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## Chapter 4: Vascular Access

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- 80.3% of patients were using a catheter at hemodialysis initiation in 2014, which has changed little since 2005 (Figure 4.1).
- At 90 days after initiation of dialysis, 68.3% of hemodialysis patients were still using a catheter in 2014 (Figure 4.7.a).
- AV fistula use at hemodialysis initiation rose from 12% to 16.9% over the period 2005-2014 (Figure 4.1).
- The percentage of patients at hemodialysis initiation using an AV fistula or with a maturing AV fistula increased from 28.9% to 33.8%, over the same period (Figure 4.1).
- The percentage of patients using an AV fistula exclusively at the end of one year on hemodialysis was 65%, up from 17% at initiation (Figure 4.7.a).
- The proportion of patients with an AV graft for vascular access was 3% at hemodialysis initiation, and 15% at 1 year after initiation (Figure 4.7.a).
- At 1 year after hemodialysis initiation, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter (Figure 4.7.a).
- By December 2014, 63.4 % of prevalent dialysis patients were using an AV fistula (Figure 4.6).
- In 2014, 33.8% of AV fistulas placed failed to be in use following placement, with a median of 114 days to first AV fistula use (Table 4.7).
- The percent of AV fistula that successfully matured was higher with younger age; similarly, the median time to first AV fistula use was somewhat shorter with younger age (Table 4.7).

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### Introduction

Clinical practice guidelines recommend an autogenous arteriovenous (AV) fistula as the preferred vascular access for hemodialysis (National Kidney Foundation, 2006). A recent systematic review of 62 cohort studies with 586,337 patients evaluated the association between type of vascular access and risk of mortality, infection, and major cardiovascular events. While recognizing the risk of selection bias inherent in observational studies, it concluded that central venous catheters (hereafter, catheter[s]) were associated with the highest risk of death, infection, and cardiovascular events, compared with other types of vascular access, and that patients who had a usable AV fistula were at the lowest risks for these events (Ravani et al., 2013).

The international Dialysis Outcomes and Practice Patterns Study (DOPPS) highlighted the fact that U.S. dialysis practices with respect to vascular access lagged behind other industrialized countries of the world (Pisoni et al., 2002; Goodkin et al., 2010; Robinson et al., 2010). In large part, these international comparisons served as impetus for implementation of the Fistula First Breakthrough Initiative (FFBI) by the Centers for Medicare & Medicaid (CMS) (Vassalotti et al., 2012). A steady increase in AV fistula placement efforts followed in the United States over the next decade, such that the proportion of prevalent hemodialysis patients using an AV fistula rose from 32% in 2003 to 63% by 2014.

A robust debate continues as to whether an AV fistula should remain the access of first choice in every dialysis patient. Although an AV fistula continues to

be considered the optimal type of vascular access in many patients owing to its potential for durability and lower risk of infection and intervention to ensure patency, the focus has shifted somewhat toward creating the most appropriate access for the individual patient, based upon the clinical situation, patient characteristics, life expectancy, patient preference, and other factors. Whether this approach will indeed prove superior can only be determined by further detailed, prospective studies, and/or clinical trials.

A landmark clinical trial where maturation of an AV fistula was a secondary outcome, revealed the high prevalence of failure of newly placed fistulas ever coming to use (Dember et al., 2008). This topic is of great interest to the nephrology community (Riella, et al., 2013) and led to the NIDDK funded Hemodialysis Fistula Maturation Study (Dember et al., 2014) designed to study this phenomenon further. Between primary surgical failures and maturation failures, 33.8% of AV fistula placements in the United States are unsuccessful (Table 4.7). The many potential factors underlying this phenomenon need to be rigorously evaluated so that primary surgical success rates and subsequent optimal maturation of the AV fistula can be ensured. In this regard, greater emphasis on AV fistula placement during surgical training may need to be prioritized in the United States (Saran et al., 2008; Goodkin et al., 2010). A number of other factors, including patient motivation for access placement, timeliness of referral for nephrology care and vascular access placement, likely impact successful AV fistula placement—suggesting that a systematic, multilevel approach is required for ensuring optimal vascular access for every hemodialysis patient (Huber, 2015).

Interventional nephrology has gained prominence in the United States over the last decade or so, introducing a new class of specialists involved with vascular access procedures to a field previously dominated primarily by surgeons and interventional radiologists trained in vascular access procedures. The impact of this phenomenon on patient outcomes has yet to be systematically studied. In addition, technological advances, such as bioengineered vessels, continue to be studied, and have the potential to influence future vascular access practice and patient outcomes.

All of the above considerations make it imperative to comprehensively and carefully track vascular access placements, related practices, and outcomes. In addition to patient characteristics, other factors such as technological advances, improved surgical and medical treatments, use of specific medications, payment reform and bundling, and improved pre-dialysis care can impact vascular access practice patterns and outcomes. Despite the emphasis on improving AV fistula success rates, at the time of their initial dialysis, 80% of patients are still using a catheter. Well-coordinated pre-dialysis care during the critical transition period to ESRD may be the key to future improvements in this suboptimal practice pattern.

This chapter describes patterns of vascular access use among incident and prevalent dialysis patients by patient characteristics and geographic region over the last decade. In addition, we explore variation in time-to-first-use of AV fistula after placement as a surrogate of AV fistula maturation across the country. Additional information describing vascular access use by dialysis providers is provided in [Chapter 10: Dialysis Providers](#) in Volume 2 of this Annual Data Report.

## Methods

This chapter uses data from the Centers for Medicare & Medicaid Services (CMS). Details of the data source are described in the [Data Sources](#) section of the ESRD Analytical Methods chapter.

See the section on [Chapter 4](#) in the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the study cohorts, figures, and tables in this chapter.

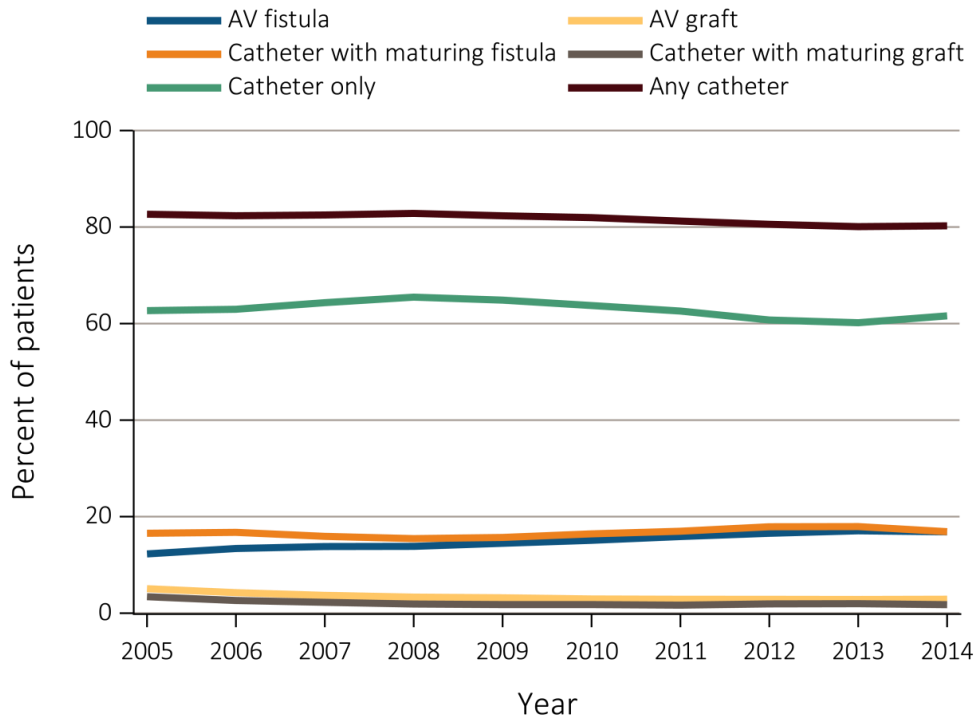
## Vascular Access Use at Initiation of Hemodialysis

A total of 80.3% of patients were using a catheter at hemodialysis initiation in 2014, which has changed little since 2005. Figure 4.1 shows that, in 2014, 61.6% of hemodialysis patients incident to ESRD had neither an AV fistula nor AV graft in place (or maturing) at their first outpatient hemodialysis session. This peaked at 65.4% in 2008, and has been relatively stable near 60% since around 2012. Over the last seven

years, there has been a relatively small absolute increase in AV fistula use at hemodialysis initiation, rising from 12.3% in 2005 to 16.9% in 2014. Over the

same period, the percentage of patients with either an AV fistula or a maturing AV fistula has increased from 28.9% to 33.8%.

**vol 2 Figure 4.1 Vascular access use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2005-2014**



*Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2005-2014. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.*

Table 4.1 shows dialysis access use at hemodialysis initiation stratified by patient characteristics. The 0-21 year old age group had the highest percentage of catheter use at hemodialysis initiation (92.3%) and lowest percentage of AV fistula use (6.6%). Many of these patients were children who received a renal transplant relatively quickly, with hemodialysis serving as a bridge to transplantation, and those in the youngest age categories, who, being small, may have presented surgical challenges in creating an AVF fistula. The 65-74 year age group had the highest percentage of patients with AV fistula use at hemodialysis initiation (18.4%) with slightly lower levels of 17.1% and 16.6% AV fistula

use seen for individuals  $\geq 75$  years old and 45-64 years old, respectively. Patients of Hispanic ethnicity displayed the lowest proportion with AV fistula being used (11.7%) at hemodialysis initiation and the highest catheter alone use (69.5%). Blacks/African Americans (hereafter, Blacks) displayed the highest proportion of AV graft use at hemodialysis initiation (4.2%) compared with 1.9% to 3% for individuals of other races or of Hispanic ethnicity. Those with cystic kidney disease had higher rates of AV fistula use at hemodialysis initiation (42.8%), perhaps related to younger age at disease detection, slower progression of underlying CKD, earlier referral, and relatively preserved vasculature.

vol 2 Table 4.1 Vascular access used at hemodialysis initiation by patient characteristics from the ESRD Medical Evidence form (CMS 2728), 2014

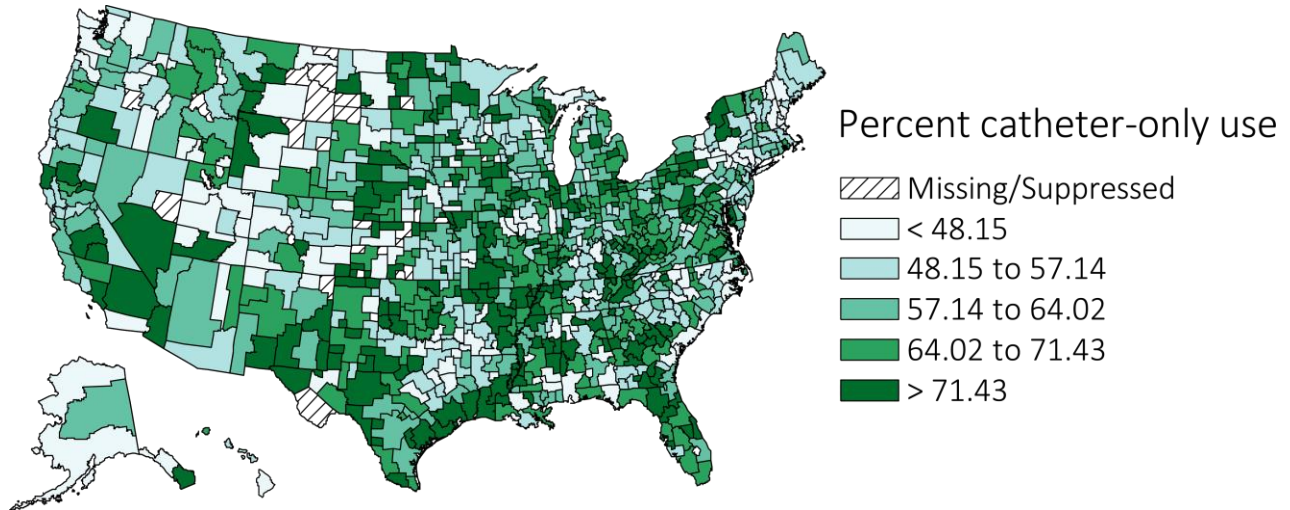
	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
<b>All</b>	16.9	2.9	16.9	1.8	61.6
<b>Age</b>					
0-21	6.6	0.7	10.8	0.4	81.4
22-44	13.9	1.9	17.1	1.5	65.7
45-64	16.6	2.7	18.2	1.6	60.8
65-74	18.4	3.1	17.0	1.8	59.7
75+	17.1	3.4	14.8	2.1	62.6
<b>Sex</b>					
Male	18.4	2.2	17.5	1.5	60.4
Female	14.8	3.8	16.1	2.2	63.2
<b>Race/Ethnicity</b>					
Hispanic	11.7	1.8	15.6	1.4	69.5
<b>Non-Hispanic</b>					
White NH	17.7	2.4	16.6	1.6	61.7
Black/African American NH	15.3	4.2	17.6	2.3	60.6
Native American NH	15.6	1.9	23.0	0.8	58.7
Asian NH	19.6	3.0	16.9	1.9	58.6
<b>Primary Cause of ESRD</b>					
Diabetes	17.6	3.1	19.4	1.9	58.1
Hypertension	17.1	3.0	16.1	1.8	61.9
Glomerulonephritis	18.4	2.4	15.4	1.4	62.3
Cystic Kidney	42.8	4.6	14.1	1.2	37.3
Other Urologic	14.7	2.4	14.0	1.6	67.3
Other Cause	9.3	1.9	10.6	1.4	76.8
Unknown/Missing	11.7	2.5	12.5	1.4	72.0
<b>Comorbidities</b>					
Diabetes	16.8	2.9	18.4	1.9	60.0
Congestive heart failure	12.9	2.5	17.6	2.0	65.0
Atherosclerotic heart disease	16.8	3.2	18.6	2.1	59.4
Cerebrovascular disease	14.7	3.5	18.2	2.4	61.1
Peripheral vascular disease	15.3	2.7	18.7	2.1	61.2
Hypertension	17.4	3.0	17.3	1.8	60.5
Other cardiac disease	14.0	2.5	16.2	1.7	65.6

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease; NH, non-Hispanic.

Figures 4.2 and 4.3 illustrate the geographic variation in catheter use alone and AV fistula use, respectively, at hemodialysis initiation by Health Service Area. Considerable variation is seen in both of these categorizations, even within individual states.

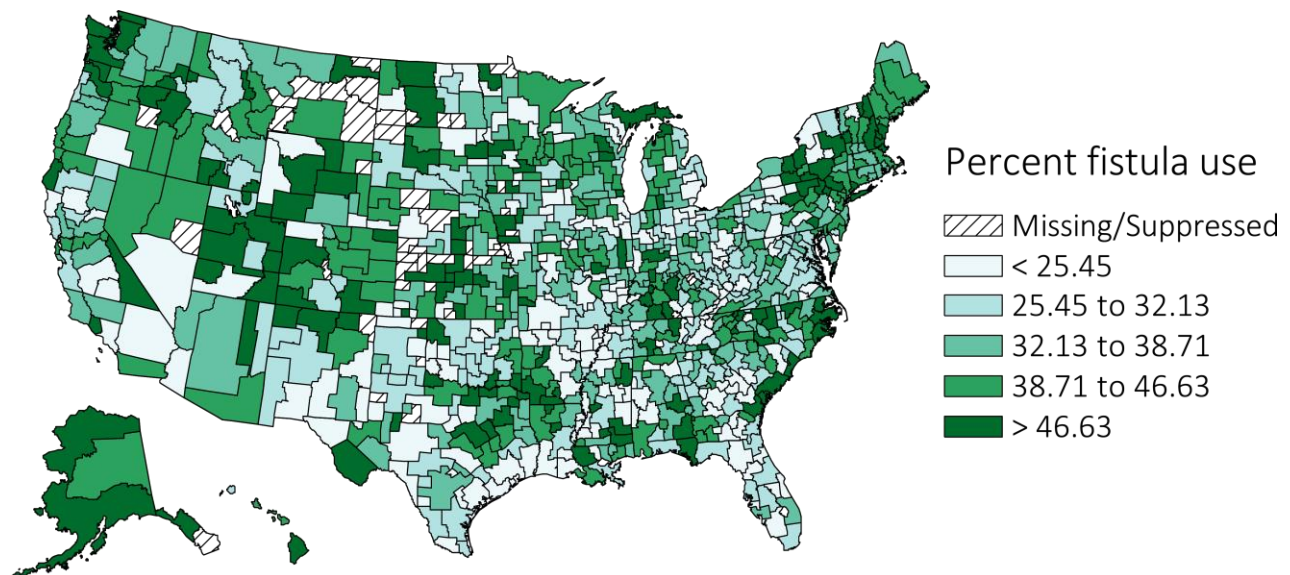
New England, the Northwest, and parts of the East coast tend to have a lower percentage of catheter use and a higher percentage of AV fistula use at initiation. Some of the Central and Western mountain states appear to have a higher incidence of AV fistula use.

**vol 2 Figure 4.2 Geographic variation in percentage of catheter-only use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2014**



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

**vol 2 Figure 4.3 Geographic variation in percentage of AV fistula use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2014**



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.



## Vascular Access Use Among Prevalent Hemodialysis Patients

Table 4.2 shows patterns of access use among prevalent hemodialysis patients (those with ESRD for  $\geq 90$  days). By December 2014, 63.1% of prevalent hemodialysis patients were using an AV fistula. In general, demographic variation was similar to the patterns observed among incident patients. Among prevalent hemodialysis patients, the 0-21 year old age group displays the highest catheter use, while the 45-

64 year old age group had the lowest catheter use. Black/African Americans displayed the lowest AV fistula utilization but highest utilization of an AV graft. Highest catheter use was reported for White, non-Hispanic hemodialysis patients. When examined among individuals by primary cause of ESRD, those with cystic kidney disease maintained the highest fistula usage, although the differences in vascular access use between patients with different etiologies were smaller compared with what was observed in patients new to dialysis (Table 4.1).

vol 2 Table 4.2 Distribution of type of vascular access in use among prevalent hemodialysis patients in 2014, from CROWNWeb data, December 2014

	AV fistula	AV graft	Catheter
<b>All</b>	63.1	18.1	18.8
<b>Age</b>			
0-21	49.6	6.2	44.2
22-44	65.3	15.2	19.4
45-64	64.8	17.4	17.8
65-74	62.5	18.8	18.7
75+	59.4	20.4	20.1
<b>Sex</b>			
Male	69.1	14.0	16.9
Female	55.4	23.4	21.2
<b>Race/Ethnicity</b>			
Hispanic	68.0	15.2	16.8
<b>Non-Hispanic</b>			
White NH	64.9	13.7	21.4
Black/ African American NH	57.7	24.9	17.4
Native American NH	75.1	10.8	14.1
Asian NH	67.5	16.3	16.2
<b>Primary Cause of ESRD</b>			
Diabetes	63.4	17.9	18.7
Hypertension	62.5	19.0	18.5
Glomerulonephritis	65.3	17.9	16.8
Cystic Kidney	70.1	16.7	13.2
Other Urologic	61.6	17.7	20.7
Other Cause	58.1	16.8	25.2
Unknown/Missing	62.8	17.6	19.7

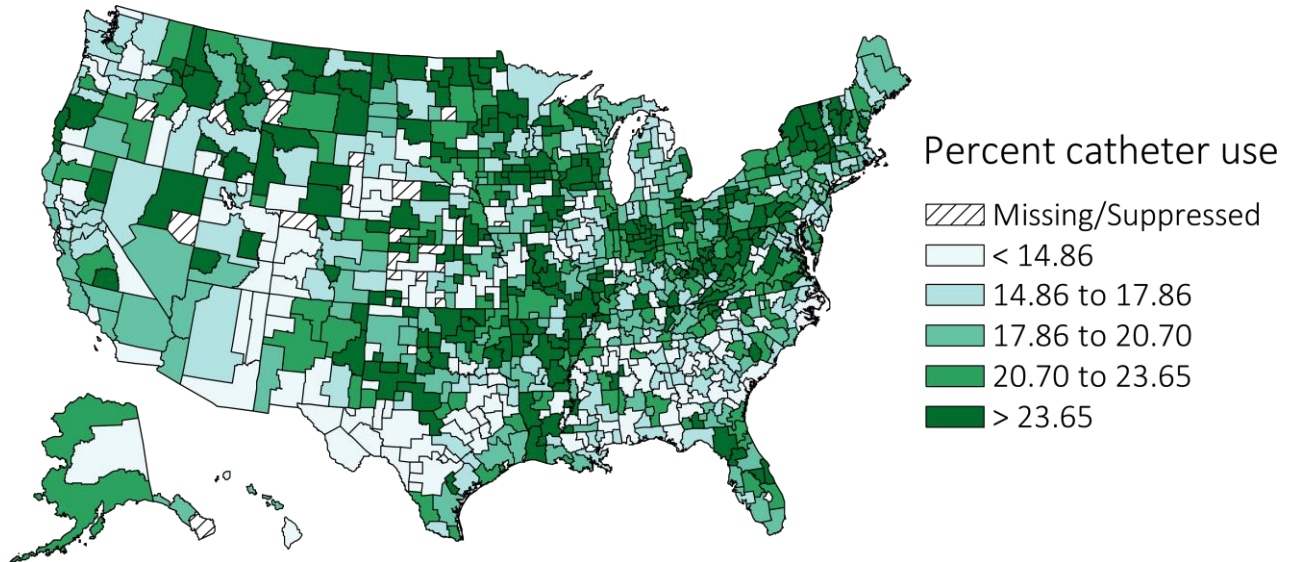
Data Source: Special analyses, USRDS ESRD Database. CROWNWeb data, catheter = any catheter use; fistula and graft use shown are without the use of a catheter. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease; NH, non-Hispanic.

Figure 4.4, shows the geographic variation in proportion of patients using a catheter among prevalent hemodialysis patients in the United States in 2014. Significant variation was observed across the country. Clusters of high catheter utilization are evident in parts of Montana and upper Idaho (in contrast to the Pacific Northwest), in southern Missouri, two-thirds of Arkansas and Oklahoma, and along the Appalachian Mountain range from northeastern

upstate New York through parts of Pennsylvania and West Virginia, to the eastern portion of Tennessee.

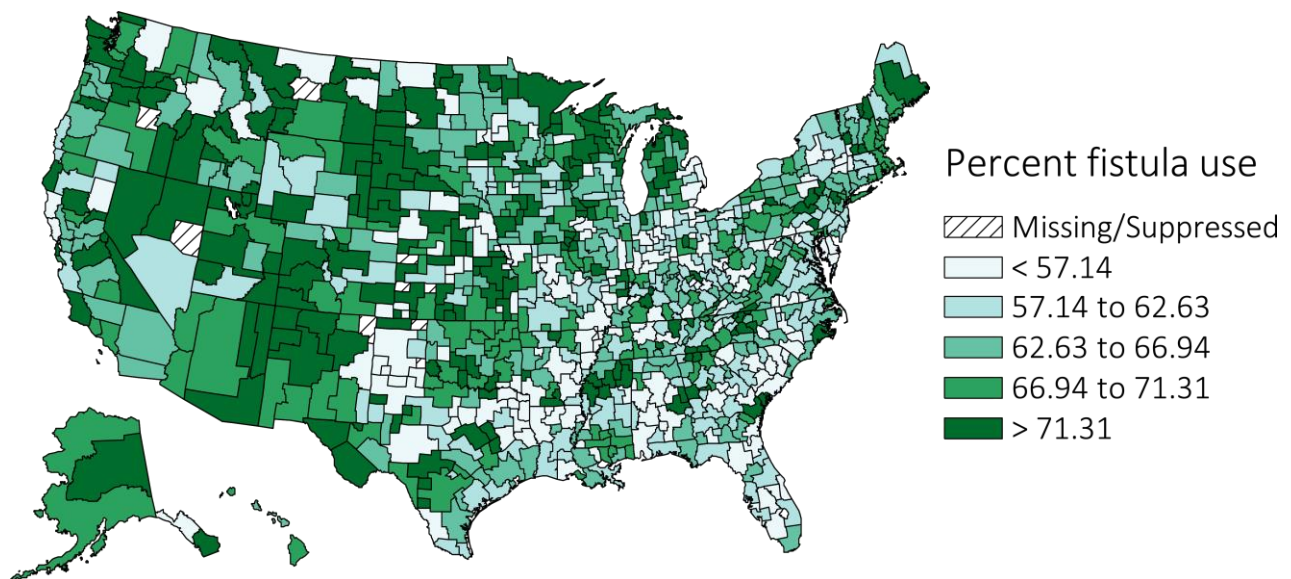
Figure 4.5 shows variation in fistula use among prevalent hemodialysis patients in the United States in 2014. While there are pockets where there is greater than 71% utilization of AV fistula among prevalent hemodialysis patients throughout the country, higher fistula use is more apparent in the western half of the country.

**vol 2 Figure 4.4 Geographic variation in percentage catheter use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2014**



Data Source: Special analyses, USRDS ESRD Database. Abbreviation: CROWNWeb, Consolidated Renal Operations in a Web-enabled Network.

**vol 2 Figure 4.5 Geographic variation in percentage AV fistula use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2014**

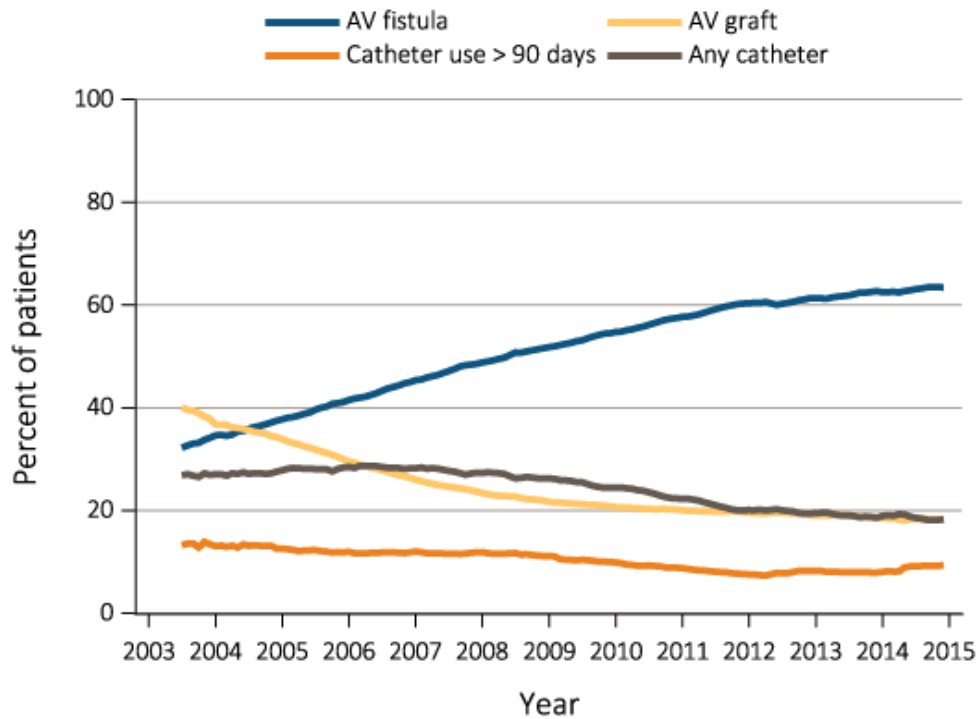


Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network.

Figure 4.6 displays trends in vascular access use among prevalent hemodialysis patients from 2003-2014. There has been a large rise in AV fistula use since 2003, with use increasing from 32% to 63% of patients. In contrast, AV graft use has decreased from 40% to

18% over the same period. Catheter use has also declined, albeit not as dramatically, decreasing from 27% to 18%. In 2014, only 9% of prevalent hemodialysis patients had been using a catheter for >90 days.

vol 2 Figure 4.6 Trends in vascular access type use among ESRD prevalent patients, 2003-2014



Data Source: Special analyses, USRDS ESRD Database and Fistula First data. Fistula First data reported from July 2003 through April 2012, CROWNWeb data are reported from June 2012 through December 2014. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

### Change in Type of Vascular Access During the First Year of Dialysis

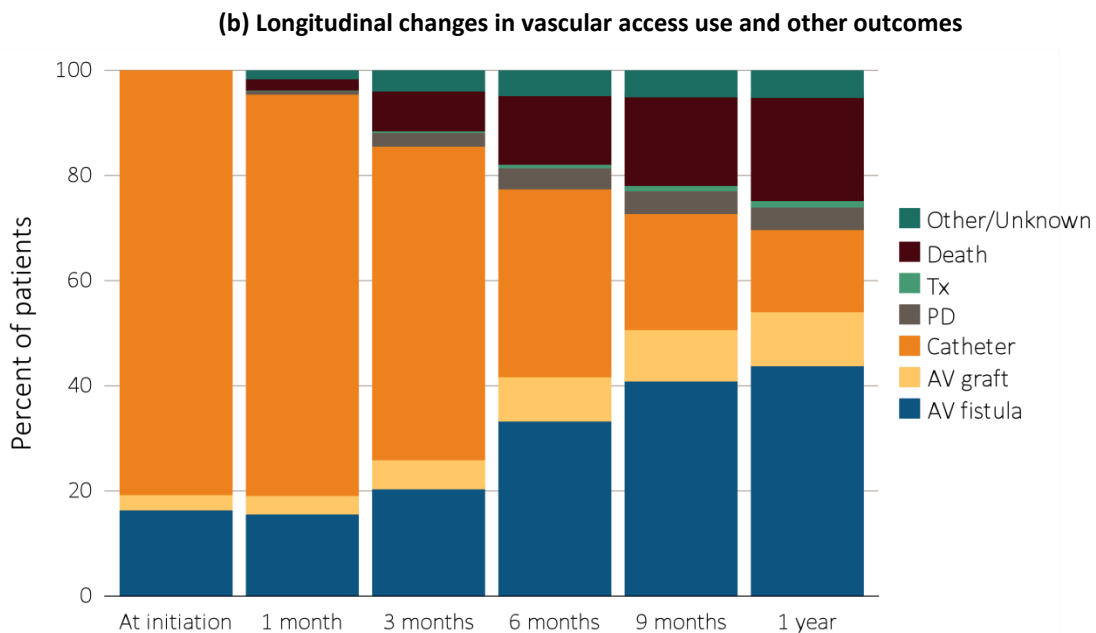
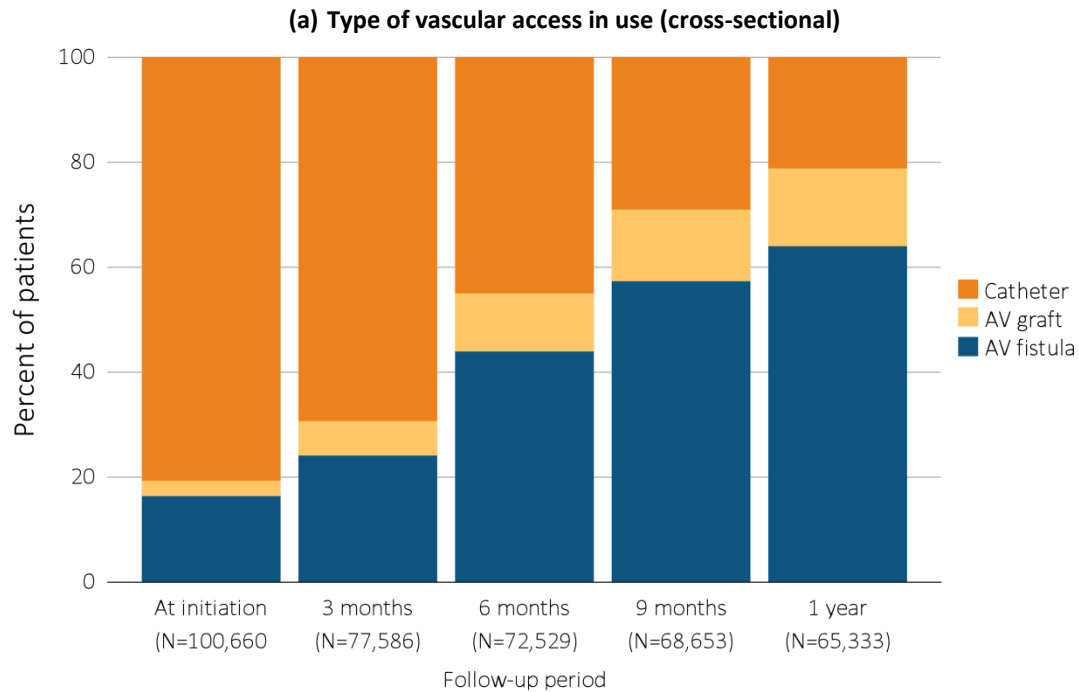
Figure 4.7.a shows cross-sectional data from both the CMS Medical Evidence form (CMS 2728) (for vascular access information at initiation) and CROWNWeb (for follow-up data with respect to vascular access in use at 3, 6, 9 months and 1 year). At 90 days, most hemodialysis patients were still using a catheter, highlighting the importance of ongoing efforts to improve pre-dialysis access planning. The percentage of patients using an AV fistula exclusively at the end of 1 year on dialysis was 65%, up from 17% seen at hemodialysis initiation. The proportion of patients with an AV graft for vascular access was 3% at initiation, and 15% at 1 year. Thus, at 1 year, 80% of

patients were using either an AV fistula or AV graft without the presence of a catheter.

Figure 4.7.b displays one-year longitudinal changes in vascular access use and other outcomes in the cohort of patients who initiated ESRD via hemodialysis in 2014. In the incident ESRD hemodialysis cohort, 80.3% of patients initiated hemodialysis using a central venous catheter. After 12 months, 44.3% were using an AV fistula, 10.3% were using an AV graft, 13.6% were dialyzing with a catheter only, 2.0% were dialyzing with a catheter but had AV access in place, 1.2% were living with a kidney transplant, 4.3% were receiving peritoneal dialysis, 19.6% had died, and 4.7% were classified as other/unknown.



vol 2 Figure 4.7 Change in type of vascular access during the first year of dialysis among patients starting ESRD via hemodialysis in 2014 quarterly: (a) type of vascular access in use (cross-sectional), and (b) longitudinal changes in vascular access use and other outcomes, ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2014-2015



Data Source: Special analyses, USRDS ESRD Database. Data from January 1, 2014 to December 31, 2014: (a) Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. (b) ESRD patients initiating hemodialysis (N =102,367). Patients with a maturing AV fistula / AV graft with a catheter in place were classified as having a catheter. The apparent decrease in AV fistula and AV graft use at 1 month is related to missing data due to the different data sources used for incident and prevalent patients. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease; HD, hemodialysis; PD, peritoneal dialysis.

Tables 4.3 through 4.5 show cross-sectional distributions of vascular access use at several time points during the first year of hemodialysis therapy, stratified by age, race, and sex. Catheter use was most common at initiation and at the end of one year in the 0-21 year old age group for reasons discussed earlier (e.g., higher transplant rates, anatomical challenges). AV graft use was higher in the 75+ age group both at initiation and at the end of one year. At 1 year, catheter use of approximately 20% is seen in all age groups, except the 0-21 year old cohort, indicating that barriers still remain in establishing surgical access, even after one year. Black patients have the highest

proportion of AV graft use, both at initiation and at 1 year. At 1 year, 20.0% of Black patients were using an AV graft compared to 13.0% of Asians and 12.5% of Whites. Females have a higher proportion of AV graft use and males a higher proportion of AV fistula use both at initiation and at 1 year. At 1 year, catheter use was highest in patients of other/unknown race and females. For most adult patients, an AV fistula prevalence of 60% or higher is achieved by 1 year on hemodialysis. At 1 year, the highest proportions of AV fistula were seen among males, those of Native American or Asian race, and the lowest AV fistula proportion was observed among African Americans.

vol 2 Table 4.3 Cross-sectional distributions of vascular access use, quarterly during the first year of hemodialysis, among patients new to hemodialysis in 2014, by age group, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2014-2015

Age	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
0-21	AV fistula	6.7	12.1	32.7	40.5	47.0
	AV graft	0.7	0.8	1.7	3.8	3.9
	Catheter	92.6	87.1	65.6	55.6	49.1
22-44	AV fistula	13.9	21.5	44.3	58.6	66.3
	AV graft	1.9	4.5	7.6	10.0	10.6
	Catheter	84.3	74.0	48.1	31.4	23.1
45-64	AV fistula	16.7	24.7	45.5	59.7	66.7
	AV graft	2.8	5.7	9.6	11.9	13.0
	Catheter	80.5	69.6	44.9	28.4	20.4
65-74	AV fistula	18.6	26.5	45.7	58.8	65.2
	AV graft	3.1	6.6	11.4	14.1	15.4
	Catheter	78.3	66.9	42.9	27.1	19.4
75+	AV fistula	17.2	24.3	41.8	53.9	59.9
	AV graft	3.5	9.0	15.0	18.1	19.4
	Catheter	79.4	66.7	43.2	28.1	20.7

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

vol 2 Table 4.4 Cross-sectional distributions of vascular access use, quarterly during the first year of hemodialysis among patients new to hemodialysis in 2014, by race, from the ESRD Medical Evidence form (CMS-2728) and CROWNWeb, 2014-2015

Race	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Native American	AV fistula	16.0	25.9	53.9	67.8	75.0
	AV graft	2.0	4.0	6.9	8.3	9.4
	Catheter	82.0	70.0	39.2	23.9	15.6
Asian	AV fistula	19.3	27.1	49.4	62.5	69.7
	AV graft	2.9	6.7	10.3	12.2	13.0
	Catheter	77.8	66.2	40.3	25.3	17.3
Black/African American	AV fistula	15.3	21.6	39.4	52.0	58.5
	AV graft	4.2	9.2	15.0	18.3	20.0
	Catheter	80.5	69.2	45.6	29.6	21.5
White	AV fistula	17.5	25.8	46.3	60.1	66.9
	AV graft	2.4	5.4	9.4	11.7	12.5
	Catheter	80.1	68.7	44.3	28.2	20.6
Other/Unknown	AV fistula	14.9	21.5	42.9	62.5	66.7
	AV graft	4.2	6.0	10.7	11.0	10.3
	Catheter	81.0	72.5	46.3	26.5	23.1

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

vol 2 Table 4.5 Cross-sectional distributions of vascular access use, quarterly during the first year of hemodialysis among patients new to hemodialysis in 2014, by sex, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2014-2015

Sex	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Male	AV fistula	18.4	27.9	50.4	64.2	70.9
	AV graft	2.2	5.1	8.6	10.6	11.4
	Catheter	79.3	66.9	41.1	25.2	17.7
Female	AV fistula	14.9	20.2	36.5	49.3	55.9
	AV graft	3.8	8.5	14.5	17.9	19.5
	Catheter	81.2	71.2	49.0	32.9	24.6

Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

## Predictors of AV Fistula Use at Hemodialysis Initiation

Programs such as Fistula First and Fistula First Catheter Last were created to inform and educate the medical community on the higher morbidity, mortality, and costs associated with catheter use, while encouraging greater AV fistula use. Although AV fistula use has increased greatly in prevalent patients, improvement in AV fistula use at initiation continues to lag behind. Many reasons can be postulated for these trends, such as access to primary and/or nephrology care, disparities in health-care access, difficulty in AV fistula maturation in certain patient groups, such as the elderly diabetic or those with limited transportation or financial incentives, and the wide variety of health care providers with differing expertise in creating AV fistula for dialysis patients. The following figures and tables examine associations between clinical and patient characteristics and

successful surgical access use (AV fistula as well as AV fistula/AV graft use) at initiation of hemodialysis.

Table 4.6 examines patient characteristics as well as factors such as length of pre-ESRD care and ESRD networks. Asians have the highest odds of AV fistula use at hemodialysis initiation, while both Asians and Blacks have the highest odds of a surgical access (AV fistula or AV graft) in use at hemodialysis initiation, with females less likely to be using an AV fistula/AV graft at initiation. ESRD Network 16 (Northwest Renal Network) displays the highest odds of patients using an AV fistula at initiation as well as higher odds of AV fistula or AV graft use at hemodialysis initiation. Patients with ESRD secondary to diabetes are less likely to use an AV fistula or AV graft at hemodialysis initiation compared with patients for whom the primary cause of ESRD was not diabetes. This model has somewhat different findings from other published models, such as that by Zarkowsky, et al. (2015), as it adjusts for different covariates.



vol 2 Table 4.6 Odds ratios and 95% confidence intervals from logistic regression models of (a) AV fistula use at hemodialysis initiation, and (b) AV fistula or graft use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2014

Predictors	AV fistula use at initiation			AV fistula or graft use at initiation		
	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
		Lower bound	Upper bound		Lower bound	Upper bound
<b>Pre-ESRD nephrology care</b>						
0 months	0.05	0.05	0.06	0.06	0.06	0.07
>0 -<6 months	0.28	0.26	0.29	0.29	0.28	0.31
6-12 months	0.59	0.56	0.62	0.60	0.57	0.62
>12 months	Ref.			Ref.		
Unknown	0.20	0.18	0.21	0.20	0.19	0.21
<b>Age</b>						
0-21	0.31	0.23	0.42	0.28	0.21	0.38
22-44	0.89	0.84	0.96	0.84	0.79	0.90
45-64	Ref.			Ref.		
65-74	1.01	0.97	1.06	1.04	0.99	1.08
75+	0.89	0.85	0.93	0.95	0.91	0.99
<b>Sex</b>						
Female	0.74	0.72	0.77	0.85	0.83	0.88
Male	Ref.			Ref.		
<b>Race</b>						
Hispanic	0.77	0.69	0.86	0.76	0.69	0.84
<b>Non-Hispanic</b>						
White NH	Ref.			Ref.		
Black/African American NH	0.97	0.93	1.01	1.13	1.09	1.18
Native American NH	0.81	0.68	0.98	0.82	0.69	0.98
Asian NH	1.03	0.95	1.12	1.03	0.95	1.11
Other/Unknown NH	0.82	0.58	1.15	0.96	0.70	1.31
<b>Diabetes as cause of ESRD</b>	0.96	0.93	0.99	0.98	0.95	1.01
<b>Facility census</b>						
< 20	Ref.			Ref.		
20-50	0.94	0.91	0.98	0.93	0.89	0.96
51-100	0.75	0.70	0.81	0.71	0.66	0.77
101-200	0.36	0.24	0.54	0.47	0.34	0.66
>200	1.17	0.85	1.61	1.38	1.03	1.84
<b>ESRD network</b>						
1 (vs. average network)	1.13	1.04	1.23	1.11	1.02	1.20
2 (vs. average network)	1.08	1.01	1.16	1.07	1.01	1.14
3 (vs. average network)	0.84	0.78	0.92	0.87	0.80	0.94
4 (vs. average network)	0.97	0.89	1.04	1.01	0.94	1.08
5 (vs. average network)	0.99	0.92	1.06	0.93	0.87	1.00
6 (vs. average network)	1.02	0.96	1.09	1.01	0.96	1.07
7 (vs. average network)	0.68	0.63	0.73	0.69	0.64	0.74
8 (vs. average network)	0.95	0.88	1.02	0.96	0.89	1.03
9 (vs. average network)	0.98	0.92	1.04	0.97	0.92	1.03
10 (vs. average network)	0.91	0.83	0.99	0.92	0.85	1.00
11 (vs. average network)	1.01	0.95	1.08	0.98	0.92	1.04
12 (vs. average network)	0.86	0.78	0.94	0.86	0.79	0.94
13 (vs. average network)	1.08	1.00	1.17	1.03	0.95	1.11
14 (vs. average network)	0.73	0.69	0.78	0.78	0.73	0.83
15 (vs. average network)	1.24	1.15	1.34	1.16	1.08	1.25
16 (vs. average network)	1.42	1.30	1.54	1.44	1.33	1.56
17 (vs. average network)	1.28	1.18	1.38	1.36	1.27	1.47
18 (vs. average network)	1.14	1.06	1.21	1.13	1.06	1.20

Data Source: Special analyses, USRDS ESRD Database. For more on ESRD networks, see <http://www.cms.gov/About-CMS/Agency-Information/RegionalOffices/RegionalMap.html>. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

## Fistula Maturation

Timely fistula maturation is an area of central interest for the dialysis community. While AV fistula utilization among prevalent hemodialysis patients has improved (Figure 4.6), the proportion of patients using a dialysis catheter at incidence of ESRD remains high (Figure 4.1). Limiting catheter exposure time is critical, as prolonged catheter use is often associated with bacteremia, sepsis, thrombosis, and central venous stenoses (Morsy et al., 1998), which limits future access survival, as well as poor long-term patient outcomes (Pisoni et al., 2009). “Observational data indicate catheter use is associated with higher mortality risk, compared to other access types, potentially through the greater risk for sepsis and as a source of inflammation due to the ‘foreign body’ in the bloodstream effect, biofilm formation and other mechanisms, which may cause persistent adverse outcomes even after catheter removal” (Foley et al., 2004). While AV grafts are ready for use sooner and more reliably, they require more procedures to assure their long-term patency. They are associated with a higher frequency of other complications that can significantly impact mortality and morbidity, including dialysis access-associated ischemia (also known as “distal hypoperfusion ischemic syndrome” or “steal syndrome”) and infections (Churchill et al., 1992; Stevenson, 2002; Ravani, 2013), adding significant risk with this choice of conduit. These complications can also have a significant impact on quality of life as well. Furthermore, the premature use of an AV graft may limit access options in the future (National Kidney Foundation, 2006) — a significant concern for those with longer life expectancy. At the present time, it is unclear whether prolonged AV fistula maturation time, and the risks associated with prolonged catheter exposure should warrant prioritizing AV graft placement in certain patient populations such as the elderly. Conversion from a catheter to permanent access of either type has been shown to be associated with better patient outcomes (Bradbury et al., 2009).

In an effort to better understand which patients experience longer maturation times, data on

prevalent hemodialysis patients was examined, as these patients are more likely to experience use of their AV fistula as soon as it is reasonable to do so. Fistula placement was identified through inpatient, outpatient, and physician/supplier Medicare claims using the following ICD-9 procedure codes: 36818, 36819, 36820, 36821 and 36825. Subsequent first use of the placed fistula was determined by finding evidence of fistula use in CROWNWeb data through the end of 2015. If the fistula was indicated as being used in CROWNWeb following its placement (and prior to any subsequent fistula placements), the fistula was considered to have successfully matured for use. If CROWNWeb data did not indicate the fistula was used following placement, the fistula was assumed to have failed to mature. In order to be included in the analyses patients were required to have vascular access use data in CROWNWeb following the fistula placement. Time to maturation was determined using the date of fistula placement in claims data, and the date of first use in CROWNWeb data through the end of 2015, given that the exact time of fistula maturity is currently not determinable exclusively from CROWNWeb data. The percentage of fistula placements that failed was calculated as the number of failed placements over the total number of placements in 2014 among patients with vascular access use data in CROWNWeb. Patients who died following the fistula placement were included in the analysis.

In 2014, 33.8% of AV fistulas placed failed to be in use following placement, with a median of 114 days to first AV fistula use (Table 4.7), among those that were used. Younger patients tended toward higher maturation rates, with patients over age 75 displaying higher failure rates than the overall rate; the oldest patients had the longest median time to first AVF use (117 days) and the youngest patients had the shortest median time to first AVF use (108 days). Males had a higher maturation rate compared to females, and with a shorter time to first use. AV fistula placement failure rates among Native Americans and Asians were lower than the overall rate, while Blacks experienced higher failure rates.

vol 2 Table 4.7 Distribution of number of days between AV fistula placement and first successful use\*, overall and by patient characteristics, for new AV fistulas created in 2014 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2014-2015

	Total AV fistula placements	Percentage of failed placements	Number of days between AV fistula placement and first use			
			Average	Median	25 <sup>th</sup> percentile	75 <sup>th</sup> percentile
<b>Overall</b>	31,720	33.8	136	114	78	171
<b>Age</b>						
0-21	142	26.8	157	108	79	175
22-44	3,612	29.7	133	110	73	165
45-64	11,978	32.1	136	113	75	171
65-74	8,757	34.6	139	116	80	174
75+	7,231	37.7	136	117	81	169
<b>Race</b>						
Hispanic	1,641	26.8	132	108	75	162
<b>Non-Hispanic</b>						
White NH	17,885	33.4	137	115	79	171
Black/African American NH	10,336	36.3	137	114	74	175
Native American NH	384	29.9	128	118	76	158
Asian NH	1,076	28.6	130	110	75	162
Other/Unknown NH	398	28.4	141	116	74	184
<b>Sex</b>						
Male	17,962	29.6	130	110	76	162
Female	13,758	39.2	147	124	81	187
<b>Primary Cause of ESRD</b>						
Diabetes	14,679	34.0	138	116	78	174
Hypertension	9,609	34.1	134	114	78	168
Glomerulonephritis	2,816	31.9	131	107	71	162
Cystic kidney	530	28.7	135	113	71	170
Other urologic	482	34.0	131	111	73	157
Other cause	2,676	35.1	135	113	76	169
Unknown cause	928	32.0	147	117	77	185

Data Source: Special analyses, USRDS ESRD Database. \*With follow-up through the end of 2014; date of first use was the date the given access was first reported in CROWNWeb to be in use in a particular patient. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

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## Notes