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Does Vascular Access Type Affect Access–Related Costs?

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Successful treatment of ESKD with maintenance hemodialysis (HD) is inextricably dependent on reliable access to the bloodstream, typically three times a week. The vascular access, therefore, is the literal "lifeline" for the patient on HD. In numerous studies, including a meta-analysis of 62 cohort studies with 586,337 participants, patients dialyzing with an arteriovenous (AV) fistula have been observed to have less morbidity and mortality (1). Although AV fistulas are the preferred form of vascular access if they can become functional, they are limited by high rates of nonuse. Specifically, substantial proportions (20%–60%) of new AV fistulas are never useable for dialysis or require assistance to mature and be functional (1). In a comparative national study on elderly patients on HD, we found that AV grafts were almost twice as likely as AV fistulas to be successfully used for dialysis within 6 months (adjusted odds ratio, 1.86; 95% confidence interval, 1.73 to 1.99), that an intervention to achieve successful use for dialysis was required more frequently in patients with an AV fistula versus those with an AV graft (odds ratio, 2.66; 95% confidence interval, 2.26 to 3.12), and that patients receiving an AV fistula had a 2-month longer catheter dependence prior to successful use compared with patients with AV grafts ($P<0.001$) (2).

Taking these issues into consideration, Kosa *et al.* (3) conducted an innovative study comparing the costs of attaining and maintaining patency for AV fistulas compared with AV grafts among patients on HD. In addition to comparing undifferentiated costs over 1, 3, and 5 years, the authors analyzed AV access type and risk of failure to mature (FTM) on total costs. Given the higher rates of nonmaturation among AV fistulas, this analysis provides a new and perhaps more appropriate (or "fair") basis in which to compare and analyze costs by access type. The authors conclude that median total costs are not associated with AV access type when the interaction between AV access type and FTM risk stratum is considered. The authors also found, unsurprisingly, that the costs of attaining and maintaining patency increased with increasing risk of fistula maturation failure at 1, 3, and 5 years. On the basis of these new study findings, Kosa *et al.* (3) thereby debunk previous studies that have found that AV fistulas are less costly then grafts (4,5).

This is an original and thoughtful study that is innovative in its use of the FTM risk tool to stratify costs. More studies such as this one are needed to evaluate the "real world" feasibility of the Fistula First Initiative to help vulnerable patients (*i.e.*, the elderly, diabetics, women, and others) (6,7) at highest risk of FTM and their providers make better vascular access choices. This study builds on the multitude of recent multicenter vascular access studies (the Dialysis Access Consortium study [8] and the Hemodialysis Fistula Maturation study [9]) that have highlighted the high frequency of unsuccessfully used AV fistulas for dialysis and the requirement for (often multiple) maturation interventions to make the AV fistula functional.

In our 2018 study using contemporary national data from Medicare and Centers for Medicaid and Medicare Services (CMS) claims to examine the rate and timing of vascular access events and the Medicare costs on the basis of various scenarios of AV fistula function, we determined that per patient per year vascular access costs in 3 years after surgical creation were four times as high as for patients whose AV fistula was not used compared with patients with an AV fistula that did not require an intervention in the first year ($7871± SD $14,183 versus $31,630± SD $103,941, $P=0.05$). The higher costs associated with nonuse or FTM reflect interventions to promote AV fistula maturation, new access surgeries, and complications associated with prolonged exposure to catheters, including elevated rates of bacteremia, osteomyelitis, and endocarditis (10,11). We also found that AV fistula FTM resulted in higher costs for multiple years. A major limitation of our national study was that we did not compare costs between AV fistulas and AV grafts on the basis of vascular access outcome scenarios. We believe that evaluating the costs on the basis of access type differentiated by vascular access outcomes remains an important research question that would help in determining whether different patient selection criteria should be used for permanent access that could affect outcomes or costs. The paper by Kosa *et al.* (3) is the first to compare AV graft versus AV fistula costs directly while also considering important differences in FTM on the basis of access type.

In other work (2), we found that, although vascular access events preceding successful use favor AV grafts, those occurring after successful use favor AV fistulas. These observations, like those in the paper by Kosa *et al.* (3), highlight the important tradeoffs of

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permanent vascular access placement in patients on HD initiating HD with a catheter. They suggest the need for a more nuanced approach to Fistula First recommendations that addresses the tradeoffs of earlier AV graft access use versus longer AV fistula patency. Ultimately, when considering selection and placement of the best vascular access for patients on dialysis, the clinician is wise to consider the results of this study and to balance the importance of removing the catheter and minimizing the need for interventions to make the vascular access functional (favoring AV graft placement) versus a longer-lasting vascular access with fewer maintenance interventions (favoring AV fistula placement).

There are some important limitations of this study. First, the study was conducted over a long time period (from 2002 to 2018), and this could possibly have affected the cost outcomes. Could there be a bias toward AV graft or AV fistula given advances during this time period in the access technology and/or improved surgical techniques? Notably, the authors did find that year of creation was negatively associated with cost, suggesting that "more recent advances in technologies and strategies to inform vascular access placement may have been effective in reducing AV access related costs over time." Second, the study would have been stronger if additional cost data were collected related to secondary patency loss (abandonment) or subsequent costs of a catheter and/or new vascular access insertion. Unfortunately, the end point that was chosen was "end date of the patients' primary AV access during study period" instead of continuing to collect vascular access–related information and costs through year 1, year 3, and year 5. Third, the analysis was conducted on the basis of the experience of a single institution in Canada and thus, does not necessarily reflect the experience of other jurisdictions or the national experience in Canada or in other countries.

Despite recognition of the complexities associated with vascular access creation and use, few studies have evaluated the disparate costs related to AV fistula management in a representative HD population, and even fewer have compared AV graft with AV fistula in this regard. AV fistulas remain the preferred form of vascular access and are incentivized by the CMS in the Fistula First program, the Quality Incentive Program, and 5-Star programs. The CMS, the principal payer of dialysis services in the United States, has actively promoted use of AV fistulas with the twin goals of improving health outcomes and lowering costs. The study of Kosa *et al.* (3) suggests that both outcomes and costs are related to accurately predicting patients in whom the AV fistula is likely to have unsuccessful use for dialysis, therefore determining with greater confidence who may be better suited to undergo AV graft placement. In other words, the findings of this study "highlight the need for careful consideration of vascular access choice based on the patient's risk of fistula maturation failure from not only a clinical but also an economic standpoint." However, predicting who is at risk for permanent vascular access nonmaturation is only as good as the tools available. The FTM risk score used in the study by Kosa *et al.* (3) has been validated previously, but the authors admit that (*1*) other risk factors, such as need for an urgent start on dialysis, might be important to adjust for in future analyses to minimize the bias in outcomes and costs and that (*2*) the FTM risk equation was developed prior to the use of many modern surgical techniques and maturation assisting procedures and requires further validation in more current samples. To this author's knowledge, no other predictive risk score exists to address this important problem of stratifying patients in terms of maturation risk prior to the selection of a permanent access. More effort is needed to further validate and update the FTM risk equation as well as develop new competing risk scores that are integrated into routine nephrology clinical practice.

Finally, at the heart of this issue is the lack of information about why such a large proportion of fistulas (nearly half in many studies) is created but never used. Identifying the causes of the high levels of AV fistula nonuse (*e.g.*, failed maturation and patient refusal) would be important to mitigate the large economic effect found in this analysis and others. In summary, there remains a burgeoning unmet clinical need for improving outcomes and reducing avoidable costs after vascular access creation by better surgical techniques, new vascular access technologies, and improved patient selection.

Author Contributions

M. Thamer conceptualized the study, wrote the original draft, and reviewed and edited the manuscript.

Disclosures

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See related article, "The Effect of Risk of Maturation Failure and Access Type on Arteriovenous Access-Related Costs among Hemodialysis Patients" on pages 248–257.