Trends in Incident Hemodialysis Access and Mortality

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**IMPORTANCE** Based on evidence of survival benefit when initiating hemodialysis (HD) via arteriovenous fistula (AVF) or arteriovenous graft (AVG) vs hemodialysis catheter (HC), the National Kidney Foundation–Kidney Disease Outcomes Quality Initiative published practice guidelines in 1997 recommending 50% or greater AVF rates in incident HD patients. A decade after, lapses exist and the impact on HD outcomes is uncertain.

**OBJECTIVE** To assess the achievement of the practice goals for incident vascular access and the effects on HD outcomes.

**DESIGN, SETTING, AND PARTICIPANTS** This retrospective cohort study was conducted using the US Renal Data System. All patients with end-stage renal disease in the United States without prior renal replacement therapy who had incident vascular access for HD created between January 1, 2006, and December 31, 2010 (N = 510,000) were included.

**MAIN OUTCOMES AND MEASURES** Incident vascular access use rates and mortality. Relative mortality was quantified using multivariable Cox proportional hazard models. Coarsened exact matching and propensity score–matching techniques were used to better account for confounding by indication.

**RESULTS** Of 510,000 patients included in this study, 82.6% initiated HD via HC, 14.0% via AVF, and 3.4% via AVG. Arteriovenous fistula use increased only minimally, from 12.2% in 2006 to 15.0% in 2010. Patients initiating HD with AVF had 35% lower mortality than those with HC (adjusted hazard ratio, 0.65; 95% CI, 0.64-0.66; \( P < .001 \)). Those initiating HD with AVF had 23% lower mortality than those initiating with an HC while awaiting maturation of an AVF (adjusted hazard ratio, 0.77; 95% CI, 0.76-0.79; \( P < .001 \)).

**CONCLUSIONS AND RELEVANCE** Current incident AVF practice falls exceedingly short years after recommendations were made in 1997. The impact of this shortcoming on mortality for patients with end-stage renal disease is enormous. Functioning permanent access at initiation of HD confers lower mortality even compared with patients temporized with an HC while awaiting maturation of permanent access. A change of current policies and structured multidisciplinary efforts are required to establish matured fistulae prior to HD to ameliorate this deficit in delivering care.

Published online March 4, 2015.

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emodialysis catheters (HCs) appeared in the 1980s, supplanting arteriovenous fistulas (AVFs) as the dominant access mode during the 1990s and increasing di-alysis-associated costs.1 By 2010, there were 593 086 patients in the United States with end-stage renal disease (ESRD), of whom 383 992 patients (65%) were on hemodialysis (HD).2 In 2010, Medicare expenditures for HD were $23.6 billion overall, or $87 756 per person, accounting for 4.5% of the total Medi-icare budget; comparative renal transplant costs were $2.8 bil-lion overall and $32 914 per person.2 Classic teaching highlights the benefits of HD of AVF.3 However, to our knowledge, few studies have ad-ressed the different mortality rates in access types in a large sample of patients or how practice trends in the initiation of dialysis access have changed over time.

The National Kidney Foundation–Kidney Disease Out-comes Quality Initiative first published practice guidelines re-garding permanent HD access creation and maintenance in 1997, targeting a 50% or greater incidence rate for AVF.4 The pur-pose of the current study was to evaluate whether this target was met and to determine the effect of failure or delay in creating functional permanent access on mortality risk using the US Renal Data System (USRDS) population.

Methods

The USRDS maintains a prospective database of patients with ESRD receiving renal replacement therapy. Information on pa-tient characteristics was obtained from the Centers for Medi-care and Medicaid Services (CMS) Form 2728: End Stage Re-nal Disease Medical Evidence Report.5 In 2005, information on dialysis access methods was added to the form. Cause of death was ascertained from the CMS 2746 ESRD death notification form, which is included with the USRDS data. Date of dialysis initiation was derived from Form 2728, and information per-taining to renal transplantation was obtained from the United Network for Organ Sharing. The study was approved by the Johns Hopkins institutional review board and USRDS. All data used in this study were obtained from the publicly available USRDS dataset, and patient consent was obtained according to USRDS protocols.

We performed a retrospective analysis of the cohort of pa-tients in the USRDS database who initiated dialysis between January 1, 2006, and December 31, 2010. We compared pa-tients who initiated dialysis using AVF vs arteriovenous graft (AVG) vs HC. We also performed a subgroup analysis of HC pa-tients who had maturing AVF and AVG. Descriptive analyses were performed using χ² and analysis of variance tests. Kaplan-Meier hazard probabilities were computed to display life-table mortality experience over time for each group, and Wilcoxon rank sum tests were used to compare hazard probabilities between groups. The first 90 days after initiation of dialysis were excluded from the survival analysis because of the time required for patients to qualify for Medicare and the lack of complete data during that time. Patients were excluded if they received HD before 2006 or if they received a kidney trans-plant. A multivariable Cox proportional hazard model examined mortality, using HC as the reference group and controlling for age, sex, race/ethnicity, insurance status prior to ESRD coverage, obesity, reason for ESRD, congestive heart failure, atherosclerotic heart disease, cerebrovascular disease, periph-eral vascular disease, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, smoking history, cancer, al-cohol and drug dependence, and ability to ambulate. All morta-lity analyses were performed with an intention-to-treat ap-proach, meaning that patients were assumed to maintain their initial dialysis access over the 5-year study period (ie, changes in access type were not accounted for).

To further account for imbalances in patient characteris-tics between the AVF/AVG and HC groups, matched subanaly-ses were also performed. In the first analysis, coarsened exact matching was performed to obtain 2 groups that were comparable with respect to patient characteristics. A second matched analysis was also performed using all available pa-tient characteristics to generate propensity scores. For both coarsened exact matching and propensity score methods, 1-to-1 and many-to-1 matching techniques were used. In addition, t tests and χ² tests were used to check for balance between the 2 groups with respect to each patient characteristic, and percentage bias was calculated for each characteristic. Stata statistical software (StataCorp) was used for all analyses.

Results

From this data set containing 2 377 166 patients, there were 736 946 patients who had the 2005 revision of CMS Form 2728. Of these, 562 508 initiated dialysis between 2006 and 2010. There were 52 508 patients missing data on dialysis access method, resulting in a total study cohort of 510 000 patients. Of these, 71 452 (14.0%) initiated HD with AVF, 17 562 (3.4%) initiated with AVG, and 420 986 (82.5%) initiated with HC.

Patient Characteristics and Incident Use

Associations between HD access method and patient charac-teristics are shown in Table 1. Annual figures on HD access method showed that HD initiation with AVF increased slightly from 12.2% in 2006 to 15.0% in 2010, while initiation with AVG had a modest decline over the same period from 4.2% to 2.9%. Hemodialysis initiation with HC remained consistent at 82.5% between 2006 and 2010 (Figure 1). A portion of patients who initiated HD with HC had a maturing AVF or AVG at the time of HD initiation. This proportion remained unchanged for the maturing AVF (approximately 16% of the total population), while the maturing AVG frequency declined from 2.6% in 2006 to 1.8% in 2010 (P < .001).

Survival

Kaplan-Meier survival analysis showed a rapid decline in sur-vival in the HC group during the first year after HD initiation, while there was a steady decline in the other 2 groups (Figure 2). Survival at 1 year was 78% in the HC group compared with 84% for the AVG group and 89% for the AVF group (Wilcoxon
Five-year survival in the HC group was 45% compared with 48% in the AVG group and 55% in the AVF group (Wilcoxon $P < .001$).

Mortality: Cox Proportional Hazard Model
A Cox proportional hazard model adjusting for the factors listed in Table 1 showed a 35% reduction in mortality rate in the AVF group compared with the HC group (aHR, 0.65; 95% CI, 0.64-0.66; $P < .001$) and an 18% reduction in mortality rate in the AVG group compared with the HC group (aHR, 0.82; 95% CI, 0.80-0.84; $P < .001$). Older age, male sex, congestive heart failure, atherosclerotic heart disease, cerebrovascular disease, peripheral vascular disease, insulin-dependent diabetes mellitus, chronic obstructive pulmonary disease, smoking, cancer, alcohol dependence, drug dependence, and inability to ambulate were all independent factors associated with increased mortality risk (all $P < .05$). Race/ethnicity other than white, hypertension, higher body mass

Table 1. Patient Characteristics by Hemodialysis Access Method

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Hemodialysis Access Method, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>AVF 64.0 (14.1) AVG 65.4 (13.9) HC 63.0 (15.8)</td>
</tr>
<tr>
<td>Sex</td>
<td>Male 45 903 (15.9) Female 25 549 (11.5)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>White 40 206 (15.2) Black 18 663 (12.5) Hispanic 8221 (11.8) Other 4362 (16.1)</td>
</tr>
<tr>
<td>Insurance status</td>
<td>None 2870 (7.3) Medicaid 6721 (11.1) Private 44 115 (14.8) Medicare, VA 17 746 (15.9) BMI, mean (SD) 29.3 (7.5)</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>29.4 (8.1) 28.9 (7.9)</td>
</tr>
<tr>
<td>ESRD etiology</td>
<td>Diabetes mellitus 34 459 (14.8) Hypertension 20 980 (14.3) Glomerulonephritis 5636 (18.3) Polycystic kidney disease 3164 (35.9) Other urologic 850 (12.0) Other 4515 (7.0) Unknown 1848 (9.4) CHF 18 975 (11.1) ASHD 15 894 (14.3) CVD 64 18 (12.9) PVD 95 27 (13.0) Hypertension 63 636 (14.7) Diabetes mellitus No 33 280 (14.1) Diet controlled 3753 (14.8) Oral medication 9515 (15.4) Insulin dependent 24 904 (13.3) COPD 5342 (11.0) Current smoker 4247 (13.2) Cancer 4904 (12.6) Alcohol dependence 636 (7.2) Drug dependence 605 (8.2) Inability to ambulate 2154 (5.7) Nephrologist care No 3320 (2.0) Yes 64 274 (22.8)</td>
</tr>
</tbody>
</table>

Abbreviations: ASHD, atherosclerotic heart disease; AVF, arteriovenous fistula; AVG, arteriovenous graft; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CHF, congestive cardiac failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; ESRD, end-stage renal disease; HC, hemodialysis catheter; PVD, peripheral vascular disease; VA, Veterans Affairs.
Patients initiating HD with an AVF exhibited a 23% reduction in mortality risk compared with those initiating with an HC and a maturing AVF (aHR, 0.77; 95% CI, 0.76-0.79; \( P < .001 \)). Similarly, patients initiating HD with an AVG exhibited a 13% reduction in mortality risk compared with those initiating with an HC and a maturing AVG (aHR, 0.90; 95% CI, 0.83-0.91; \( P < .001 \)).

Of the 193,053 deaths in this study, 36.3% were attributed to cardiovascular causes, 9.0% were caused by sepsis, 31.0% were due to other causes, and 23.6% were of unknown causes. Arteriovenous fistula was associated with a 38% lower hazard of cardiovascular mortality (aHR, 0.62; 95% CI, 0.61-0.64; \( P < .001 \)) and AVG was associated with a 23% lower hazard of cardiovascular mortality (aHR, 0.77; 95% CI, 0.74-0.81; \( P < .001 \)). Arteriovenous fistula was associated with a 44% lower hazard of sepsis-related mortality (aHR, 0.56; 95% CI, 0.53-0.59; \( P < .001 \)) and AVG was associated with a 23% lower hazard of sepsis-related mortality (aHR, 0.77; 95% CI, 0.71-0.84; \( P < .001 \)).

Mortality: Matching

For the purposes of matched analyses, a subset of 440,263 patients was used, consisting of patients with complete data for all patient characteristics. In this subset, there were 82,739 AVF/AVG patients and 357,524 HC patients. Coarsened exact matching techniques were used to obtain an AVF/AVG group and an HC group with similar patient characteristics. The 8 characteristics with the strongest relationship to HD access method were used for matching: age, race/ethnicity, nephrology care, congestive heart failure, reason for ESRD, ability to ambulate, diabetes mellitus, and hypertension. If an exact age match was not available, matching was done within 10-year age groups. Of the 82,739 AVF/AVG patients, matched HC cases were obtained for 81,328 patients (98.3%). The Cox proportional hazards regression performed previously was repeated and the resulting mortality HR was 0.69 (95% CI, 0.68-0.70). The mean bias improved from 7.3% before matching to 1.3% after matching. A comparable 1-to-many matched analysis was performed with similar results (Figure 3).

Propensity scores were calculated for each patient using all the patient characteristics listed in Table 1, plus a qua-
dramatic term for age. The propensity scores were used to match AVF/AVG patients 1 to 1 with HC patients. The same Cox proportional hazards regression was repeated and the resulting mortality HR was 0.68 (95% CI, 0.67-0.69). The average percentage bias decreased from 7.3% before matching to 0.36% after matching. Propensity scores were also used to match at a 1:4 AVF/AVG:HC ratio. The HRs and 95% CIs were similar to those obtained from the methods previously discussed (Figure 3).

Estimation of Mortality Benefit With AVF vs HC
In 2010, there were approximately 115,000 incidence cases of patients who commenced dialysis (incident cases). Of these, 94,300 (82%) started dialysis with HC, of which 24,716 (26.2%) died within the first year. If all 115,000 patients had started dialysis with an AVF instead, only 10,741 patients (9.3%) would have died within the first year, resulting in a total saving of 13,975 lives in a single year.

Discussion

According to Fistula First Breakthrough Initiative6 data, the prevalence of AVF has increased from 23% in 2003 to 60% in 2011, indicating that vascular access progress is possible. This shift has occurred since the inception of the Fistula First Breakthrough Initiative to increase the use of AVF as the optimal form of vascular access for HD. However, despite the Kidney Disease Outcomes Quality Initiative and Fistula First Breakthrough Initiative’s call for a change in practice to one that favors fistulae first, an alarming 80% of patients initiating HD in the United States do so with HC. These patients are exposed to additional mortality risk.

There has been no significant improvement in incident autogenous access over the 5-year period of this study. In contrast, HD initiation occurs via an AVF in 76% of European patients, who also experience lower mortality than US patients.7 Our analysis showed a 37% reduction in 5-year mortality when initiating HD with an autogenous fistula compared with HC. These results are consistent with several studies8-22 in smaller populations in the United States, Canada, and Europe, as well as the results of a large meta-analysis that included more than 500,000 patients from 62 cohort studies.23 The size of our study population provided for accurate estimation of the benefit of AVF and allowed for complex matched analyses, which provide further support for the validity of these results. Overall, we noted a marked potential for increasing the number of lives saved if dialysis is initiated with AVF instead of HC, totaling nearly 14,000 lives per year.

Previous studies have also established the mortality benefit of predialysis nephrology care,24-26 a factor which is also strongly associated with fistula creation.27-32 Conversely, patients who seek medical care late in the course of their renal disease may have poor nutritional status, multiple comorbidities, anemia, and tenuous socioeconomic standing and are more likely to be members of racial or ethnic minorities.28 Thus, the same factors that predispose patients to dialysis initiation with a catheter may also predispose patients to higher mortality. However, in the present study, many of the demographic and clinical factors that could contribute to selection bias and confounding were accounted for, both by multivariate regression modeling and by matching. After adjusting for

### Table 2. Mortality Risk Based on Cox Proportional Hazards Modeling

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Adjusted Hazard Ratio (SE)</th>
<th>P Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVF</td>
<td>0.651 (0.006)</td>
<td>&lt;.001</td>
<td>0.640-0.662</td>
</tr>
<tr>
<td>AVG</td>
<td>0.818 (0.012)</td>
<td>&lt;.001</td>
<td>0.795-0.841</td>
</tr>
<tr>
<td>HC</td>
<td>1 [Reference]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.029 (0.000)</td>
<td>&lt;.001</td>
<td>1.028-1.029</td>
</tr>
<tr>
<td>Female</td>
<td>0.987 (0.005)</td>
<td>.02</td>
<td>0.977-0.998</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.677 (0.006)</td>
<td>&lt;.001</td>
<td>0.665-0.689</td>
</tr>
<tr>
<td>Black</td>
<td>0.746 (0.005)</td>
<td>&lt;.001</td>
<td>0.736-0.756</td>
</tr>
<tr>
<td>Other</td>
<td>0.638 (0.009)</td>
<td>&lt;.001</td>
<td>0.621-0.656</td>
</tr>
<tr>
<td>White</td>
<td>1 [Reference]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>1.447 (0.022)</td>
<td>&lt;.001</td>
<td>1.404-1.492</td>
</tr>
<tr>
<td>Private</td>
<td>1.380 (0.020)</td>
<td>&lt;.001</td>
<td>1.342-1.419</td>
</tr>
<tr>
<td>Medicare, VA</td>
<td>1.079 (0.016)</td>
<td>&lt;.001</td>
<td>1.049-1.111</td>
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<tr>
<td>None</td>
<td>1 [Reference]</td>
<td></td>
<td></td>
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<tr>
<td>Reason for ESRD</td>
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<td></td>
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</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes, insulin</td>
<td>1.139 (0.009)</td>
<td>&lt;.001</td>
<td>1.121-1.154</td>
</tr>
<tr>
<td>No, cystic</td>
<td>0.555 (0.017)</td>
<td>&lt;.001</td>
<td>0.522-0.589</td>
</tr>
<tr>
<td>Other nephrology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes, yes medication</td>
<td></td>
<td>&lt;.001</td>
<td>1.014-1.065</td>
</tr>
<tr>
<td>No, oral medication</td>
<td></td>
<td>&lt;.001</td>
<td>0.953-0.990</td>
</tr>
<tr>
<td>Yes, insulin</td>
<td>1.139 (0.009)</td>
<td>&lt;.001</td>
<td>1.121-1.157</td>
</tr>
<tr>
<td>COPD</td>
<td>1.229 (0.010)</td>
<td>&lt;.001</td>
<td>1.210-1.249</td>
</tr>
<tr>
<td>Current smoker</td>
<td>1.120 (0.012)</td>
<td>&lt;.001</td>
<td>1.096-1.144</td>
</tr>
<tr>
<td>Cancer</td>
<td>1.305 (0.012)</td>
<td>&lt;.001</td>
<td>1.282-1.328</td>
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<tr>
<td>Alcohol dependence</td>
<td>1.095 (0.024)</td>
<td>&lt;.001</td>
<td>1.049-1.143</td>
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<tr>
<td>Drug dependence</td>
<td>1.327 (0.032)</td>
<td>&lt;.001</td>
<td>1.266-1.390</td>
</tr>
<tr>
<td>Inability to ambulate</td>
<td>1.569 (0.014)</td>
<td>&lt;.001</td>
<td>1.541-1.597</td>
</tr>
<tr>
<td>Other</td>
<td>0.911 (0.005)</td>
<td>&lt;.001</td>
<td>0.901-0.922</td>
</tr>
</tbody>
</table>

Abbreviations: ASHD, atherosclerotic heart disease; AVF, arteriovenous fistula; AVG, arteriovenous graft; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CHF, congestive cardiac failure; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; ESRD, end-stage renal disease; HC, hemodialysis catheter; PVD, peripheral vascular disease; VA, Veterans Affairs.
these factors, there was still a significant reduction in mortality associated with initiating HD with a fistula or graft. Furthermore, our mortality benefits were likely underestimated because 22% of patients initiating HD with HC often had a maturing AVF/AVG and could have benefited from the use of the AVF/AVG sometime after dialysis initiation. However, we also found a mortality benefit with incident AVF over HC with maturing AVF/AVG, suggesting that dialysis access at the time of dialysis initiation has an important association with the risk for death. Survival benefits of fistula/graft compared with catheter also applied to mortality due to cardiovascular causes and sepsis. This result was consistent with a smaller study published by Wasse et al\textsuperscript{16} in 2008.

The fact that the prevalence of AVF remains steady at 7%, which is half of the incident fistulae prevalence of 16%, attests to the significant delay in referring patients for permanent access.\textsuperscript{2} One might expect that patients initiating HD with HC have significantly more comorbidities and are at prohibitive risk for surgery. However, when we attempted to match each AVF/AVG patient with 1 or more comparable HC patients, we were able to find matches for 99.2% of AVF/AVG patients and 87.5% of HC patients. This suggests that there are many HC patients who might have been candidates for permanent access placement. In the clinical setting, initiating HD with HC might be considered an acceptable temporizing measure while maturing a permanent access, particularly among older patients.\textsuperscript{23} However, the key finding of our study was that the risk for mortality was higher in patients with incident HC compared with initiates with matured fistulae. The presence of a maturing fistula implies that these patients were good surgical candidates and delay causes significant mortality. This emphasizes the need for prompt preemptive referral for fistula creation to allow for matured access at dialysis initiation.

There was also an 18% reduction in mortality risk associated with prosthetic graft implantation compared with HD catheterization. However, this benefit that patients initiating HD with HC might be considerably smaller than the benefit of an autogenous fistula and, as a result, we believe that graft implantation should thus be viewed as a last resort in patients with unfavorable anatomy rather than an alternative to autogenous fistula creation.

There are several potential solutions to address the low (15%) incidence of incident AVF. Health insurance reimbursement policies contribute to the lack of timely fistula creation. Patients who become eligible for Medicare Part A coverage as a result of their ESRD are not covered until after they initiate dialysis.\textsuperscript{34} Thus, services necessary to prepare for dialysis, including permanent access creation, are not covered.\textsuperscript{35} In contrast, patients who receive kidney transplants can receive retroactive insurance for up to 2 months prior to transplant surgery, which covers all related services.\textsuperscript{36,37} Policy changes are needed to provide patients who have inadequate insurance the opportunity to receive permanent dialysis access prior to HD, with sufficient time allowed for fistula/graft maturation. For example, one solution would be to implement a new policy that provides retrospective Medicare/Medicaid coverage for patients on HD. This coverage could extend 3 to 4 months prior to initiating HD to cover the cost of placing permanent access. This retrospective coverage currently exists for transplant patients; however, it is not available for patients who need dialysis but are not transplant candidates. In the current study, 91% of patients with no health insurance initiated dialysis with a catheter compared with 86% of Medicaid patients and 81% of patients with private insurance, Medicare, or Veterans Affairs coverage. Although the 5% to 10% difference in incident HC use for the uninsured group appears small, the clinical implications are large given that the number of patients on HD was nearly 400,000 as of 2010.\textsuperscript{2} Thus, while having adequate insurance was beneficial for patients with ESRD, there remains an unacceptably large number of patients with adequate insurance who do not get timely permanent access creation. Therefore, changes in reimbursement policies must be accompanied by changes in physician referral patterns.

A second potential solution to improve incident AVF use would be to provide incremental reimbursement for primary care physicians, nephrologists, and surgeons who have a high percentage of successful matured fistulae at the time of dialysis initiation. Previous studies have shown that catheter-based dialysis initiation is the result of patients not being referred in time to the nephrologist.\textsuperscript{10,23-27,38} Accordingly, identifying candidates for fistula creation deserves prompt multidisciplinary coordination between general practitioners, nephrologists, and surgeons. Appropriate and timely nephrology referral by the primary care physician is a key element in establishing a functional AVF for incident dialysis patients. Also important is the nephrologist’s prompt referral to a knowledgeable and successful dialysis access surgeon when the need for dialysis is likely, as well as a timely surgical evaluation and procedure scheduling. The
surgeon’s training, knowledge of all AVF options, and technical proficiency, along with clinical and ultrasonography experience in vessel mapping and operative planning, also impact success rates. By providing financial incentives to promote the early recognition and referral of appropriate patients with chronic kidney disease (CKD) for predialysis AVF placement, we may be able to improve the incidence of mature AVF at the time of dialysis initiation. Other essential tools for the successful creation of a working fistula prior to a patient’s initiation of dialysis include hospital systems’ early detection of CKD; the avoidance of peripherally inserted central catheters and venous access into commonly used AVF vein sites; and improved patient education for compliance with AVF creation before dialysis. By improving team-based strategies to care for patients with ESRD, permanent dialysis access can be established more efficiently and prevent the need for high-risk temporizing HCs.

The cost implications of opting for incident permanent dialysis are important. Hemodialysis costs Medicare more than $23 billion per year overall, representing a substantial opportunity for cost savings. Arteriovenous fistulae are generally acknowledged to be associated with lower costs compared with HCs as a result of better patency, fewer infections, and improved longevity.\(^2\) However, there is concern that some patients who undergo early fistula creation procedures may, in fact, never require HD, resulting in unnecessary health care expenditures. Among 356 patients in the Choices for Healthy Outcomes in Caring for End-Stage Renal Disease Center Study, 49% of patients with CKD with fistulae were found to develop ESRD over a median follow-up of 10 months.\(^2\) Similarly, Solid and Carlin\(^3\) addressed this concern in a study of 550 retrospectively identified patients with ESRD who received an AVF 2 years prior to dialysis initiation. During the course of the 3-year study, 71% of patients developed ESRD, while 21% were still alive but had not progressed to ESRD and 8% had died before developing ESRD. Despite this 29% unnecessary procedure rate, the authors calculated a potential cost savings of $500 to $1200 per patient per year, resulting in an estimated $500 million per year overall. Consistent with this notion, we estimated that if all HC patients in our study started dialysis with an AVF, the annual cost savings would be on the order of billions of dollars. The estimated annual cost for a patient with incident AVF is $103 869 vs $127 677 for HC,\(^3\) which equals a net cost savings of $23 808 per AVF patient per year. If all 420 986 patients in our study had initiated dialysis with AVF, the total cost savings would equal more than $10 billion over the course of 2006 through 2010, or $2 billion per year. These estimated savings are likely attributable to the reduction in the costs of treating morbidity associated with catheter use. Future prospective studies investigating the relative costs of predialysis AVF formation in patients with CKD are needed to truly understand the scope of this issue, but all currently existing data on the topic point to significant savings with a fistula-first approach.

The limitations of our study were the same as those with any study that uses data from the USRDS. There is little direction provided on the CMS 2728 Form regarding the definition of comorbidities, as well as the timing or extent of such comorbid conditions relative to the initiation of dialysis. As a result, comorbidity data in our cohort were limited by the assumption that all recorded comorbidities were binary events. The large size of our study cohort was helpful for minimizing the effects of this assumption and of any potential effects of incorrect coding. It is not clear why 9.3% of patients who initiated dialysis between 2006 and 2010 had missing data on dialysis access method. It appeared that the data were not missing at random. The mortality experience for patients with missing access data were very similar to that for AVF patients, suggesting that perhaps the missing data were specific to follow-up or coding issues related to a specific treatment group. However, even if we assign all of the patients with missing access data to the HC group, the aHR for AVG remains highly significant (0.66; 95% CI, 0.65-0.68). This conservative analysis suggests that the exclusion of patients with missing access data was unlikely to bias our results. The USRDS database does not contain information on prevalent vascular access use. As a result, we did not have information in the current study regarding whether patients who initiated dialysis with a catheter eventually had a fistula or graft placed or when maturation occurred. However, this limitation would tend to underestimate the benefit of permanent access because patients who initiated dialysis with a catheter and who later converted to permanent access and received some benefit thereof were counted in the catheter group.

Conclusions

Initiating HD with an AVF provides a significant mortality benefit compared with initiating dialysis with an AVG or HC. Despite this, most patients in the United States initiate HD with HC, and incident AVG use falls markedly short of the initial Kidney Disease Outcomes Quality Initiative target of 50% that was established more than 15 years ago. Antiquated health care policies prevent patients and health care professionals from being properly reimbursed for creating optimum HD access, resulting in an unnecessary economic burden on the US health care system and an unwarranted risk to patients’ lives. A review of current policies and a push toward better multidisciplinary efforts in our care of patients with chronic renal disease are necessary to allow for the establishment of AVF with time for maturation to ameliorate this deficit in delivering care.
Trends in Hemodialysis Access Mortality

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Obtained funding: Malas.

Administrative, technical, or material support: Hicks, Arhuidese, Qazi, Black.

Study supervision: Malas, Schneider, Freschlag.

Conflict of Interest Disclosures: None reported.

Disclaimer: Dr Freschlag was the editor of JAMA Surgery at the time this manuscript was accepted and had no role in the review or editorial decision process of this article.

REFERENCES


