Chapter 4: Vascular Access

- 80.2% of patients were using a catheter at hemodialysis initiation in 2013, which has changed little since 2005.
- At 90 days after initiation of dialysis, 68.3% of hemodialysis patients were still using a catheter in 2013.
- Between 2005-2013, AV fistula use at hemodialysis initiation rose from 12% to 17.1%.
- The percentage of patients with either an AV fistula or a maturing AV fistula has increased from 28.9% to 35.1%, over the same period.
- By December 2013, 62.5 % of prevalent dialysis patients were using an AV fistula.
- The percentage of patients using an AV fistula exclusively at the end of 1 year on hemodialysis was 65%, up from 17% at initiation.
- The proportion of patients with an AV graft for vascular access was 3% at hemodialysis initiation, and 15% at 1 year after initiation.
- At 1 year after hemodialysis initiation, 80% of patients were using either an AV fistula or AV graft without the presence of a catheter.
- Asians have the highest odds of successful AV fistula use at hemodialysis initiation. Both Asians and Blacks have the highest odds of AV fistula or AV graft use at hemodialysis initiation. Females are less likely than males to be using an AV fistula/AV graft at initiation.
- In 2013, 35.9% of AV fistulas placed failed to be in use following placement, with a mean of 135 days to first AV fistula use.
- Younger patients tended toward higher maturation rates, with patients over 75 years old displaying higher failure rates than the overall rate, with the oldest and youngest age categories having longer times to first AV fistula use.

Introduction

For the first time, the USRDS devotes an entire chapter of this year's ADR to the critically important topic of vascular access for hemodialysis patients, previously covered in *Chapter 3: Clinical Indicators and Preventive Care*. In addition, monthly CROWNWeb data on type of vascular access in use is being reported for the first time in the ADR for all dialysis patients in the United States; not just those with Medicare claims. For details on CROWNWeb, see the *ESRD Analytical Methods* chapter. 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 a total of 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 associated with the lowest risk (Ravani et al., 2013).

The international Dialysis Outcomes and Practice Patterns Study (DOPPS) brought much needed attention to vascular access practices around the world and 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 by the Health Care

Financing Administration (HCFA) (now the Centers for Medicare & Medicaid [CMS]), which was later renamed the Fistula First Breakthrough Initiative (FFBI). 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 with AV fistula rose from 32% in 2003 to 62% by 2013.

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, 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 more robust prospective studies/clinical trials, which will most likely be challenging to conduct.

A landmark clinical trial where maturation of an AV fistula was a secondary outcome, revealed the high prevalence of failure of newly place fistulae ever coming to use (Dember et al., 2008). This topic remains of high interest to the nephrology community (Riella, et al., 2013) and led to the NIDDK funded Fistula Maturation Study (Dember et al., 2014) designed to study this phenomenon further. Between primary surgical failures and maturation failures, 30-50% of AV fistula placements in the United States are unsuccessful (Table 4.9). 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, could be ensured. In this regard, greater emphasis on AV fistula placement during surgical training may need to be prioritized (Saran et al., 2008; Goodkin et al., 2010) in the United States.

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.

All of the above considerations make it imperative to comprehensively and carefully track vascular access placements and 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 initial dialysis 80% of patients are using a catheter. Improvements in 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.

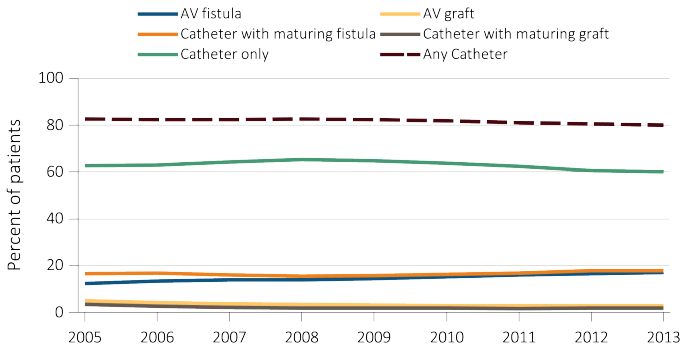
Analytical Methods

See the ESRD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Vascular Access Use at Initiation of Hemodialysis

Figure 4.1 shows that, in 2013, at their first outpatient hemodialysis session, 60.2% of patients with incident ESRD used a catheter alone for vascular access. This peaked at 65.4%, earlier in 2008, and has been declining since then. However, if patients using a catheter who also had a maturing AV fistula or AV graft are included in this group, a total of 80.2% of patients were using a catheter at hemodialysis initiation in 2013, which has changed little since 2005. Over the last seven years, there has been an increase in AV fistula use at hemodialysis initiation, rising from 12% in 2005 to 17.1% in 2013. The percentage of patients with either an AV fistula or a maturing AV fistula has increased from 28.9% to 35.1%, over the same period.

vol 2 Figure 4.1 Vascular access use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2005-2013

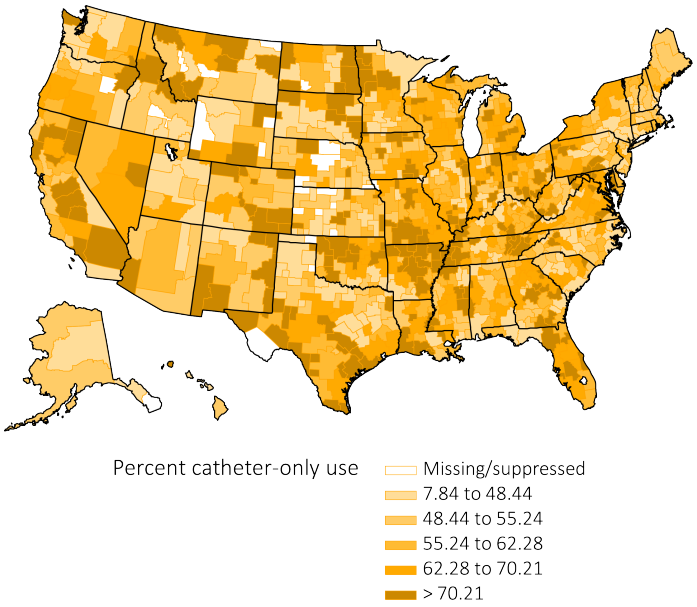


Data Source: Special analyses, USRDS ESRD Database. ESRD patients initiating hemodialysis in 2005-2013. Abbreviations: AV, arteriovenous; CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

Table 4.1 shows dialysis access use at hemodialysis initiation stratified by patient characteristics. The 0-21 year old age group has the highest percentage of catheter use at hemodialysis initiation (92%) and lowest percentage of AV fistula use/AV fistula maturing (17.5%). Many of these pediatric patients receive a renal transplant relatively quickly, with hemodialysis serving as a bridge to transplantation. Furthermore, patients in these youngest age groups often may not be suitable candidates for AV fistula creation due to anatomical challenges. The 65-74 year age group had the highest percentage of patients with AV fistula use/AV fistula maturing at hemodialysis initiation (37%) with slightly lower levels of 33% and 36% AV fistula use/AV fistula maturing seen for individuals >74 years old and 45-64 years old, respectively. Patients of Hispanic ethnicity displayed the lowest proportion with AV fistula being used or maturing (29%) at hemodialysis initiation and the highest catheter alone use (68%). Blacks/African Americans displayed the highest proportion of AV graft use/AV graft maturing at hemodialysis initiation (7%) compared with 2.6% to 4.7% for individuals of other races or of Hispanic ethnicity. Those with cystic kidney disease had higher rates of AV fistula use/AV fistula maturing at hemodialysis initiation (59%), perhaps related to younger age at disease detection, slower progression of underlying CKD, and relatively preserved vasculature.

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 catheters use and a higher percentage of AV fistula use at initiation. Some of the Central and Western mountain states appear to have a lower prevalence 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), 2013



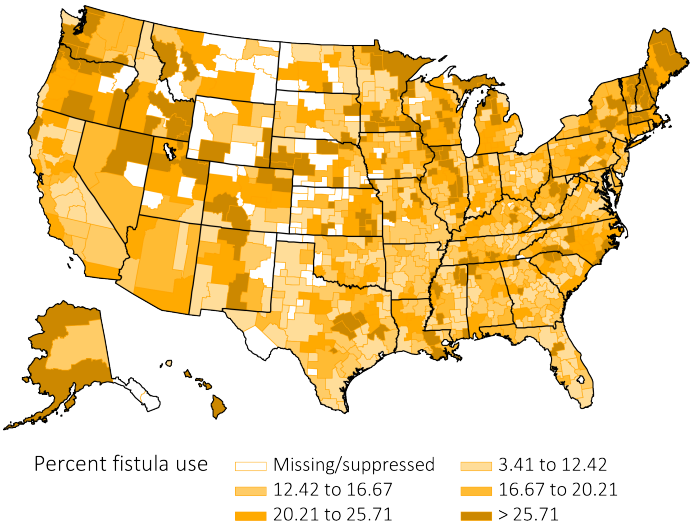
Data Source: Special analyses, USRDS ESRD Database. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

vol 2 **Table 4.1 Vascular access used at hemodialysis initiation by patient characteristics from the ESRD Medical Evidence form (CMS 2728), 2013**

	AV fistula	AV graft	Catheter with maturing fistula	Catheter with maturing graft	Catheter only
All	17.1	2.8	18.0	2.0	60.2
Age					
0-21	7.6	0.6	9.9	1.0	80.9
22-44	13.2	1.9	18.3	1.6	65.0
45-64	17.1	2.6	19	1.7	59.5
65-74	18.6	3.0	18.4	2.1	57.9
75+	17.3	3.5	16.1	2.3	60.8
Sex					
Male	18.7	2.1	18.4	1.6	59.2
Female	14.9	3.8	17.4	2.4	61.4
Race					
White	17.9	2.3	17.6	1.7	60.5
Black/African American	15.5	4.2	18.5	2.7	59.0
Native American	14.9	2.8	25	1.4	55.9
Asian	20.0	2.9	19.3	1.8	56.0
Ethnicity					
Hispanic	12.4	1.2	16.7	1.4	68.3
Primary Cause of ESRD					
Diabetes	17.7	2.9	20.9	2.0	56.4
Hypertension	17.5	3.2	16.6	2.0	60.6
Glomerulonephritis	18.6	2.3	16.5	1.8	60.7
Cystic Kidney	43.6	4.0	15.2	1.5	35.8
Other Urologic	14.2	3.3	14.4	2.1	66.0
Other Cause	9.2	1.8	11.5	1.7	75.9
Unknown/Missing	11.1	2.4	13.9	2.0	70.5
Comorbidities					
Diabetes	16.8	2.9	19.8	2.0	58.5
Congestive heart failure	13.3	2.4	19.3	2.2	62.8
Atherosclerotic heart disease	17	2.6	20.6	2.1	57.7
Cerebrovascular disease	15	3.4	18.9	2.5	60.2
Peripheral vascular disease	14.8	2.5	20.8	2.1	59.7
Hypertension	17.8	2.9	18.4	2.0	58.9
Other cardiac disease	14.5	2.4	17.9	2.1	63.1

Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; 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), 2013**



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 ≥90 days). By December 2013 62.5% 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 age group has 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 between patient categories were less compared with what was observed in patients new to dialysis (Table 4.1).

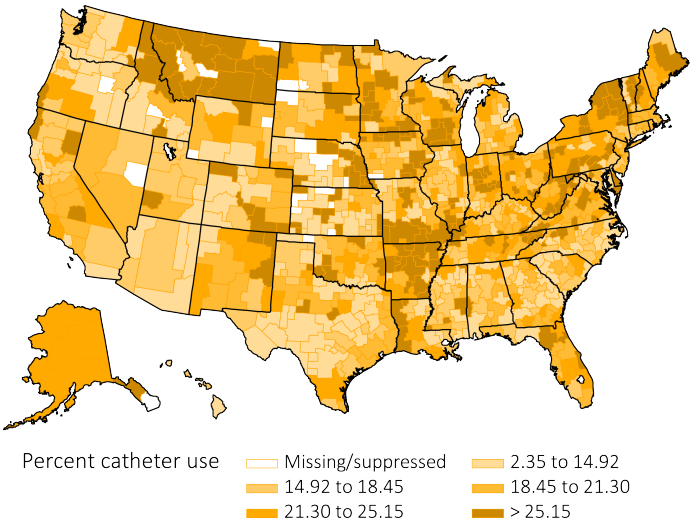
vol 2 **Table 4.2 Distribution of type of vascular access in use among prevalent hemodialysis patients in 2013, from CROWNWeb data, December 2013**

	AV fistula	AV graft	Catheter
All	62.5	18.4	19.2
Age			
0-21	47.0	6.8	46.1
22-44	64.8	15.7	19.6
45-64	64.2	17.7	18.1
65-74	61.9	19.3	18.8
75+	58.7	20.4	20.9
Sex			
Male	68.7	14.2	17.1
Female	54.5	23.7	21.8
Race			
White	64.3	13.6	22.1
Black/African American	56.9	25.4	17.7
Native American	73.3	12.1	14.6
Asian	67.2	16.7	16.1
Ethnicity			
Hispanic	67.5	15.4	17.1
Primary Cause of ESRD			
Diabetes	62.7	18.2	19.1
Hypertension	61.9	19.3	18.8
Glomerulonephritis	64.8	18.1	17.2
Cystic Kidney	69.5	16.9	13.7
Other Urologic	61.9	17.6	20.4
Other Cause	57.5	17.2	25.3
Unknown/Missing	61.4	17.6	21.0

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; ESRD, end-stage renal disease.

Figure 4.4, shows the geographic variation in proportion of patients using catheter among prevalent hemodialysis patients in the United States in 2013. Significant variation was observed across the country. Pockets of high catheter utilization are evident in most of Montana and upper Idaho (in contrast to the Pacific Northwest), and in southern Missouri, two-thirds of Arkansas, and northeastern upstate New York.

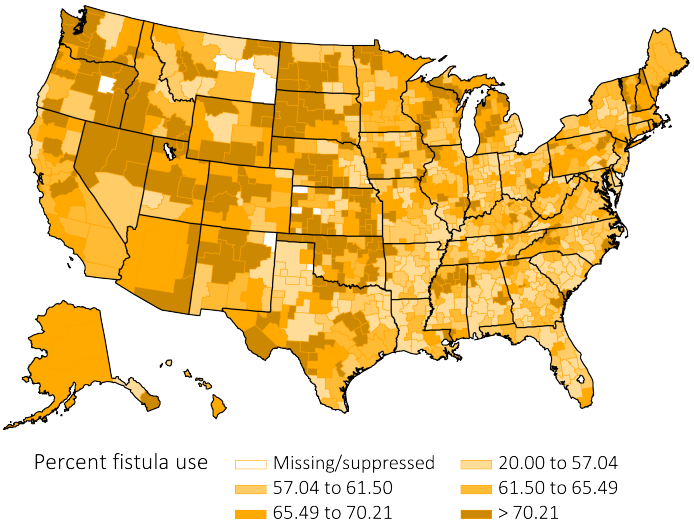
vol 2 Figure 4.4 Geographic variation in percentage catheter use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2013



Data Source: Special analyses, USRDS ESRD Database. Abbreviation: ESRD, end-stage renal disease.

Figure 4.5 shows variation in fistula use among prevalent hemodialysis patients in the United States in 2013. While there are pockets where there is higher than 70% utilization of AV fistula among prevalent hemodialysis patients throughout the country, fistula use is more apparent in the western half of the country.

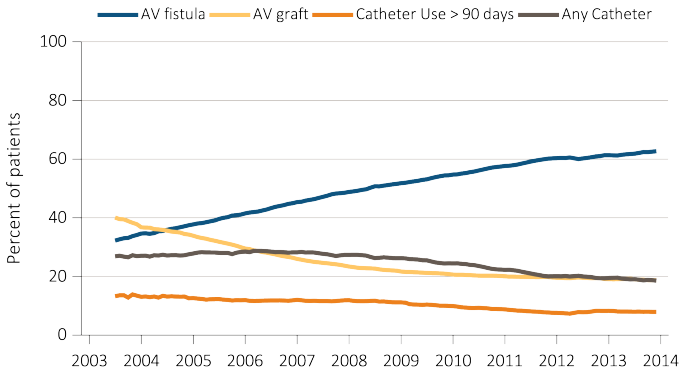
vol 2 Figure 4.5 Geographic variation in percentage AV fistula use among prevalent hemodialysis patients by Health Service Area, from CROWNWeb data, December 2013



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

Figure 4.6 displays trends in vascular access use among prevalent hemodialysis patients from 2003-2013. There has been a large rise in AV fistula use and AV fistula placement since 2003, with use increasing from 32% to nearly 63% and placement increasing from 38% to 66% of patients, respectively. In contrast, AV graft use has decreased from 40% to 19% over the same time period. Catheter use has also declined, albeit not as dramatically, decreasing from 27% to 19%. In 2013, only 8% 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

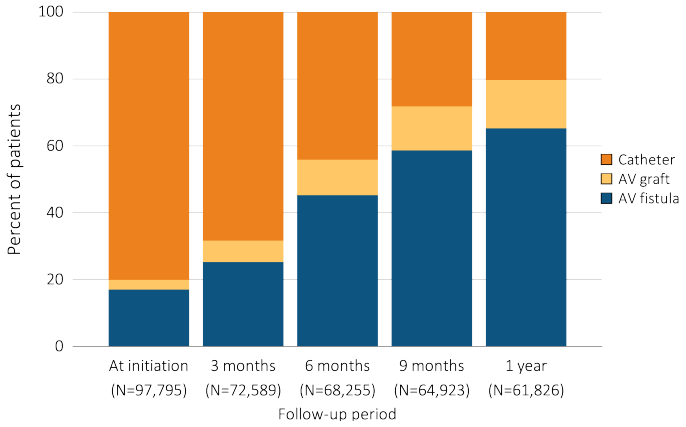


Data Source: Special analyses, USRDS ESRD Database, and Fistula First data. Fistula First data reported from July 2003 through April 2012, CROWNWeb data are reported from June 2012 through December 2013. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

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

Figure 4.7 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% at initiation of hemodialysis. 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.

vol 2 Figure 4.7 Vascular access use during the first year of hemodialysis by time since initiation of ESRD treatment, among patients new to hemodialysis in 2013, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb data, 2013-2014



Data Source: Special analyses, USRDS ESRD Database. Medical Evidence form (CMS 2728) at initiation and CROWNWeb for subsequent time periods. Abbreviations: CMS, Centers for Medicare & Medicaid; ESRD, end-stage renal disease.

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 gender. Catheter use is most common at initiation and at the end of one year in the 0-21 year old age group for reasons discussed above (higher transplant rates, anatomical challenges). AV graft use is higher in the 75+ age group both at initiation and at the end of 1 year. At 1 year, catheter use of approximately 20% is seen in all age groups, except the 0-21 year old cohort, indicating barriers still remain in establishing surgical access, even after 1 year. Black patients have the highest proportion of AV graft in use, both at initiation and at 1 year. At one year, 19.8% of Black patients had an AV graft in use compared to 13.5% of Asians and 12.2% 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 one year. Catheter use was highest in patients of other/unknown race and females at 1 year. For most adult patient age groups, over 60% higher fistula prevalence is achieved by one year on hemodialysis. At one 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.

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 CMS geographic regions (http://www.cms.gov/About-CMS/Agency-Information/RegionalOffices/RegionalMap.html). Asians have the highest odds of successful 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. Region 10 (Northwest) 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.

vol 2 **Table 4.3 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by age group, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2014**

Age group	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
0-21	**AV fistula**	7.5	13.4	31.9	46.0	50.6
	AV graft	0.6	0.6	2.3	2.9	3.1
	Catheter	91.8	86.0	65.8	51.2	46.3
22-44	**AV fistula**	13.3	22.4	44.6	59.5	67.2
	AV graft	1.9	4.4	7.6	9.4	10.8
	Catheter	84.8	73.2	47.9	31.1	22.0
45-64	**AV fistula**	17.2	25.3	46.1	60.2	67.1
	AV graft	2.6	5.5	9.1	11.6	13.1
	Catheter	80.2	69.2	44.8	28.3	19.8
65-74	**AV fistula**	18.7	27.1	46.7	59.1	65.6
	AV graft	3.0	6.9	11.0	13.5	15.0
	Catheter	78.3	66.1	42.3	27.4	19.5
75+	**AV fistula**	17.4	24.9	43.6	56.1	61.5
	AV graft	3.5	8.5	14.0	16.9	18.5
	Catheter	79.1	66.6	42.4	27.1	20.0

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; ESRD, end-stage renal disease.

vol 2 **Table 4.4 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by race, from the ESRD Medical Evidence form (CMS-2728) and CROWNWeb, 2013-2014**

Race	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Native American	**AV fistula**	14.7	25.5	53.3	70.0	77.1
	AV graft	2.2	4.3	6.1	6.9	8.1
	Catheter	83.1	70.2	40.6	23.2	14.8
Asian	**AV fistula**	20.2	29.4	51.6	64.3	70.5
	AV graft	2.8	6.5	9.4	11.8	13.5
	Catheter	77.0	64.1	39.0	23.9	16.0
Black	**AV fistula**	15.4	22.5	40.1	52.8	58.8
	AV graft	4.2	8.9	14.7	17.9	19.8
	Catheter	80.4	68.5	45.3	29.3	21.4
White	**AV fistula**	17.7	26.2	47.2	61.0	67.8
	AV graft	2.3	5.4	8.9	11.0	12.2
	Catheter	80.0	68.4	43.9	28.0	20.0
Other/Unknown	**AV fistula**	16.5	12.3	39.5	57.3	62.5
	AV graft	4.1	6.2	2.6	4.0	5.6
	Catheter	79.3	81.5	57.9	38.7	31.9

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; ESRD, end-stage renal disease.

vol 2 **Table 4.5 Cross-sectional distributions of vascular access use during the first year of hemodialysis therapy among patients new to hemodialysis in 2013, by sex, from the ESRD Medical Evidence form (CMS 2728) and CROWNWeb, 2013-2014**

Sex	Access type	Time				
		At initiation	3 months	6 months	9 months	1 year
Male	AV fistula	18.8	28.6	51.0	65.1	71.5
	AV graft	2.1	4.9	8.0	9.9	11.0
	Catheter	79.1	66.5	41.0	25.0	17.5
Female	AV fistula	15.0	20.8	37.9	50.2	56.9
	AV graft	3.8	8.6	14.0	17.4	19.3
	Catheter	81.2	70.6	48.1	32.4	23.7

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; 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 4.5), the proportion of patients using a dialysis catheter at incidence of ESRD remains stubbornly high (Figure 4.1). Limiting catheter exposure time is critical, as prolonged catheter use is often associated with bacteremia, sepsis, thrombosis and central stenoses (Morsy et al., 1998), which limits future access success, as well as poor long-term 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., JASN 2004). While AV grafts are ready for use sooner and more reliably, their long-term primary and assisted primary patency are not as good and 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 "dialysis hypoperfusion ischemic syndrome" and "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 currently unclear as to at what point considerations related to prolonged AV fistula maturation time, and the associated catheter exposure, warrant prioritizing placement of AV graft instead, although conversion from a catheter to permanent access of either type is beneficial (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 through the end of 2014. 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 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 and the date of first use in CROWNWeb, given that the exact time of 'fistula maturity' is currently not determinable from CROWNWeb. The percentage of fistula placements that failed was calculated as the number of failed placements over the total number of placements in 2013 among patients with vascular access use data in CROWNWeb. Patients that died following the fistula placement were included in the analysis.

vol 2 **Table 4.6 Odds ratios and 95% confidence intervals from logistic regression models of fistula use at hemodialysis initiation and fistula or graft use at hemodialysis initiation, from the ESRD Medical Evidence form (CMS 2728), 2013**

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	0.05	0.05	0.06	0.06	0.06	0.07
>0 -<6 months	0.28	0.27	0.30	0.29	0.28	0.31
6-12 months	0.61	0.59	0.64	0.61	0.59	0.64
>12 months	Ref.			Ref.		
Unknown	0.19	0.17	0.20	0.19	0.18	0.20
Age						
0-21	0.33	0.25	0.43	0.30	0.23	0.39
22-44	0.84	0.78	0.89	0.80	0.75	0.86
45-64	Ref.			Ref.		
65-74	0.99	0.94	1.03	1.02	0.97	1.06
75+	0.86	0.82	0.90	0.94	0.90	0.98
Sex						
Female	0.74	0.71	0.77	0.86	0.83	0.89
Male	Ref.			Ref.		
Race						
Native American	0.81	0.67	0.99	0.83	0.69	1.01
Asian	1.13	1.04	1.23	1.15	1.06	1.24
Black/African American	0.99	0.94	1.03	1.16	1.12	1.21
White	Ref.			Ref.		
Other/Unknown	1.13	0.68	1.86	1.30	0.82	2.08
Diabetes as cause of ESRD	0.93	0.90	0.97	0.93	0.90	0.96
CMS Region						
1 (vs. average region)	1.08	0.99	1.17	1.09	1.01	1.18
2 (vs. average region)	0.97	0.92	1.02	0.96	0.92	1.01
3 (vs. average region)	0.92	0.87	0.97	0.91	0.86	0.96
4 (vs. average region)	0.91	0.87	0.94	0.91	0.87	0.94
5 (vs. average region)	0.94	0.89	0.98	0.94	0.90	0.98
6 (vs. average region)	0.90	0.85	0.94	0.91	0.86	0.95
7 (vs. average region)	0.88	0.80	0.96	0.89	0.82	0.96
8 (vs. average region)	1.11	1.00	1.25	1.05	0.95	1.18
9 (vs. average region)	1.09	1.04	1.14	1.09	1.04	1.14
10 (vs. average region)	1.30	1.19	1.41	1.33	1.22	1.44

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

In 2013, 35.9% of AV fistulas placed failed to be in use following placement, with a mean of 135 days to first AV fistula use (Table 4.7), among those that were used. Younger patients tended toward higher maturation rates, with patients over 75 displaying higher failure rates than the overall rate, with the oldest and youngest age categories having longer times to first AV fistula use. Males had a higher maturation rate compared to females, 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. Time to first use did not necessarily correspond to maturation rates. While there was placement failure variability by ESRD etiology, those classified as having "unknown cause" were a clear outlier, with a 39.1% failure rate and longer median time to first use.

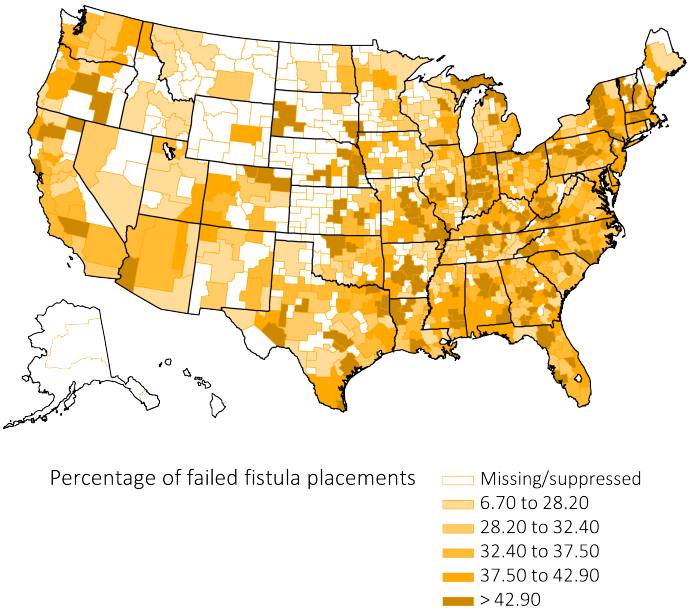
The percentage of failed fistula placements in 2013 for new AV fistulas created was mapped at the Health Service Area level in Figure 4.8. Within each state, there is typically a fair amount of variability in percentage of failed fistula. Many areas with a lower percentage of failed fistula appear to be concentrated in the Pacific Northwest and Southwest.

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 fistula created in 2013 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2013-2014

	Total AV fistula placements	Percentage of failed placements	Number of days between AV fistula placement and first use			
			Average	Median	25th percentile	75th percentile
Overall	45,475	35.9	135	112	74	171
Age						
0-21	230	31.7	139	110	71	174
22-44	5,429	32.3	132	106	70	169
45-64	17,184	33.9	134	111	72	169
65-74	12,191	36.6	137	115	76	174
75+	10,441	40.6	137	115	78	171
Race						
Native American	485	26.6	135	117	76	165
Asian	1,857	27.8	128	106	67	168
Black/African American	14,582	38.8	136	113	71	175
White	28,501	35.2	135	112	76	170
Other/Unknown	50	34.0	122	113	71	146
Sex						
Male	25,693	31.8	129	108	73	161
Female	19,782	41.3	145	120	77	188
Primary Cause of ESRD						
Diabetes	21,303	36.2	137	115	76	174
Hypertension	13,681	35.3	133	111	73	169
Glomerulonephritis	4,037	33.4	130	104	68	167
Cystic kidney	739	36.7	135	111	66	173
Other urologic	687	34.6	128	109	71	161
Other cause	3,714	38.4	134	111	72	168
Unknown cause	1,314	39.1	153	120	78	195

*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; ESRD, end-stage renal disease.*

vol 2 Figure 4.8 Percentage of failed fistula placements, by Health Service Area, for new AV fistulas created in 2013 (excludes patients not yet ESRD when fistula was placed), from Medicare claims and CROWNWeb, 2013-2014



Data Source: Special analyses, USRDS ESRD Database. Abbreviations: AV, arteriovenous; ESRD, end-stage renal disease.

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Notes