

Chapter 3: Vascular Access

- In 2015, 80% of patients were using a catheter at hemodialysis (HD) initiation (Figure 3.1).
- At 90 days after the initiation of HD, 68.5% of patients were still using catheters. (Figure 3.7.a).
- Arteriovenous (AV) fistula use at HD initiation rose from 12% to 17% over the period 2005-2015 (Figure 3.1).
- The percentage of patients using an AV fistula or with a maturing AV fistula at HD initiation increased from 28.9% to 33.4% over the same period (Figure 3.1).
- Seventeen percent of patients used an AV fistula exclusively at dialysis initiation. This increased to 65% by the end of one year on HD, and to 72% by the end of two years (Figure 3.7.a).
- The proportion of patients with an AV graft for vascular access was 3% at HD initiation, 15% at one year after initiation, and 16% at two years (Figure 3.7.a).
- At one year after HD initiation, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter. By two years, this number rose to 88% (Figure 3.7.a).
- By May 2016, 62.7 % of prevalent dialysis patients were using an AV fistula (Figure 3.6).
- Of AV fistulas placed between June 2014 and May 2015, 35.9% of failed to mature sufficiently for use in dialysis. Of those that did mature, the median time to first use was 111 days (Table 3.7).
- Patient age is a factor contributing to success with AV fistula; with younger age, the percent of AV fistulas that successfully matured was higher and the median time to first use was somewhat shorter (Table 3.7).

Introduction

Clinical practice guidelines recommend an autogenous arteriovenous (AV) fistula as the preferred vascular access for hemodialysis (HD; National Kidney Foundation, 2006). Central venous catheters (hereafter, catheter[s]) have been associated with the highest risks of death, infection, and cardiovascular events, compared to other types of vascular access. Patients with a usable AV fistula exhibit the lowest risks for these events (Ravani et al., 2013). Interestingly, recent data suggests that the comorbidities collinear with the catheter, rather than direct complications, may be partially responsible for this difference (Ravani et al., 2017; Brown et al., 2017).

The international Dialysis Outcomes and Practice Patterns Study (DOPPS) highlighted the fact that with respect to vascular access, dialysis practices in the United States (U.S.) lagged behind other industrialized countries (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). Over the next decade, a gradual but steady increase in AV fistula placement efforts followed in the U.S., such that the proportion of prevalent HD patients using an AV fistula rose from 32% in 2003 to 63% by 2014 (USRDS, 2016).

A robust debate continues as to whether an AV fistula should remain the access of first choice for every dialysis patient, with recent attention paid to the length of time and effort AV fistula creation can consume in certain higher risk populations (Lee et al., 2015; Hall et al., 2017). An AV fistula is considered optimal because of its potential for durability, lower risk of infection, and reduced need for intervention to ensure patency. However, recent focus has shifted somewhat toward tailoring the most appropriate access for individual patients, based upon their clinical situation, patient characteristics, life expectancy, preference, and other factors. Further

prospective studies and clinical trials will determine whether this approach will indeed prove superior.

A landmark clinical trial where maturation of an AV fistula was a secondary outcome revealed the high prevalence of failure of newly placed fistulas never coming to use (Dember et al., 2008). Between primary surgical failures and maturation failures, 33.8% of AV fistula placements in the U.S. are unsuccessful (USRDS, 2016). Rigorous evaluation of the many potential factors underlying this phenomenon is necessary to ensure primary surgical success and subsequent optimal maturation of the AV fistula. In this regard, patients may benefit should surgical training programs further emphasize skill in AV fistula placement (Saran et al., 2008; Goodkin et al., 2010).

Many additional factors likely influence successful AV fistula placement, including patient motivation for access placement, timeliness of referrals for nephrology care and placement, and institutional and payer support for pre-ESRD care and coordination of dialysis access placement and maintenance. These suggest that a systematic, multilevel approach is required for ensuring optimal vascular access for every HD patient (Huber, 2015).

The above considerations and other salient issues make it imperative to track carefully and comprehensively the current and future trends in vascular access placements, related practices, and outcomes. Despite the emphasis on improving AV fistula success rates, at the time of their initial dialysis 80.3% of patients used a catheter (USRDS, 2016). Well-coordinated pre-dialysis care during the critical transition period to ESRD may be the key to future improvements in this suboptimal practice pattern.

In this chapter, we describe 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 national variation in time-to-first-use of AV fistulas after placement, as a surrogate for AV fistula maturation.

Methods

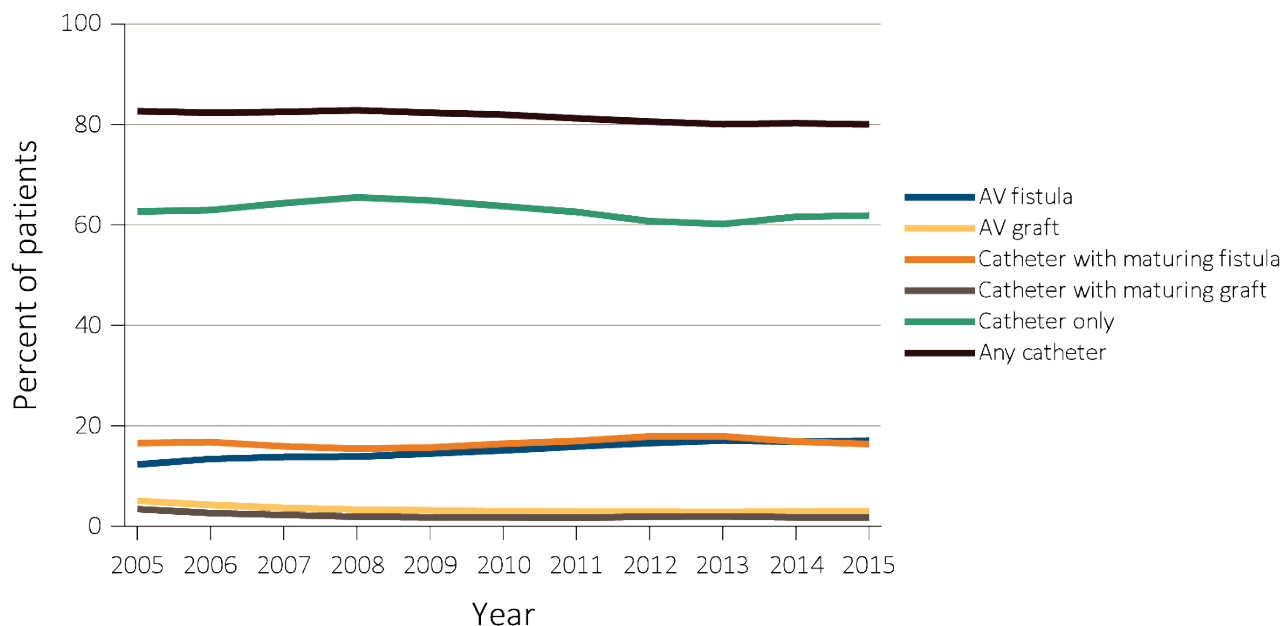
This chapter examines and reports data from the Centers for Medicare & Medicaid Services (CMS). Details of this data source are described in the [Data Sources](#) section of the [ESRD Analytical Methods](#) chapter.

See the Chapter 3 section of [Analytical Methods Used in the ESRD Volume](#) section of the [ESRD Analytical Methods](#) chapter for an explanation of the analytical methods used to generate the study cohorts, figures, and tables in this chapter. Downloadable Microsoft Excel and PowerPoint files containing the data and graphics for these figures and tables are available on the [USRDS website](#).

Vascular Access Use at Initiation of Hemodialysis

In 2015, 80% of patients were using a catheter at HD initiation, a rate that has changed only marginally since 2005. Figure 3.1 shows that in 2015, 61.9% of patients incident to ESRD had neither an AV fistula nor AV graft in place or maturing at their first outpatient HD session. This rate peaked at 65.5% in 2008, and has remained relatively stable since 2012 at near 60%. Over the last several years, there has been a relatively small absolute increase in AV fistula use at HD initiation, rising from 12.3% in 2005 to 17.0% in 2015. Over the same period, the percentage of patients with either an AV fistula or a maturing AV fistula increased from 28.9% to 33.4%.

vol 2 Figure 3.1 Vascular access use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2005-2015



Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2005-2015. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Table 3.1 shows dialysis access use at HD initiation, stratified by patient characteristics. The 0-21 year old age group had the highest percentage of catheter use at HD initiation (91.7%) and lowest percentage of AV fistula use (7.5%). Many of these patients were children who received a renal transplant relatively quickly, with HD serving as a bridge to transplantation, or those in the youngest age categories, who, being small, may have presented surgical challenges in creating an AV fistula. The 65-74 year age group had the highest percentage of patients with AV fistula use at HD initiation (18.7%), with slightly lower levels seen for individuals 75 years or older (17.0%) and those between 45-64 years (16.9%).

Patients of Hispanic ethnicity displayed both the lowest proportion of AV fistula use (14.8%) at HD initiation and the highest use of a catheter alone (65.2%). Blacks/African Americans displayed the highest proportion of AV graft use at HD initiation (4.5%) compared with 1.7% to 3.3% for individuals of other races or of Hispanic ethnicity.

Those with cystic kidney disease had higher rates of AV fistula use at HD initiation (40.2%), perhaps related to younger age at disease detection, slower progression of underlying CKD, earlier nephrology referral, more consistent pre-dialysis nephrology care, or relatively preserved vasculature.

vol 2 Table 3.1 Vascular access used at hemodialysis initiation by patient characteristics from the ESRD Medical Evidence form (CMS 2728), 2015

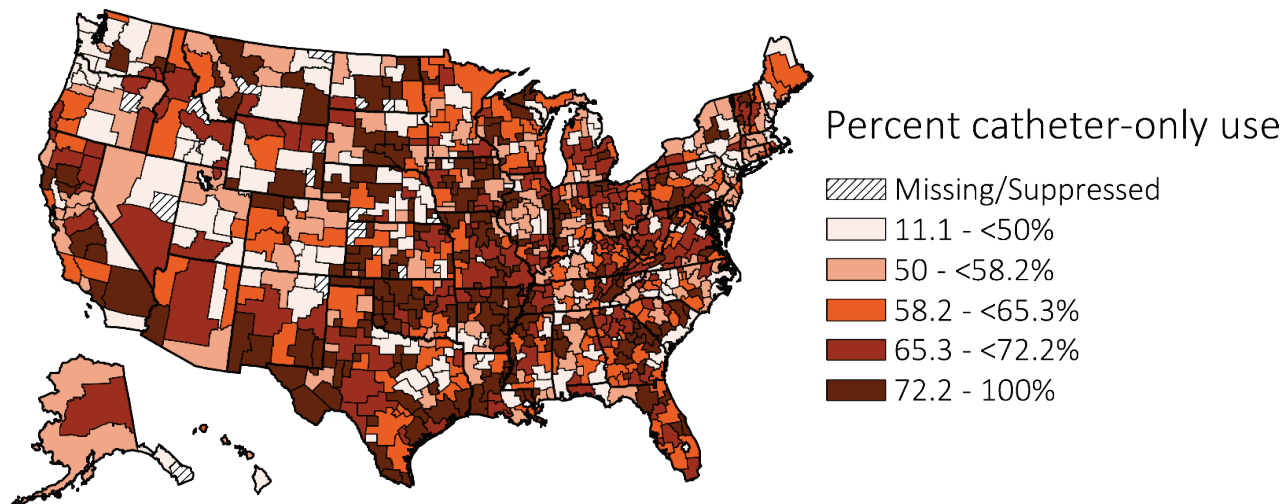
	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
All	17.0	3.0	16.4	1.8	61.9
Age					
0-21	7.5	0.8	9.2	0.6	81.9
22-44	13.5	1.9	16.2	1.7	66.6
45-64	16.9	2.6	17.6	1.7	61.2
65-74	18.7	3.4	16.5	1.8	59.6
75+	17.0	3.5	14.6	1.9	62.9
Sex					
Male	18.7	2.2	16.9	1.4	60.7
Female	14.6	4.0	15.6	2.2	63.5
Race					
White	17.4	2.4	16.2	1.5	62.6
Black/African American	15.5	4.5	16.4	2.5	61.1
American Indian or Alaska Native	19.1	1.7	22.7	0.8	55.8
Asian	20.3	3.3	16.5	1.6	58.3
Native Hawaiian or Pacific Islander	17.1	2.5	18.9	1.4	60.0
Ethnicity					
Hispanic	14.8	2.0	16.8	1.3	65.2
Non-Hispanic	17.4	3.2	16.3	1.8	61.3
Race/Ethnicity					
Non-Hispanic White	18.1	2.5	16.1	1.5	61.8
Non-Hispanic Black/African American	15.4	4.5	16.4	2.5	61.1
Primary Cause of ESRD					
Diabetes	17.8	3.1	18.8	1.9	58.4
Hypertension	17.2	3.2	15.5	1.9	62.2
Glomerulonephritis	18.4	2.6	14.0	1.5	63.6
Cystic kidney	40.2	4.8	15.5	1.4	38.1
Other urologic	13.5	2.5	13.1	1.4	69.5
Other cause	8.8	2.1	10.4	1.3	77.3
Unknown/Missing	12.8	1.9	12.1	1.2	72.0
Comorbidities					
Diabetes	16.9	3.0	17.8	1.9	60.3
Congestive heart failure	12.9	2.6	17.2	1.9	65.4
Atherosclerotic heart disease	16.2	3.1	18.6	1.9	60.1
Cerebrovascular disease	14.7	3.5	17.0	2.7	62.0
Peripheral vascular disease	15.1	2.9	18.3	2.2	61.5
Hypertension	17.6	3.1	16.8	1.8	60.8
Other cardiac disease	13.7	2.6	16.5	1.8	65.3

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

Figures 3.2 and 3.3 illustrate geographic variation by Health Service Area in the use of catheters alone or AV fistulas at HD initiation. Considerable variation occurred in both of these categorizations, even within individual states. New England, the Northwest, Utah,

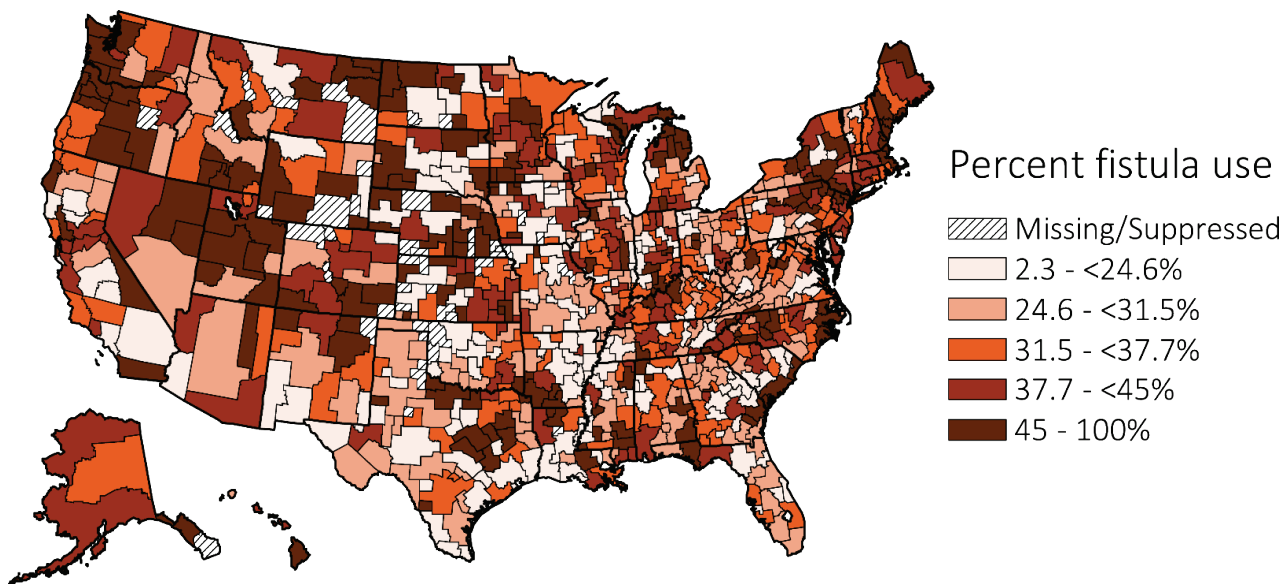
and parts of the East coast tended to have a lower percentage of catheter use and a higher percentage of AV fistula use at initiation. Some of the Central and Western mountain states also appeared to have a higher incidence of AV fistula use.

vol 2 Figure 3.2 Geographic variation in percentage of catheter-only use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2015



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

vol 2 Figure 3.3 Geographic variation in percentage of AV fistula use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2015



Special analyses, USRDS ESRD Database. AV fistula use includes not only AV fistulas, but also catheters with a maturing fistula. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Vascular Access Use among Prevalent Hemodialysis Patients

Table 3.2 shows patterns of access use among prevalent HD patients with ESRD for at least 90 days. By May 2016, 62.9% of these patients were using an AV fistula. In general, demographic variation was similar to the patterns observed for incident patients. Those in the 0-21 year old age group displayed the highest catheter use, while the 45-64 year group had the

lowest use. Blacks displayed the lowest AV fistula utilization but highest of an AV graft. Whites and non-Hispanic patients reported the highest catheter use. When examined by primary cause of ESRD, individuals 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 that observed in patients incident to dialysis (Table 3.1).

vol 2 Table 3.2 Distribution of type of vascular access in use among prevalent hemodialysis patients in 2016, from CROWNWeb data, May 2016

	AV fistula	AV graft	Catheter
All	62.9	17.7	19.4
Age			
0-21	45.6	5.7	48.6
22-44	64.5	14.8	20.7
45-64	64.9	16.8	18.4
65-74	62.3	18.5	19.1
75+	59.2	20.3	20.5
Sex			
Male	68.8	13.7	17.5
Female	55.2	23.0	21.9
Race			
White	65.6	13.8	20.6
Black/ African American	57.6	24.3	18.1
American Indian or Alaska Native	75.3	10.6	14.1
Asian	67.3	16.1	16.6
Native Hawaiian or Pacific Islander	67.3	15.3	17.4
Other or Multiracial	61.4	13.7	24.9
Ethnicity			
Hispanic	68.5	14.5	17.1
Non-Hispanic	61.7	18.4	19.9
Race/Ethnicity			
Non-Hispanic White	64.2	13.6	22.2
Non-Hispanic Black/African-American	57.6	24.4	18.0
Primary Cause of ESRD			
Diabetes	63.4	17.4	19.3
Hypertension	63.0	18.7	18.3
Glomerulonephritis	64.9	17.7	17.4
Cystic kidney	68.9	15.6	15.6
Other urologic	60.7	16.8	22.4
Other cause	56.5	16.6	26.9
Unknown/Missing	58.8	17.1	24.2

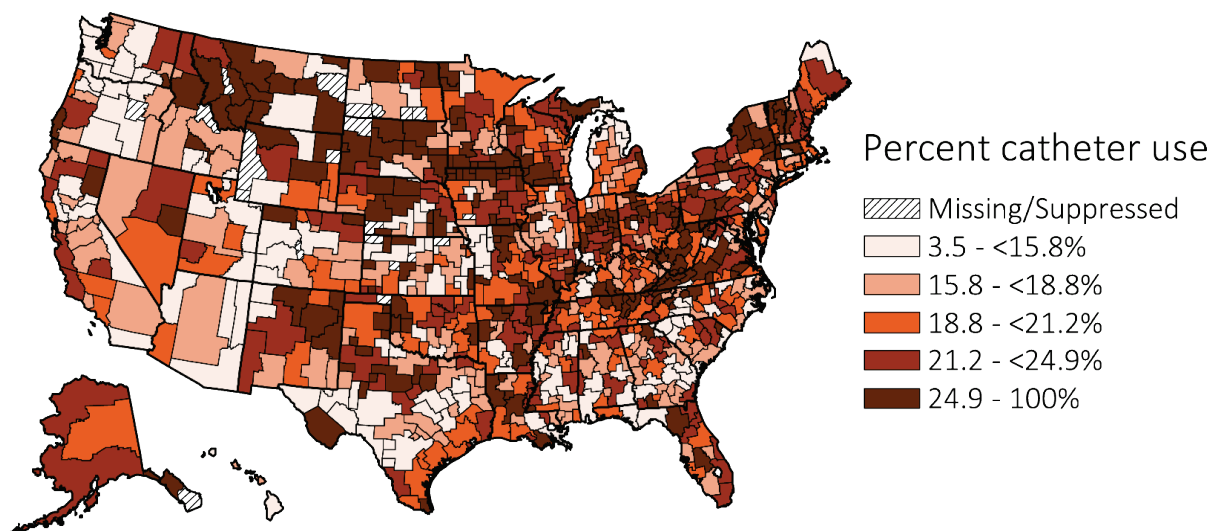
Data Source: Special analyses, USRDS ESRD Database. CROWNWeb data, catheter = any catheter use; fistula and graft use shown are without the use of a catheter. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; CROWNWeb, Consolidated Renal Operations in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

Figure 3.4 presents geographic variation of the proportion of prevalent HD patients using a catheter in 2016. Rates varied widely across the country. Clusters of high catheter utilization were evident in parts of Montana and northern Idaho, 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. In contrast, the Pacific

Northwest, parts of Georgia, and the mountainous portions of the Southwest exhibited lower catheter use.

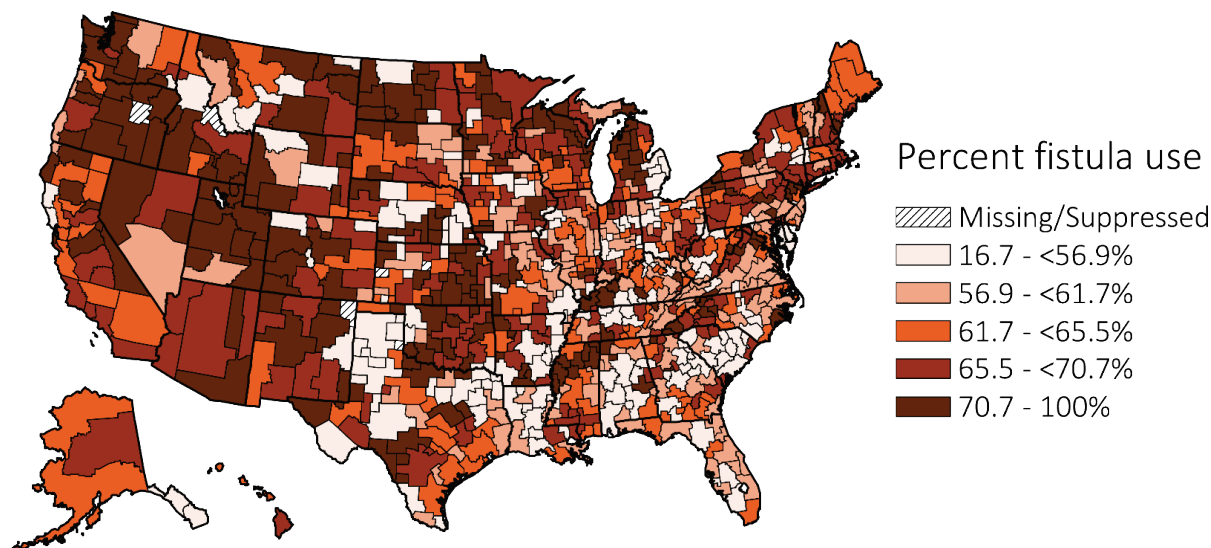
Figure 3.5 shows variation in AV fistula use among 2016 prevalent HD patients. While there were areas of greater than 70.8% utilization throughout the country, higher fistula use was most apparent in the western half. The deep South and the Texas Panhandle continued to have lower rates of fistula use.

vol 2 Figure 3.4 Geographic variation in percentage catheter use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, May 2016



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

vol 2 Figure 3.5 Geographic variation in percentage AV fistula use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, May 2016

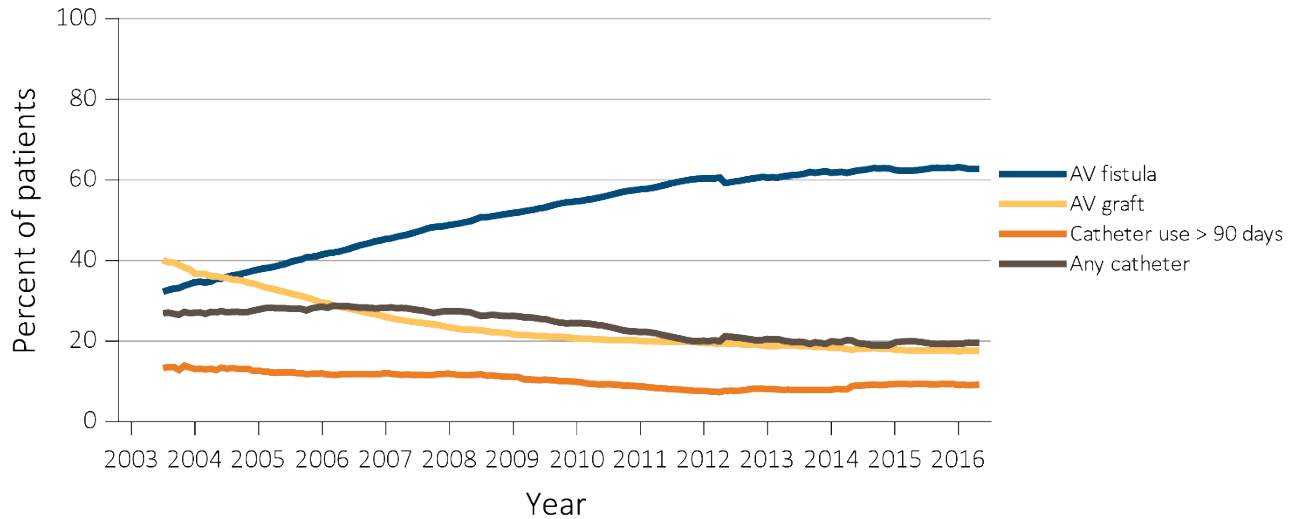


Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network.

Figure 3.6 displays trends in vascular access use among prevalent HD patients from 2003 to mid-2016. A large increase in AV fistula use has occurred since 2003, from 32% to 62.7% of patients; this has recently begun to plateau. In contrast, AV graft use has

decreased from 40% to 17.6% over the same period. Catheter use has had a complementary decline, decreasing from 27% to 19.5%. In 2016, only 9.2% of prevalent HD patients had been using a catheter for greater than 90 days.

vol 2 Figure 3.6 Trends in vascular access type use among ESRD prevalent patients, 2003-2016



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 May 2016. Abbreviations: AV, arteriovenous; CROWNWeb, Consolidated Renal Operations in a Web-enabled Network; ESRD, end-stage renal disease.

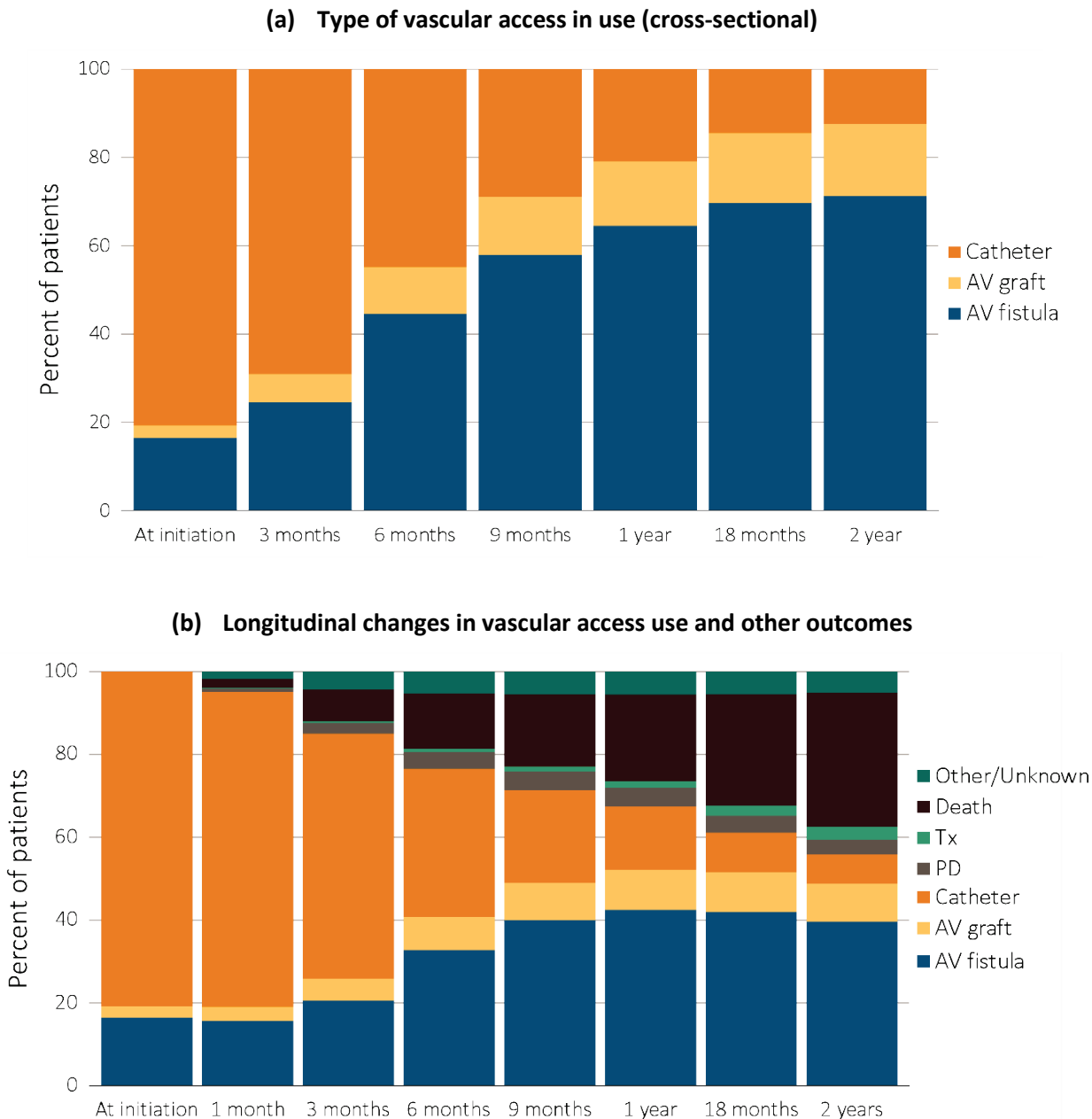
Change in Type of Vascular Access during the First Year of Dialysis

Figure 3.7.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 three, six, and nine months, and one year). At 90 days, the majority of HD patients were still using a catheter, highlighting the importance of ongoing efforts to improve access to pre-dialysis nephrology care and surgical access planning. Compared to 17% seen at HD initiation, the percentage of patients using an AV fistula exclusively at the end of one year on dialysis increased to 65%, and to 72% by the end of two years. The proportion of patients with an AV graft for vascular access was 3% at initiation, 15% at one year, and 16% at two years. Thus,

at one year, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter. At two years after HD initiation, this number rose to 88%.

Figure 3.7.b displays one-year longitudinal changes in vascular access use and other outcomes in the cohort of patients who initiated ESRD via HD in 2013. In the incident ESRD HD cohort, 80.1% of patients initiated HD using a central venous catheter. After 12 months, 43.1% were using an AV fistula, 9.7% were using an AV graft, and 15.2% were dialyzing with a catheter only. Of this cohort, 1.7% were living with a kidney transplant, 4.5% were receiving peritoneal dialysis, 20.8% had died, and 4.9% were classified as having an Other/Unknown outcome. Thus, much of the percentage increase in fistula use can be attributed to higher mortality among catheter users.

vol 2 Figure 3.7 Change in type of vascular access during the first year of dialysis among patients starting ESRD via hemodialysis in 2013 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, 2013-2016



Data Source: Special analyses, USRDS ESRD Database. Data from January 1, 2013 to May 30, 2016: (a) Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. (b) ESRD patients initiating hemodialysis (N =101,453). Patients with a maturing AV fistula / AV graft with a catheter in place were classified as having a catheter. 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 3.3 through 3.5 show cross-sectional distributions of vascular access use at several time points during the first year of HD 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. Contributing influences discussed earlier include different pediatric nephrology practice patterns, higher transplant rates, or anatomical challenges. AV graft use was higher in the 75+ age group both at initiation and at the end of one year. At one year, approximately 20% of persons in all age groups, except the 0-21 year old cohort, used catheters. This indicates that barriers remain in establishing surgical access, even after one year of dialysis therapy. As noted above, much of the decrease in catheter use can be attributed to mortality effects.

Black patients had the lowest proportion of AV graft use at initiation, one year, and two years. At one year, 20.0% of Black patients were using an AV graft compared to 14.4% of Asians and 12.3% of Whites. At initiation, one year, and two years, females had a higher proportion of AV graft use and males a higher proportion of AV fistula use. At one year, catheter use was highest in patients of other or multiple races, and females. For most adult patients, an AV fistula prevalence of 60% or higher was achieved by one year of HD. At one year, males and those of American Indian /Alaska Native race has the highest proportions of AV fistula use; females and Blacks had the lowest AV fistula proportion.

vol 2 Table 3.3 Cross-sectional distributions of vascular access use, quarterly during the first two years of hemodialysis, among patients new to hemodialysis in 2013, by age group, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2016

Age	Access type	Time						
		At initiation	3 months	6 months	9 months	1 year	18 months	2 years
0-21	AV fistula	7.7	12.9	31.7	45.4	50.4	59.9	58.5
	AV graft	0.6	0.8	2.5	3.3	3.5	3.5	4.9
	Catheter	91.7	86.4	65.8	51.3	46.0	36.6	36.6
22-44	AV fistula	13.5	22.5	44.6	59.6	67.2	73.0	74.6
	AV graft	1.8	4.3	7.5	9.5	10.8	12.3	13.0
	Catheter	84.7	73.2	47.9	31.0	22.0	14.7	12.4
45-64	AV fistula	17.3	25.3	46.1	60.1	67.1	72.6	74.1
	AV graft	2.6	5.5	9.2	11.7	13.2	14.4	15.0
	Catheter	80.1	69.2	44.7	28.2	19.7	13.0	10.9
65-74	AV fistula	18.6	27.1	46.6	59.1	65.5	70.7	72.0
	AV graft	3.1	6.9	11.0	13.5	15.0	16.2	16.8
	Catheter	78.3	66.1	42.4	27.4	19.4	13.1	11.2
75+	AV fistula	17.3	24.9	43.6	56.1	61.6	66.0	67.5
	AV graft	3.5	8.5	14.0	16.9	18.5	19.6	19.8
	Catheter	79.2	66.6	42.4	27.0	20.0	14.5	12.6

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.

vol 2 Table 3.4 Cross-sectional distributions of vascular access use, quarterly during the first two years of hemodialysis among patients new to hemodialysis in 2013, by race, from the ESRD Medical Evidence form (CMS-2728) and CROWNWeb, 2013-2016

Race/Ethnicity	Access type	Time						
		At initiation	3 months	6 months	9 months	1 year	18 months	2 years
White	AV fistula	17.6	26.0	47.0	60.7	67.6	72.9	74.5
	AV graft	2.3	5.4	8.9	11.1	12.3	13.3	13.5
	Catheter	80.1	68.6	44.1	28.3	20.2	13.9	12.0
Black/African American	AV fistula	15.5	22.5	40.0	52.6	58.7	63.9	65.5
	AV graft	4.2	8.9	14.7	18.0	20.0	21.7	22.4
	Catheter	80.3	68.6	45.2	29.3	21.3	14.4	12.1
American Indian or Alaska Native	AV fistula	15.0	26.0	53.6	70.1	77.3	82.3	84.0
	AV graft	2.2	4.3	6.2	6.7	8.0	7.8	8.9
	Catheter	82.9	69.7	40.2	23.2	14.7	9.9	7.2
Asian	AV fistula	20.1	29.1	51.5	64.5	70.4	75.8	76.6
	AV graft	2.8	7.0	10.3	12.5	14.4	14.6	15.0
	Catheter	77.1	63.9	38.2	23.0	15.3	9.7	8.3
Native Hawaiian or Pacific Islander	AV fistula	18.6	28.5	48.8	61.3	69.7	77.1	77.2
	AV graft	2.3	4.5	6.1	9.2	10.2	11.2	13.3
	Catheter	79.0	67.1	45.1	29.5	20.1	11.7	9.5
Other or Multiracial	AV fistula	16.0	11.9	38.8	55.6	61.5	60.0	60.9
	AV graft	4.0	6.0	3.8	4.9	5.1	6.7	15.6
	Catheter	80.0	82.1	57.5	39.5	33.3	33.3	23.4
Hispanic	AV fistula	14.5	23.1	45.0	60.5	67.8	73.9	75.6
	AV graft	1.9	4.7	8.5	10.6	11.9	13.4	13.7
	Catheter	83.7	72.2	46.5	28.9	20.3	12.7	10.7
Non-Hispanic	AV fistula	17.6	25.5	45.2	58.1	64.5	69.6	71.0
	AV graft	3.0	6.7	11.0	13.6	15.2	16.4	17.0
	Catheter	79.4	67.7	43.8	28.3	20.3	14.1	12.0
Non-Hispanic White	AV fistula	18.5	26.9	47.6	60.7	67.4	72.4	74.0
	AV graft	2.4	5.6	9.1	11.2	12.4	13.2	13.5
	Catheter	79.1	67.5	43.4	28.0	20.1	14.4	12.5
Non-Hispanic Black/African American	AV fistula	15.5	22.4	40.0	52.6	58.7	63.9	65.5
	AV graft	4.2	9.0	14.8	18.1	20.0	21.7	22.5
	Catheter	80.3	68.5	45.2	29.3	21.3	14.4	12.0

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 3.5 Cross-sectional distributions of vascular access use, quarterly during the first two years of hemodialysis among patients new to hemodialysis in 2013, by sex, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2016

Sex	Access type	Time						
		At initiation	3 months	6 months	9 months	1 year	18 months	2 years
Male	AV fistula	18.7	28.5	50.9	65.0	71.4	76.3	77.7
	AV graft	2.1	4.9	8.0	9.9	11.0	11.9	12.3
	Catheter	79.2	66.7	41.1	25.2	17.6	11.8	10.0
Female	AV fistula	14.9	20.6	37.6	49.9	56.7	62.3	64.0
	AV graft	3.8	8.5	14.1	17.5	19.4	21.1	21.9
	Catheter	81.3	70.9	48.4	32.7	23.9	16.6	14.2

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 the rate of use at initiation continues to lag. There are many possible contributors to these trends, including access to primary and/or nephrology care, disparities in health-care access, difficulty with AV fistula maturation in specific patient groups such as elderly diabetics or those with limited transportation or financial incentives, and the wide variation in provider expertise in creating AV fistulas. The following figures and tables examine associations between clinical and patient characteristics and successful surgical access use, for both AV fistula and AV fistula/AV graft use, at initiation of HD.

Table 3.6 examines the influence of patient characteristics and factors such as length of pre-ESRD care and specific ESRD network of residence. At HD initiation, Asians had the highest odds of AV fistula use, while both Asians and Blacks had the highest odds of an AV fistula or AV graft surgical access in use. Females were less likely to be using an AV fistula/AV graft at initiation.

ESRD Network 16 (Alaska, Idaho, Montana, Oregon, and Washington) displayed the highest odds of patients using an AV fistula and higher odds of AV fistula or AV graft use at HD initiation. ESRD Networks 15 (Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming) and 17 (American Samoa, Guam, Mariana Islands, Hawaii, and Northern California) had outcomes approaching that of ESRD Network 16. Patients with ESRD secondary to diabetes were less likely to use an AV fistula or AV graft at HD initiation compared to patients for whom the primary cause of ESRD was not diabetes. Note that 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 3.6 Odds ratios and 95% confidence intervals from logistic regression models of AV fistula use at hemodialysis initiation, and AV fistula or graft use at hemodialysis initiation, from the CMS 2728, 2015

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
Pre-ESRD nephrology care						
0 months	0.06	0.05	0.06	0.07	0.06	0.07
>0 - <6 months	0.30	0.28	0.32	0.32	0.30	0.33
6 - 12 months	0.62	0.59	0.64	0.64	0.61	0.66
>12 months	Ref			Ref		
Unknown	0.19	0.18	0.20	0.19	0.18	0.21
Age						
0-21	0.34	0.26	0.46	0.32	0.24	0.42
22-44	0.87	0.81	0.93	0.83	0.78	0.88
45-64	Ref			Ref		
65-74	1.03	0.99	1.08	1.08	1.04	1.13
75+	0.88	0.84	0.92	0.95	0.91	1.00
Sex						
Female	0.71	0.69	0.74	0.83	0.81	0.86
Male	Ref			Ref		
Race						
White	Ref			Ref		
Black/African American	0.99	0.94	1.03	1.18	1.13	1.22
American Indian or Alaska Native	0.97	0.81	1.15	0.94	0.79	1.12
Asian	1.09	1.00	1.19	1.12	1.02	1.22
Native Hawaiian or Pacific Islander	0.95	0.81	1.12	0.95	0.81	1.11
Other or Multiracial	0.97	0.70	1.33	0.97	0.71	1.31
Ethnicity						
Hispanic	0.98	0.93	1.04	0.97	0.92	1.02
Non-Hispanic	Ref			Ref		
Diabetes as cause of ESRD						
	0.97	0.94	1.01	0.98	0.95	1.01
Facility census						
< 20	Ref			Ref		
20-50	0.95	0.92	0.99	0.94	0.90	0.97
51-100	0.83	0.77	0.89	0.80	0.75	0.86
101-200	0.22	0.11	0.46	0.37	0.23	0.62
>200	0.21	0.10	0.44	0.16	0.08	0.33
ESRD network (vs. average network)						
1 CT, ME, MA, NH, RI, VT	1.20	1.10	1.29	1.19	1.10	1.28
2 NY	1.12	1.05	1.19	1.11	1.04	1.18
3 NJ, PR, VI	0.87	0.80	0.95	0.86	0.80	0.93
4 DE, PA	1.01	0.94	1.09	1.01	0.94	1.09
5 VA, WV, MD, DC	0.92	0.86	0.99	0.90	0.84	0.96
6 GA, NC, SC	1.02	0.96	1.08	0.97	0.92	1.03
7 FL	0.74	0.69	0.79	0.74	0.69	0.79
8 AL, MS, TN	1.00	0.93	1.08	1.04	0.98	1.12
9 IN, KY, OH	0.94	0.89	1.00	0.93	0.88	0.99
10 IL	0.90	0.83	0.98	0.97	0.90	1.05
11 MN, MI, ND, SD, WI	0.94	0.88	1.01	0.91	0.85	0.97
12 IA, KS, MO, NE	0.80	0.73	0.88	0.81	0.74	0.88
13 AR, LA, OK	1.04	0.96	1.13	0.99	0.92	1.07
14 TX	0.76	0.71	0.81	0.77	0.73	0.82
15 AZ, CO, NV, NM, UT, WY	1.26	1.17	1.35	1.21	1.13	1.30
16 AK, ID, MT, OR, WA	1.36	1.25	1.48	1.38	1.27	1.50
17 AS, GU, MP, HI, Northern CA	1.29	1.20	1.39	1.37	1.28	1.47
18 Southern CA	1.10	1.03	1.18	1.12	1.05	1.19

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; CMS 2728, CMS ESRD Medical Evidence form 2728; ESRD, end-stage renal disease.

Of AV fistulas placed between June 2014 and May 2015, 35.9% failed to mature sufficiently for use in dialysis. Of those that matured and were eventually used, the median time to first use was 111 days (Table 3.7). Younger patients tended toward higher maturation rates, with patients over age 75 displaying higher failure rates than the overall. Patients aged 65-74 had the longest median time to first AV fistula use (116 days) while patients aged 0-21 and 22-44 had the shortest (106 days). Males had a higher maturation rate compared to females, and a shorter time to first use. AV fistula placement failure rates were lower than the overall rate among American Indians/Alaska Natives, Native Hawaiians/Pacific Islanders, Asians, and those of Unknown race, while Blacks and those of Other/Multiracial race experienced higher failure rates.

Timely fistula maturation continues to be an area of central interest for the dialysis community. While AV fistula utilization among prevalent HD patients has improved (Figure 3.6), the proportion of patients using a dialysis catheter at incidence of ESRD remains stubbornly high (Figure 3.1). 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). Such complications limit future access patency and can result in poor long-term patient outcomes (Pisoni et al., 2009). Observational data suggest that central venous catheter use is associated with higher

mortality (Powe et al., 1999). While the exact cause of this risk is difficult to discern, there is potentially greater risk for sepsis from the foreign body itself, from resulting biofilm or chronic thrombus formation, or other such mechanisms—some of which can persist after catheter removal.

While AV grafts are ready for use sooner and more reliably than fistulas, they require more procedures to assure their long-term patency. They are associated with a higher frequency of other complications that can significantly affect 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 to this choice of conduit. Furthermore, the premature placement of an AV graft may limit access options in the future (NKF, 2006)—a significant concern for those with longer life expectancy.

Currently 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. Recent studies, however, suggest a benefit in more liberal use of AV grafts in specific populations (Lee et al., 2015; Hall et al., 2017; Woo et al., 2017). Furthermore, conversion from a catheter to a permanent vascular access of either type has a demonstrated association with better patient outcomes (Bradbury et al., 2009).

vol 2 Table 3.7 Distribution of number of days between AV fistula placement and first successful use*, overall and by patient characteristics, for new AV fistulas created in 2014-2015 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2014-2016

	Total AV fistula placements	Percentage of failed placements	Number of days between AV fistula placement and first use			
			Average	Median	25 th percentile	75 th percentile
Overall	43,530	35.9	132	111	75	166
Age						
0-21	167	29.3	137	106	75	159
22-44	5,011	31.5	130	106	69	162
45-64	16,284	34.0	131	109	73	167
65-74	12,297	36.7	136	116	79	169
75+	9,771	40.3	130	112	77	163
Race						
White	26,881	35.1	132	112	77	165
Black/African American	13,973	38.5	133	111	71	170
American Indian or Alaska Native	592	30.4	137	115	81	165
Asian	1,450	29.4	124	108	69	152
Native Hawaiian or Pacific Islander	458	31.9	131	110	72	180
Other or Multiracial	128	34.4	116	97	27	156
Unknown	27	29.6	167	143	54	228
Ethnicity						
Hispanic	6,211	31.4	128	108	75	158
Non-Hispanic	37,192	36.6	133	113	75	168
Race/Ethnicity						
Non-Hispanic White	20,937	36.2	133	113	78	167
Non-Hispanic Black/African American	13,776	38.4	133	111	71	170
Sex						
Male	24,495	34.8	113	104	71	144
Female	18,654	46.9	123	112	75	161
Primary Cause of ESRD						
Diabetes	20,308	36.0	135	113	77	169
Hypertension	13,312	36.1	131	111	75	164
Glomerulonephritis	3,852	33.1	126	105	68	160
Cystic kidney	710	32	128	109	69	162
Other urologic	625	34.9	124	107	66	156
Other cause	3,631	38.8	131	110	74	164
Unknown cause	1,092	34.6	131	108	70	165

Data Source: Special analyses, USRDS ESRD Database. *Fistulas placed between June 1, 2014 and May 31, 2015, with follow-up through the June 2016; 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