.96	.95
6 months	.90	.90
12 months	.88	.83
18 months	.86	.79

eTable IIc: Comparison of Patients Initiating Hemodialysis with Each Vascular Access Type using Claims-based Ascertainment versus Medical Evidence Form.

	claims-based method		
medical evidence form	Graft (%)	Fistula (%)	Catheter (%)
Graft	51.7%	19.0%	26.0%
Fistula	32.4%	79.2%	70.0%
Catheter	14.5%	17.5%	89.0%

Note: Numbers from medical evidence form (CMS 2728) do not add up to 100% due to a fraction of accesses categorized as "unknown." This analysis excludes patients for whom hemodialysis is not their initial modality.

eTable III. Sensitivity Analyses – Varying Assumptions about Actual Visits Performed on Months with 2-3 Visits

Visit Frequency and Vascular Access Repair	OR	p-value	LCI	UCI
2-3 visits = 2 visits	1.12	<0.001	1.11	1.14
2-3 visits = 3 visits	1.14	<0.001	1.13	1.15

Visit Frequency and Vascular Access Survival	HR	p-value	LCI	UCI
2-3 visits = 2 visits	1.00	0.67	0.99	1.02
2-3 visits = 3 visits	1.02	0.01	1.00	1.04

eTable IV: Sensitivity Analysis – Hazard of Access Failure as a Function of Visit Frequency, Excluding Visit Frequency in Months with Greater than 2 Hospitalizations

	HR	p-value	LCI	UCI
Visit frequency: One additional visit	1.01	0.08	1.00	1.03
Demographic & Socioeconomic				
Male sex	0.88	<0.001	0.86	0.91
Age - 10 years	1.04	0.006	1.01	1.07
Race (white as referent)[1]				
American Indian	0.84	0.08	0.69	1.02
Black	1.16	<0.001	1.12	1.21
Other race	1.05	0.29	0.96	1.14
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	0.92	0.01	0.86	0.98
Medicaid coverage	1.07	0.001	1.03	1.12
Comorbidities				
Diabetes	1.10	<0.001	1.06	1.14
Coronary disease	1.00	0.83	0.97	1.04
Cancer	1.07	0.002	1.03	1.12
Heart failure	1.08	<0.001	1.04	1.12
Pulmonary disease	1.08	<0.001	1.04	1.12
Cerebrovascular disease	1.04	0.03	1.01	1.08
PVD	1.07	<0.001	1.04	1.11
Smoking history	0.99	0.84	0.92	1.07
Immobility	1.19	<0.001	1.12	1.27
Drug or alcohol use	1.11	0.08	0.99	1.25
Dialysis prior to access - 90 days	1.01	<0.001	1.01	1.02
Vascular Access Type (lower arm AV fistula as referent)				
Graft	1.54	<0.001	1.48	1.60
Upper arm AV fistula	0.96	0.13	0.91	1.01
Geographic and Facility (metroplolitan as referent)				
Rural or small town	1.05	0.20	0.98	1.12
Micropolitan	1.08	0.001	1.03	1.14
For profit facility	1.06	0.07	1.00	1.12
Hospital-based facility	1.01	0.73	0.94	1.09
Facility size - 25 patients	1.00	0.85	0.99	1.01

[1] P-value testing the joint significance of race variables.

eTable V: Sensitivity Analysis – Odds of Access Repair as a Function of Visit Frequency, Excluding Visit Frequency in Months with Greater than 2 Hospitalizations

	OR	p-value	LCI	UCI
Visit frequency: One additional visit per month	1.12	<0.001	1.11	1.13
Demographic & Socioeconomic				
Male sex	0.93	<0.001	0.91	0.96
Age - 10 years	1.05	<0.001	1.03	1.08
Race (white as referent)				
American Indian	0.88	0.10	0.76	1.03
Black	1.33	<0.001	1.29	1.37
Other race	1.07	0.04	1.00	1.15
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	0.95	0.06	0.91	1.00
Medicaid coverage	0.99	0.75	0.96	1.03
Comorbidities				
Diabetes	1.11	<0.001	1.08	1.14
Coronary disease	1.02	0.24	0.99	1.04
Cancer	1.05	0.006	1.01	1.09
Heart failure	1.03	0.02	1.01	1.06
Pulmonary disease	1.00	0.75	0.98	1.03
Cerebrovascular disease	0.99	0.45	0.96	1.02
Peripheral vascular disease	1.06	<0.001	1.04	1.09
Smoking history	0.92	0.002	0.87	0.97
Immobility	1.10	<0.001	1.05	1.16
Drug or alcohol use	1.01	0.88	0.91	1.11
Dialysis prior to access - 90 days	1.03	<0.001	1.02	1.03
Vascular Access Type (lower arm AV Fistula as referent)				
Graft	1.58	<0.001	1.54	1.63
Upper arm AV fistula	1.15	<0.001	1.11	1.20
Geographic and Facility (metropolitan as referent)				
Rural or small town	1.01	0.70	0.96	1.06
Micropolitan	0.95	0.002	0.91	0.98
For profit facility	1.07	0.003	1.02	1.12
Hospital-based facility	1.08	0.005	1.02	1.14
Facility size - 25 patients	1.00	0.42	0.99	1.00

[1] P-value testing the joint significance of race variables.

eTable VI. Sensitivity to Assumptions about Initiation of AV Fistula and Graft Use

Graft Survival			
	HR	LCI	UCI
AVG used at day 14, AVF used at day 40	1.01	1.00	1.03
AVG used at day 21, AVF used at day 90[1]	1.01	1.00	1.03
AVG used at day 28, AVF used at day 180	1.02	1.01	1.04
Vascular Access Repair			
	OR	LCI	UCI
AVG used at day 14, AVF used at day 40	1.13	1.12	1.14
AVG used at day 21, AVF used at day 90[1]	1.13	1.12	1.14
AVG used at day 28, AVF used at day 180	1.13	1.12	1.15

[1] This was the assumption used in our primary analyses.
Note: AVG is arteriovenous graft, AVF is arteriovenous fistula

eTable VII. Analyses Stratified by Vascular Access Type

Visit Frequency and Vascular Access Repair	OR	p-value	LCI	UCI
Fistula	1.13	<0.001	1.11	1.15
Graft	1.13	<0.001	1.11	1.14
Visit Frequency and Vascular Access Survival	**HR**	**p-value**	**LCI**	**UCI**
Fistula	1.01	0.46	0.99	1.03
Graft	1.02	0.10	1.00	1.04

eTable VIII: Cox Regression of the Association between Visit Frequency and Hazard of Vascular Access Failure

	HR	p-value	LCI	UCI
Visit frequency: One additional visit per month	1.01	0.09	1.00	1.03
Demographic & Socioeconomic				
Male sex	0.90	<0.001	0.87	0.93
Age - 10 years	1.00	0.001	1.00	1.01
Race (white as referent)		<0.001[1]		
American Indian	0.85		0.69	1.06
Black	1.18		1.13	1.23
Other race	1.07		0.98	1.17
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	1.07	0.003	1.02	1.12
Medicaid coverage	0.00	<0.001	0.00	0.00
Comorbidities				
Diabetes	1.01	0.49	0.98	1.05
Coronary disease	1.07	0.004	1.02	1.12
Cancer	1.07	0.001	1.03	1.11
Heart failure	1.06	0.001	1.02	1.10
Pulmonary disease	1.03	0.14	0.99	1.07
Cerebrovascular disease	1.07	<0.001	1.03	1.11
PVD	0.99	0.72	0.91	1.06
Smoking history	1.18	<0.001	1.10	1.26
Immobility	1.12	0.08	0.99	1.27
Drug or alcohol use	1.00	<0.001	1.00	1.00
Dialysis prior to access - 90 days	1.05	<0.001	1.05	1.06
One additional day per month hospitalized	0.00	<0.001	0.00	0.00
Vascular Access Type (lower arm AV fistula as referent)				
Graft	1.62	<0.001	1.55	1.68
Upper arm AV fistula	0.99	0.65	0.93	1.04
Geographic and Facility (metropolitan as referent)				
Rural or small town	0.00	<0.001	0.00	0.00
Micropolitan	1.02	0.58	0.95	1.10
For profit facility	1.08	0.004	1.03	1.14
Hospital-based facility	1.04	0.23	0.98	1.11
Facility size - 25 patients	1.01	0.90	0.93	1.09

[1] P-value testing the joint significance of race variables.

Note: Interaction between visits and days hospitalized was non-significant (p=0.07), and therefore removed from the model.

eTable IX: Logistic Regression of the Association between Visit Frequency and Odds of Hospitalization for Vascular Access Infection

	OR	p-value	LCI	UCI
Visit frequency: One additional visit per month	0.91	<0.001	0.86	0.95
Demographic & Socioeconomic				
Male sex	1.08	0.23	0.96	1.21
Age - 10 years	1.30	<0.001	1.18	1.43
Race (white as referent)[1]		0.002		
American Indian	0.50		0.23	1.11
Black	1.19		1.03	1.37
Other race	1.44		1.12	1.87
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	1.08	0.44	0.88	1.33
Medicaid coverage	1.31	<0.001	1.14	1.51
Comorbidities				
Diabetes	1.07	0.31	0.94	1.21
Coronary disease	1.04	0.52	0.92	1.17
Cancer	1.15	0.06	0.99	1.33
Heart failure	1.10	0.13	0.97	1.25
Pulmonary disease	1.11	0.09	0.98	1.25
Cerebrovascular disease	1.23	0.001	1.08	1.41
PVD	1.16	0.02	1.03	1.31
Smoking history	0.96	0.75	0.75	1.23
Immobility	1.54	<0.001	1.28	1.85
Drug or alcohol use	1.23	0.31	0.83	1.82
Dialysis prior to access - 90 days	1.02	0.02	1.00	1.05
One additional day per month hospitalized	1.06	<0.001	1.04	1.08
Visit*Hospital day interaction	1.02	<0.001	1.01	1.02
Geographic and Facility (metropolitan as referent)				
Rural or small town	0.80	0.09	0.61	1.04
Micropolitan	1.01	0.87	0.86	1.20
For profit facility	1.00	0.98	0.83	1.21
Hospital-based facility	1.07	0.53	0.86	1.34
Facility size - 25 patients	1.00	0.76	0.98	1.03

[1] P-value testing the joint significance of race variables.

eTable X: Logistic Regression of the Association between Visit Frequency and Odds of Intravenous Antibiotics during Outpatient Hemodialysis

	OR	p-value	LCI	UCI
Visit frequency: One additional visit per month	1.09	<0.001	1.05	1.14
Demographic & Socioeconomic				
Male sex	0.94	0.16	0.86	1.03
Age - 10 years	0.96	<0.001	0.89	1.04
Race (white as referrent)[1]		0.02		
American Indian	0.73		0.45	1.19
Black	0.85		0.75	0.95
Other race	1.10		0.84	1.43
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	1.09	0.28	0.93	1.28
Medicaid coverage	1.07	0.30	0.94	1.20
Comorbidities				
Diabetes	1.07	0.19	0.97	1.18
Coronary disease	1.05	0.29	0.96	1.16
Cancer	1.03	0.64	0.91	1.16
Heart failure	1.19	0.001	1.07	1.32
Pulmonary disease	1.10	0.06	1.00	1.21
Cerebrovascular disease	1.17	0.004	1.05	1.30
PVD	1.18	0.001	1.07	1.30
Smoking history	1.04	0.73	0.84	1.28
Immobility	1.42	<0.001	1.19	1.69
Drug or alcohol use	0.92	0.74	0.57	1.49
Dialysis prior to access - 90 days	1.02	<0.001	1.0	1.03
One additional day per month hospitalized	1.05	<0.001	1.04	1.07
Visit*Hospital day interaction	1.01	<0.001	1.01	1.02
Vascular Access Type (lower arm AV fistula as referent)				
Graft	1.29	<0.001	1.17	1.43
Upper arm AV fistula	1.01	0.92	0.87	1.16
Geographic and Facility (metropolitan as referent)				
Rural or small town	1.10	0.32	0.91	1.31
Micropolitan	1.25	0.001	1.10	1.43
For profit facility	0.99	0.89	0.83	1.18
Hospital-based facility	0.73	0.003	0.60	0.90
Facility size - 25 patients	1.05	<0.001	1.03	1.06

[1] P-value testing the joint significance of race variables.

eTable XI: Parametric Hazard Model Regression Output

	HR	p-value	LCI	UCI
One additional visit per month	1.02	0.05	1.00	1.03
Demographic & Socioeconomic				
Male sex	0.90	<0.001	0.87	0.93
Age - 10 years	1.07	<0.001	1.04	1.10
Race (white as referent)		<0.001[1]		
American Indian	0.84		0.69	1.01
Black	1.17		1.12	1.22
Other race including asian	1.07		0.98	1.17
Ethnicity (non-hispanic as referent)				
Hispanic ethnicity	0.90	0.002	0.84	0.96
Medicaid coverage	1.08	0.001	1.03	1.12
Comorbidities				
Diabetes	1.11	<0.001	1.07	1.15
Coronary disease	1.01	0.58	0.97	1.05
Cancer	1.08	0.001	1.03	1.13
Heart failure	1.08	<0.001	1.04	1.12
Pulmonary disease	1.08	<0.001	1.04	1.12
Cerebrovascular disease	1.04	0.07	1.00	1.08
PVD	1.08	<0.001	1.04	1.12
Smoking history	1.00	0.90	0.92	1.07
Immobility	1.21	<0.001	1.13	1.29
Drug or alcohol use	1.12	0.072	0.99	1.27
Dialysis prior to access - 90 days	1.03	<0.001	1.02	1.03
Average days in hospital - 1 day per month	1.05	<0.001	1.05	1.06
Vascular Access Type (lower arm AV fistula as referent)				
Graft	1.63	<0.001	1.57	1.69
Upper arm AV fistula	1.00	1.00	0.95	1.06
Geographic and Facility				
Metropolitan		reference		
Rural or smal ltown	1.02	0.547	0.95	1.10
Micropolitan	1.09	0.001	1.04	1.14
For profit facility	1.05	0.104	0.99	1.11
Hospital-based facility	1.00	0.994	0.93	1.07
Facility size - 25 patients	1.00	0.997	0.99	1.01

[1] P-value testing the joint significance of race variables.

Note: Assumes an exponential survival distribution.

eTable XII: One-Year Predicted Probabilities of Vascular Access Repair, Vascular Access Failure, and Hospitalization for Vascular Access Infection by Visit Frequency

	Vascular access repair	Hospitalization for vascular access infection	Vascular access failure
1 visit	0.540	0.027	0.140
2 visits	0.582	0.024	0.142
3 visits	0.624	0.019	0.145
4 visits	0.666	0.017	0.147

REFERENCES:

1. Dixon, BS, Novak, L, Fangman, J: Hemodialysis vascular access survival: upper-arm native arteriovenous fistula. *American Journal of Kidney Diseases,* 39**:** 92-101, 2002.
2. Huijbregts, HJT, Bots, ML, Wittens, CHA, Schrama, YC, Moll, FL, Blankestijn, PJ, group, Cs: Hemodialysis arteriovenous fistula patency revisited: results of a prospective, multicenter initiative. *Clinical Journal of The American Society of Nephrology: CJASN,* 3**:** 714-719, 2008.
3. Layton, JB, Hogan, SL, Jennette, CE, Kenderes, B, Krisher, J, Jennette, JC, McClellan, WM: Discrepancy between Medical Evidence Form 2728 and renal biopsy for glomerular diseases. *Clinical Journal of The American Society of Nephrology: CJASN,* 5**:** 2046-2052, 2010.
4. Longenecker, JC, Coresh, J, Klag, MJ, Levey, AS, Martin, AA, Fink, NE, Powe, NR: Validation of comorbid conditions on the end-stage renal disease medical evidence report: the CHOICE study. Choices for Healthy Outcomes in Caring for ESRD. *Journal of the American Society of Nephrology,* 11**:** 520-529, 2000.
5. Solid, C, Collins, A, Ebben, J, Chen, S, Faravardeh, A, Foley, R, Ishan, iA: Agreement of reported vascular access on the medical evidence report and on medicare claims at hemodialysis initiation. *BMC Nephrology,* 15(1), 2014.