A Patient-Centered Approach to Hemodialysis Vascular Access in the Era of Fistula First

Sean Kalloo[1], Peter G. Blake[2] and Jay Wish[3]

[1]Division of Nephrology, Department of Medicine, Columbia University Medical Center, New York, NY

[2]Division of Nephrology, Western University and London Health Sciences Centre, London, Ontario, Canada

[3]Division of Nephrology, Department of Medicine, Indiana University Health, Indianapolis, IN

Corresponding author:

Jay Wish, MD

Division of Nephrology, IU Health University Hospital

550 North University Blvd., Suite 6100

Indianapolis, IN 46202

317-948-0728, fax 317-944-4139

Email: jaywish@earthlink.net

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Abstract

The primary vascular access options for the hemodialysis population are arteriovenous fistulas (AVF), arteriovenous grafts (AVG) and cuffed central venous catheters (CVC). AVFs are associated with the most favorable outcomes with respect to complications, interventions required to maintain functionality and patency as well as overall cost. These population-based outcomes, in conjunction with the efforts of the Fistula First Breakthrough Initiative (FFBI), have propelled the prevalence of AVFs in the United States hemodialysis population. While this endeavor remains steadfast in assuring the continued dominance of this policy for AVF preference, it fails to take into account a subset of the dialysis population who will fail to see the benefits of an AVF. This subset of patients may include the elderly, those with poor vasculature anatomy, those with slowly progressive CKD that are more likely to die than progress to ESRD, and those with an overall poor long-term prognosis and shortened life expectancy. Thus, in an effort to avoid numerous unnecessary surgical and interventional procedures with minimal to no gains in clinical outcomes, an individualized patient approach must be adopted. The CMS instituted quality incentive program (QIP) is designed to reward high AVF prevalence while also penalizing high CVC prevalence. The current model is devoid of case-based adjustment, thus penalties are disbursed to dialysis providers in accordance with a “one-size-fits-all” fistula only approach. The most suitable access for a patient remains the one that takes into account the characteristics unique to the individual patient with a primary focus on patient comfort, satisfaction, quality of life and clinical outcomes.

Introduction

Arteriovenous fistulas (AVFs), arteriovenous grafts (AVGs) and tunneled cuffed central venous catheters (CVCs) are the three main vascular accesses used for hemodialysis. When one attempts to identify the characteristics associated with the ideal vascular access for hemodialysis, a series of imperative factors emerges. Firstly, the access must be appropriately selected based on the patients' overall characteristics (age, life expectancy, comorbidities, vascular anatomy, and personal preferences). Secondly, the access must be able to be consistently used for hemodialysis with minimal interventions, both surgical and endovascular, in order to maintain functionality. Third, it must be associated with the lowest infectious and thrombotic complication risk thus leading to the lowest associated costs. Finally and perhaps most importantly, it must offer superior patient survival and quality of life.

In 2003, the Centers for Medicare & Medicaid Services (CMS) initiated the National Vascular Access Improvement Initiative, subsequently named the Fistula First Breakthrough Initiative (FFBI), and currently renamed Fistula First Catheter Last (FFCL) with the goal of increasing the use of AVFs among hemodialysis patients for whom an AVF was deemed a viable option. The goal established by CMS was to achieve an AVF use rate of at least 66% amongst all eligible hemodialysis patients in the United States.(1) This goal has indeed been realized with the use of AVF increasing from 62 percent in August of 2010 to 66.4 percent in April 2015 (Figure 1), with corresponding decreases in CVC use percentages from 18.1 to 15.1, respectively.(2) While this is an encouraging

trend, the 2014 United States Renal Data System (USRDS) reports that 61 percent of patients with incident End Stage Renal Disease (ESRD) had a catheter alone as their primary vascular access at their first outpatient HD session and this CVC dominance persisted to the 90-day mark (Figure 2). When patients who had a maturing AVF or AVG are included in this analysis, a staggering 81 percent of patients were noted to be using a catheter at HD initiation.(3) Among those patients who began HD with a catheter, 36 percent were still using a catheter at 1 year, whereas 51 percent had transitioned to an AVF. Among patients who began HD with an AVF, 83 percent were still using an AVF at 1 year. This suggests that while placement of an AVF is possible in a majority of patients, there remains a cohort that does not succeed with this intervention. The recognition of these patients in whom the risks of an AVF outweigh the benefits requires the incorporation of a patient-centered approach to care with the elimination of a "one size fits all" approach. This approach allows for the acceptance of patients with advanced age, particular comorbid conditions or anatomical deficits in whom an AVF may not be the desired or most suitable option.(4-8).

Despite the scenario described above, CMS instituted a quality incentive program (QIP) in 2012, with the incorporation of vascular access quality outcomes into its metric in 2014, which rewards high AVF prevalence and penalizes high CVC prevalence. It should be noted that for payment year 2015, vascular access constitutes 25% of the total QIP score (9), which can indeed have a substantial financial impact. What is even more disheartening is that these rewards, penalties and percentage allocations are done so without regard for the individual patient context, such that the clinical characteristics and

preferences of the patient remain unincorporated into the ultimate goals of care. Rosas and Feldman in a cost-utility analysis concluded that the high risk of complications of temporary catheters as a bridge to AVF functionality and the overall low AVF maturation rate explains why a universal policy of fistula first for all incident dialysis patients may not optimize clinical outcomes.(10) They suggested that strong consideration should be given to a more patient-centered approach taking into account the likelihood of AVF maturation. It is precisely the “one size fits all approach” that has been an unfortunate misinterpretation of the goals set forth by the CMS and FFCL initiatives that this paper attempts to re-envision.

Individual Patient Context

The implications of the CMS QIP and the FFCL initiative are that catheter avoidance is either equally or more important than actual AVF use and this has led to the reconsideration of a “fistula only” approach. AVFs have a primary failure rate of 30-70% and a 1-year patency rate of 40-70%, with numerous procedures of varying success rates being frequently required to combat these outcomes (7, 11-13) leading to the vascular access dilemma faced by nephrologists. This dilemma may offer an explanation as to why, despite the increasing use of AVF in prevalent hemodialysis patients, the majority of patients initiating hemodialysis in the United States do so with a CVC. Allon has suggested the need for change in the current Medicare reimbursement policies that may be perpetuating the high CVC prevalence in those initiating dialysis.(14)

From a percentage allocation perspective it can be deduced that CMS acknowledges there are certain subsets of patients that are better suited for AVGs. Their goal of 66% AVF prevalence implies that the remaining 34% of patients may be better suited with another form of vascular access. The FFBI's original goal was to decrease the CVC use to <10 percent for patients on hemodialysis longer than 90 days (15-16) and so the remaining percentage of patients would be expected to obtain an AVG. A patient-centered approach to access management can be used to determine the proportion of the patient population who will reap the benefits of an AVF rather than be subjected to the risks of surgery and interventional procedures to place an AVF that will never function or allow the long-term benefits of an AVF to accrue. The "Triple Aim" of CMS is to improve the patient experience of care (including quality and satisfaction), improve the health of populations and reduce the per capita cost of health care.(17) The success of these objectives is more probable in a patient-centered approach to care.

A patient-centered approach attempts to disrupt the current established vascular access paradigm, with the overall goal of providing patients with a functioning, complication free vascular access based on their unique clinical attributes.(4) This approach remains respectful of the fact that a reliable AVF likely offers the best clinical outcomes in the dialysis *population* as a whole but is also cognizant that there are indeed subsets of patients for whom an AVF may result in either adverse clinical outcomes or minimal to no superiority with regards to a risk versus benefit analysis.

The Renal Physicians Association (RPA) via its vascular access initiative emphasizes the role of the nephrologist in driving change with respect to hemodialysis access.(18) The nephrologist plays a key role in providing guidance to vascular surgeons and interventionalists, and holding them accountable for improved vascular access outcomes. (19) In essence, the nephrologist's role has to go beyond ensuring that every patient obtains an AVF; rather the nephrologist must evaluate which patient will benefit from an AVF versus an alternative form of vascular access.(19-20) The nephrologist should be right at the helm of the decision making process, driving a shared clinical dialogue between the patient, vascular surgeon and other members of the care team such that the patient's long-term prognosis, renal progression, vascular anatomy, comfort, personal values and goals of care are all addressed.

While the patient-centered approach must include factors unique to an individual patient or subgroups of patients, it must also be inclusive of the most important aspect of any personalized care based model, that of the patient's perspective. The essence of patient centered care is a shared decision making process that requires that the patient and relevant family members receive unbiased education and that their values and wishes are then the driver of all important clinical decision making (21). Many studies address the importance of a multidisciplinary approach to hemodialysis vascular access placement and management.(22-23) The members of these multidisciplinary teams include nephrologists, interventional nephrologists/radiologists, nephrology nurses, vascular surgeons and physician assistants. The center of this team should include the patient as he/she represents the most important member of any multidisciplinary approach.

Casey et al performed a systematic review to address the patient's perspectives on hemodialysis vascular access.(24) They identified six themes which encompass the domains of interest to these patients (Table 1). These themes allow the provider to understand the despair often felt by patients undergoing this mental, physical and clinical transition. It is the responsibility of the healthcare provider to educate and counsel these patients in order to provide support is dealing with these crucial domains.

In an attempt to update their vascular access guidelines, European Renal Best Practice Workgroup surveyed a panel of kidney patients, nephrologists, nurses, surgeons and radiologists. The objective of this study was to compare the views of the patients and clinicians with respect to the priority of access-related decisions. They discovered that patients assigned higher priority to decisions regarding managing adverse effects of arteriovenous access and patient involvement in care, while clinicians prioritized decisions around sustaining patients' access options, technical aspects of access creation, and optimizing fistula maturation and patency.(25) It should come as no surprise that patients and clinicians have differing concerns; however it should reinforce the necessity of shared decision making in order to establish a unified plan that is in line with the wishes and best interests of the patients.

Investigators from Wake Forest University conducted a prospective study to explore patients' desired versus experienced roles in treatment decisions, characterize perceptions of treatment outcomes, and identify important sources of information with respect to

vascular procedures. Of the patients who had dialysis accesses placed, about a quarter felt confused or overloaded with the amount of information that they were provided and about half said that they only had one treatment recommended to them without alternative choices.(26)

Shared decision making between patients and clinicians should take into account the patients' long-term prognosis, goals of care and vascular anatomy. The patient needs to fully understand the risks, benefits and burdens of vascular access placement and hemodialysis. It is only via this shared decision/patient centered model that a benefit can truly be conferred on the patient.

The Aging Dialysis Population

Based on the 2014 USRDS report, individuals aged 75 and older represent 25.5% and 21.9% of all incident and prevalent HD patients, respectively.(3) The prevalence per million continues to increase in all age groups, with the relative magnitude of increase from 2000 to 2012 greater in older (>75) age groups.(3) When dealing with this population principal factors that must be taken into consideration are quality of life and life expectancy as age-matched survival is poorer compared to people not on dialysis. (27) Studies have shown that dialysis may not confer a survival advantage in patients with renal failure with two or more of the following: age 75 years or older, high comorbidity scores, marked functional impairment or severe chronic malnutrition.(28-37) While a discussion of whether renal replacement therapy should be offered to this

population is beyond the scope of this article, it should be recognized that alterations in treatment algorithms must occur in order to provide the most appropriate therapy for this population.

Should the same "standard of care," i.e. FFCL, be applied to this population of dialysis patients? Moreover, if the same benefits conveyed to the younger cohort of dialysis patients are not transferable to this population, then should a case-mix adjustment for age exist in the QIP measures for vascular access? These questions must be addressed given that the majority of patients initiating hemodialysis do so with a CVC.(3)

The dialysis population aged >75 presents an interesting challenge with respect to vascular access because their overall frailty and vast comorbidity burden make it unlikely that the perceived advantages of an AVF will materialize. This is reflected in a mortality rate of 30-50% within the first year of dialysis in this population.(27, 38) The beneficial aspects of an AVF (i.e. decreased thrombosis, minimal procedural interventions to maintain integrity and decreased infectious profile) over an AVG only become evident when the use of the AVF exceeds 18 months.(39) Vachharajani et al. retrospectively examined an incident octogenarian dialysis population and demonstrated that the vast majority of their patients who initiated dialysis with a CVC and subsequently underwent AVF placement died before the AVF could mature for cannulation.(40) Does this population really benefit from attempts to construct an AVF or even an AVG? Is a CVC sometimes the optimal access for elderly patients with short life expectancy and low likelihood of successful AVF maturation? Would many of these patients prefer more

emphasis on quality of life and less on invasive, often painful interventions with low rates of success and unclear survival benefits? These questions further demonstrate the need for a patient-centered approach to vascular access in this age group. Patients and their families need to be informed and their opinions then need to be listened to. This is the essence of shared decision making and patient centered care.

Multiple observational studies have shown no mortality benefit from AVF or AVG compared to a CVC in the elderly population.(41-42). Desilva et al evaluated mortality based on initial access type in 115,425 patients aged 67 and older. They demonstrated an overall significantly inferior survival in the catheter group but showed no differences in survival comparing AVG versus AVF. They further demonstrated a significant benefit with AVF over both AVG and CVC among patients aged 67 to 69 years, but outcomes with AVF and AVG were similar among patients 80 to 89 years and >90 years.(43) Drew and colleagues via a decision analysis method demonstrated that elderly patients have little survival benefit with AVFs over AVGs and CVCs.(44) Hicks et al demonstrate that AVF is superior to AVG and CVC regardless of the patient's age, including in octogenarians. However, they also reported the mortality benefit of AVG over CVC might not apply to younger (18-48 years) or older (>89 years) age groups.(45). Of course all these analyses are observational and subject to confounding as patients in whom an AVF is successfully constructed may be inherently healthier than those in whom AVF is either unsuccessful or not even attempted.

Perhaps one of the major arguments against CVCs is related to catheter-related

bloodstream infections (CRBSI). Given their poor vasculature and propensity for AVF immaturity, the elderly population is more likely to have long term CVCs and the complications that may arise from their presence. However, reports have demonstrated equivocal (46) as well as lower (47) incidence of CRBSI amongst the elderly.

A major consideration in this population is quality of life. Upon commencement of dialysis, patients will be subjected to frequent cannulations, long periods of immobility during hemodialysis, post-dialysis fatigue and possibly frequent interventions to mature and maintain their vascular access. These, in addition to the other co-morbidities, physical limitations associated with aging, and polypharmacy may result in an overall poor quality of life. Thus, when applying a patient-centered approach to the elderly population, the vascular access must be chosen based on their individual characteristics. These include prognosis for survival as identified by age, comorbidity scores, functional impairments and nutrition status. (4)

In addition to ESRD, the elderly population faces the burden of chronic kidney disease (CKD). The prevalence of CKD increases with age, from 7.2 percent at ages 65–74 to 17.0 percent at age 85 and older.(48) This high prevalence of CKD, combined with the fact that elderly patients tend to lose renal function at a slower rate than their younger counterparts (49) introduces yet another factor to be considered in terms of vascular access placement. That is, given their low incidence of progression to ESRD and overall shortened survival, the placement of an AVF may subject these patients to the complications of surgery with low likelihood of reaping the benefits.(40, 50) O'Hare and colleagues studied a cohort of US veterans and found that those who were aged >75 years

were more likely to die than develop ESRD even when their eGFRs were as low as 15-29ml/min per 1.73m2.(51) Furthermore, placement of AVFs in all patients aged >75 years with eGFR <25ml/min per 1.73m2 has been found to result in five unnecessary AVFs for every one AVF that was utilized within one year.(49, 51-55)

Vascular Anatomy

The Kidney Disease Outcome Quality Initiative (KDOQI) guidelines for hemodialysis vascular access (56) recommend that an AVF should be considered first, followed by AVG placement if AVF placement is not possible. Catheters should be avoided for HD and used only when other options listed are not available. With respect to order of creation, the following algorithm is suggested: the initial choice is that of a forearm radiocephalic fistula followed by a brachiocephalic fistula with the final option being that of a transposed brachiobasilic fistula in those with a failed forearm fistula. Should these options fail or be deemed improbable, the creation of a prosthetic AVG should be considered with a forearm loop graft preferable to a straight configuration.

Numerous factors contribute to the ideal vascular access. However, perhaps one of the most important prerequisites for an appropriate access is suitable vascular anatomy. Preoperative evaluation is essential in order to realize the ultimate goal of an ideal access. It is via this preoperative evaluation that a sequence of surgical options can be determined.(57) Preoperative vascular mapping has been shown to substantially increase the total proportion of patients dialyzing with AVFs.(58-61) The minimum criteria for venous and arterial diameter that would best support the development of a forearm AVF

are 2.5 mm and 2 mm, respectively.(62) In addition, the following factors also contribute to proper AVF placement: absence of obstruction, stenosis and thrombosis in the venous segment, a straight segment for cannulation, location within 1 cm of the skin surface and continuity with the central veins.(63)

Despite the algorithm noted in the KDOQI guidelines as well as the known factors required for proper AVF creation and development, primary maturation failure of AVFs is 30-70%. The highest rate of AVF failures is observed in older patients, female patients, African Americans, Hispanics and those with cardiovascular disease.(64) Thus, a patient-centered approach would offer the possibility of facilitating the appropriate choice of vascular access via the incorporation of anatomy along with patient attributes, values and preferences, such that the highest probability of usability of an access is made possible.

Verest et al examined the effect of clinical examination and anatomical location on native AVF maturation in high-risk patients. They found that a lower arm AVF was a significant risk factor for non-maturation and the use of upper arm AVFs if major risk factors are present can improve overall maturation rates.(65) They stressed the importance of a careful clinical exam together with an integration of risk assessment in planning for an AVF. In a similar study, Diskin and colleagues found that the upper arm as the initial site for AVF creation was associated with a significantly reduced incidence and prevalence of CVC.(66) These two studies challenge the conventional algorithm of access placement and stress the need for an overall assessment of the patient's condition prior to access surgery. Woo and colleagues found that the incidence of repeat fistula/graft creation and

tunneled catheter placement was substantially higher in the first 12 months after fistula creation compared with grafts in patients greater than 66 years old.(67) This study has been supported by previous evidence suggesting that indiscriminate placement of an AVF in elderly patients poorly suited for an AVF will result in numerous AVF-salvaging procedures that may or may not be successful and compromise quality of life. (68)

Two groups in whom the benefit of an AVF over an AVG or CVC is less likely include those with limited life expectancy (the elderly) and those with poor vasculature (elderly, diabetics and females). Lok et al devised risk equations based on the presence of four clinical predictors that were associated with failure to mature (FTM). (69) These included, age ($\geq$65), peripheral vascular disease, coronary artery disease, and white race. The four risk categories were low, moderate, high and very high based on total risk score. These categories predicted risk of FTM to be 24, 34, 50, and 69%, respectively. It is precisely this type of scoring system of personalized risk assessment that is the core of a patient-centered delivery of care model. With applying such a model, patients can be spared from repeat surgical and interventional procedures and obtain the vascular access with the highest probability of use at initiation of renal replacement therapy.

The high primary failure rates and longer maturation times of AVFs lead to prolonged catheter use and its complications. While AVGs require more interventions to maintain patency than AVFs, when factoring in the high rate of primary failures in AVFs, the cumulative patency is virtually equivalent.

While AVFs may be more cost effective when applied to an ideal population, the costs of AVFs may exceed those for AVGs, especially when dealing with a population that has a high risk of primary AVF failure.(19, 70) The one-size-fits-all model for vascular access is associated with multiple shortcomings, both clinical and financial.

Future Direction

The FFCL has fostered excellent progress in the United States with respect to vascular access goals. It is via this and other initiatives that CVC use has declined and AVF use increased. Use of CVCs in the United States is now similar to that of most European countries having the lowest levels of CVC use.(71) However, Europe continues to exceed the goals presented in the NKF-KDOQI guidelines with respect to AVF use. Other countries with high AVF incidence and low CVC prevalence have examined the subset of patients in whom CVCs and AVGs were present. A Brazilian study found that age, presence of hypertension and geographic location were factors most associated with prolonged catheter use.(72) In Taiwan, AVGs were observed most often in women, elderly persons and patients with diabetes.(73) These studies demonstrate that despite surpassing the goals for AVF prevalence, there remains a subset of the ESRD population in whom catheter elimination and AVF use may be challenging.

The QIP includes type of vascular access as two of the clinical measures for which financial penalties are determined. However, this process is devoid of an individualized clinical contextual assessment such that a universal standard is applied to a clinically

heterogeneous population. The University of Michigan Kidney Epidemiology and Cost Center, through its contract with the CMS, convened a technical expert panel (TEP) to evaluate the existing NQF (National Quality Forum)-endorsed vascular access measures. (74) Their specific objectives included: review of the current endorsed NQF vascular access measures, that is minimizing use of CVCs as chronic dialysis access and maximizing placement of AVFs, revising the vascular access measure set and the consideration of potential risk adjustments.

With respect to minimizing the use of catheters, they proposed 2 exclusions: patients with limited life expectancy and patients who have exhausted anatomic options for an AVF or AVG. A proposed list of conditions that are associated with limited life expectancy was developed and included: hospice care, metastatic cancer, and end stage liver or heart disease. The TEP further recommended that the 90-days on dialysis requirement be removed for determining the patients included in the calculation. The TEP agreed that AVFs are the preferred access for most patients, and that AVGs are still preferred to CVCs. They recommended that the AVF measure should be adjusted for conditions where an AVG might be an acceptable. These conditions included older age, diabetes, presence of vascular disease, and high BMI. The TEP further recommended that the AVF be counted only if it is being used with two needles and no dialysis catheter is present. It might further be suggested that patients' wishes be taken into account in developing metrics. If an elderly or frail patient decides after full education that they do not wish to have an AVF placed, is it appropriate to pressure them to do so?

It is these types of alterations to the current metrics that are necessary for the evolution of the QIP to make it more consistent with a patient-centered approach to care and avoid the placement of AVFs in unsuitable patients. The vascular access metrics must be aligned to encourage patient-centeredness based on medical appropriateness, patient preference, and quality of life while still recognizing the results of population studies.

Kliger describes as a balance scorecard approach to ESRD management which emphasizes that if CPMs are used to develop physician performance scores which are used to calculate physician reimbursement, then they serve not only as a quality improvement tool but also a driving force in determining the way care is provided.(75) The author further notes that the metrics used for quality reporting were developed from population studies of best practice and do not identify opportunities for individualizing care, the foundation of a patient-centered approach. His balanced scorecard consists of: population based best clinical practice, patient perceptions, and individually crafted patient goals of care. Kliger's concept is further enhanced by Nissenson's quality pyramid with biochemical and surrogate data at the base, moving into mortality, hospitalization and patient experience measures moving up the pyramid with the pinnacle representing measures of health-related quality of life.(76)

In the patient-centered approach to care the uniqueness of individuals must be understood coalescing in a tailored course of treatment. Finkelstein in his discussion of performance measures in dialysis facilities emphasizes that physicians must not be obscured by arbitrary standards and targets rather focus on tailoring treatment to maximize quality of

life.(77) It is precisely this methodology that must be applied to vascular access management. Flow diagrams for the selection of vascular access in patients at high risk for AVF failure based on age, prognosis, and vascular anatomy are proposed in Figures 3, 4, and 5, respectively.

In conclusion, while placement of an AVF may be possible in many patients, the realization that a subgroup of patients exists who are unsuitable for this particular form of vascular access is critical. By applying a patient-centered approach to the conventional vascular access algorithm, what results is an approach that lessens the costs and physical/mental pain associated with unnecessary surgical and interventional procedures with an overall improvement in an individual patient's quality of life. As nephrologists we must ensure that our patients receive the most suitable vascular access based on their unique clinical characteristics. It is the responsibility of CMS and the QIP to allow us to do so without facing penalty.

Disclosure

The authors have no relevant conflicts of interest to disclose. All authors contributed to the writing of this manuscript and gave their approval regarding submission of the final version for publication.

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Table 1. Patient Perspectives on Hemodialysis Vascular Access

Themes	Patient Perspective
Heightened Vulnerability	- Bodily intrusion - Fear of cannulation - Threat of complications and failure - Unpreparedness - Dependence on a lifeline - Wary of unfamiliar providers
Disfigurement	- Preserving normal appearance - Visual reminder of disease - Avoiding stigma
Mechanization of the Body	- Bonded to a machine - Internal abnormality - Constant maintenance
Impinging on Way of Life	- Physical incapacitation - Instigating family tension - Wasting time - Added expense
Self-Preservation and Ownership	- Task-focused control - Advocating for protection - Acceptance
Confronting Decisions and Consequences	- Imminence of dialysis therapy - Existential thoughts

From Casey et al. (24)

Figure 1.

From DOPPS Dialysis Practice Monitor. (2)

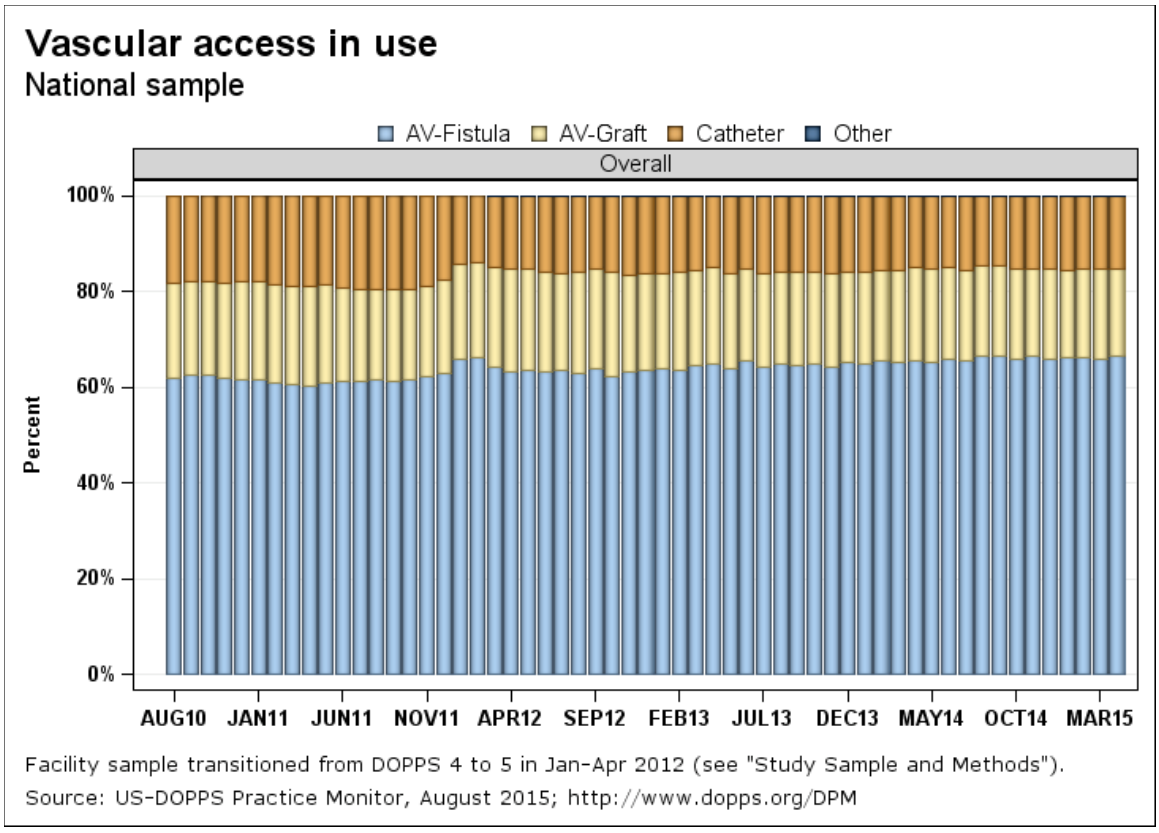


Figure 2.

Vascular access use during the first year of hemodialysis by time since initiation of ESRD treatment, among patients new to hemodialysis in 2012, from the ESRD medical evidence form (2728) and CROWNWeb data. USRDS 2014 Annual Data Report, volume 2, figure 3.15.(3)

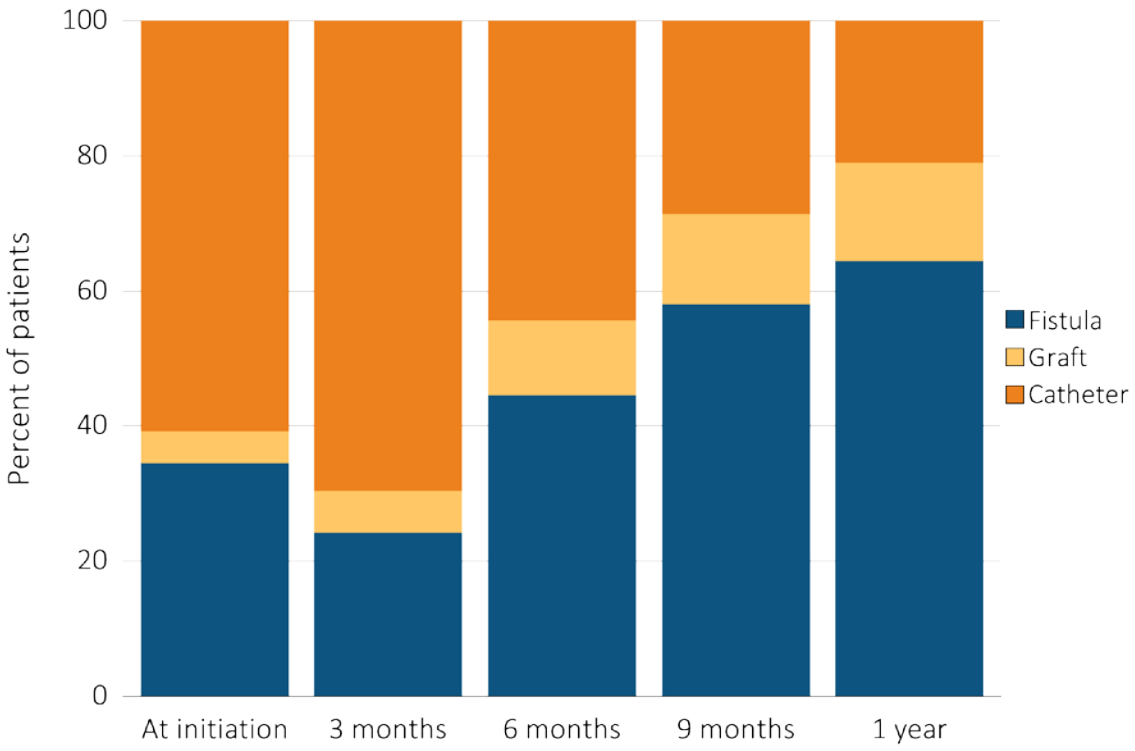


Figure 3.

Flow diagram for the selection of vascular access in elderly patients.

AVG = arteriovenous graft; AVF = arteriovenous fistula; TCD = tunneled dialysis catheter.

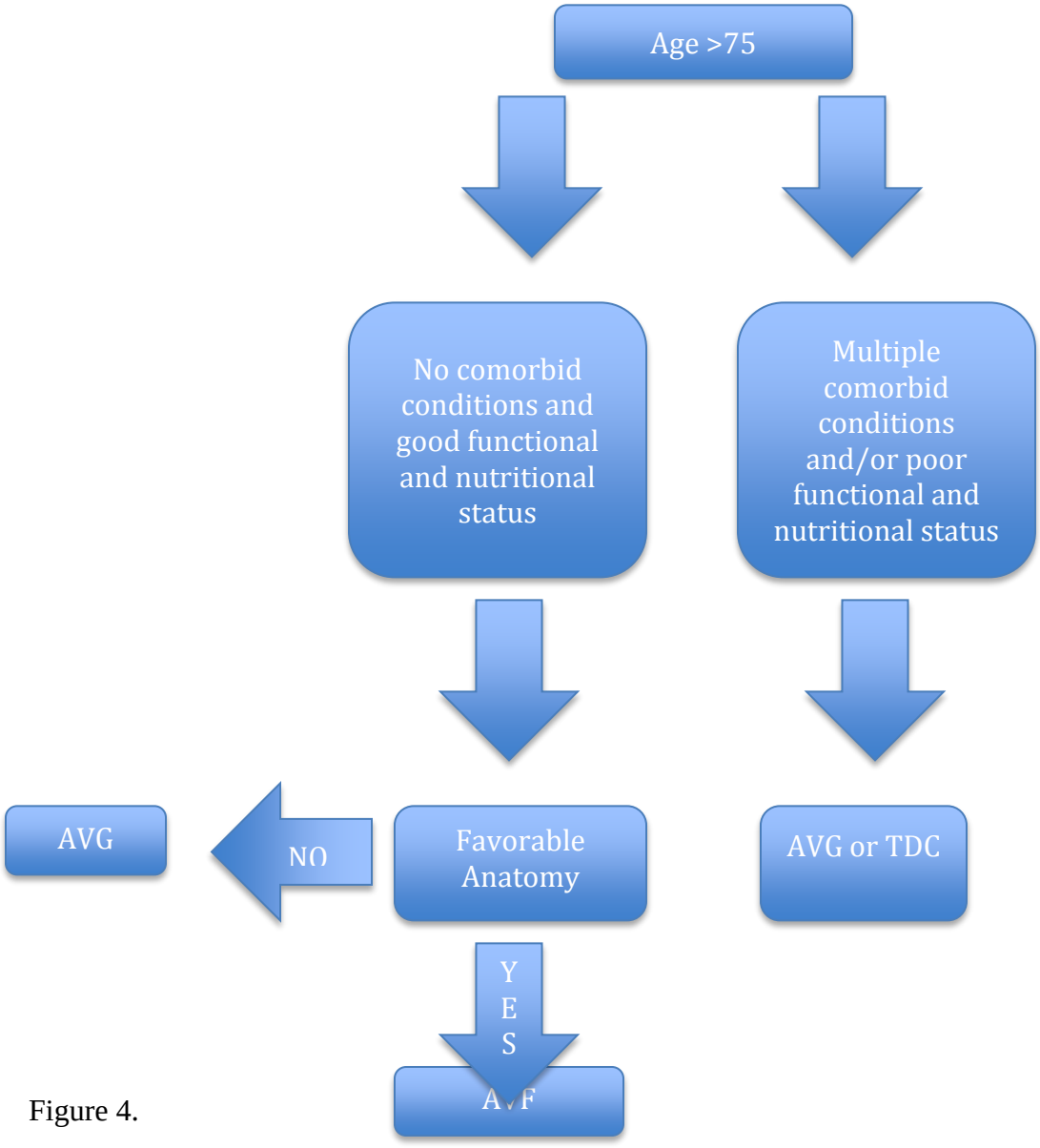


Figure 4.

Flow diagram for the selection of vascular access based on patient prognosis.

AVG = arteriovenous graft; AVF = arteriovenous fistula.

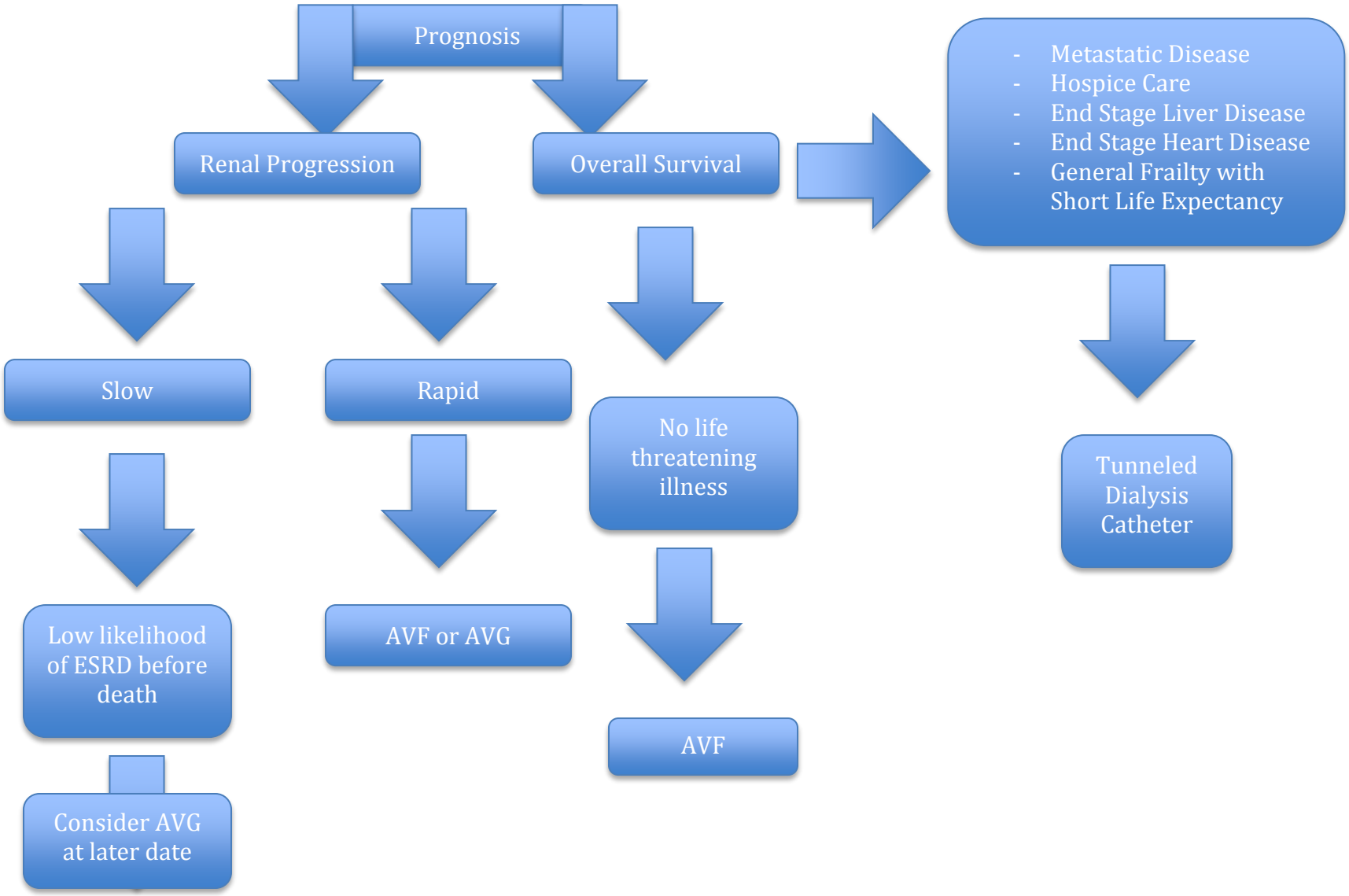
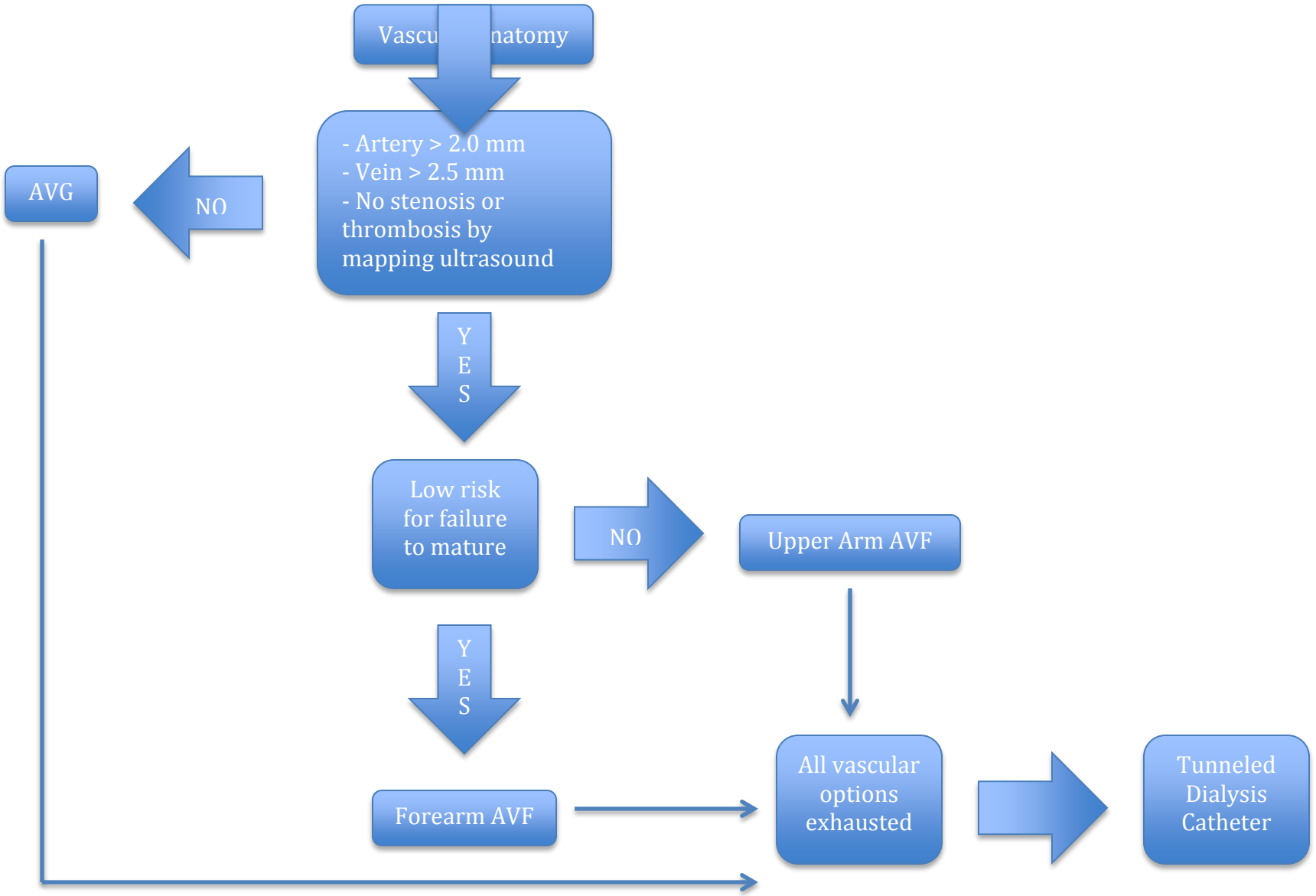

Prognosis
Renal Progression
Overall Survival
- Metastatic Disease
- Hospice Care
- End Stage Liver Disease
- End Stage Heart Disease
- General Frailty with Short Life Expectancy
Slow
Rapid
No life threatening illness
Tunneled Dialysis Catheter
Low likelihood of ESRD before death
AVF or AVG
AVF
Consider AVG at later date

Figure 5.

Flow diagram for the selection of vascular access based on vascular anatomy.

AVG = arteriovenous graft; AVF = arteriovenous fistula.


Vascu natomy
- Artery > 2.0 mm
- Vein > 2.5 mm
- No stenosis or thrombosis by mapping ultrasound
NO
AVG
YES
Low risk for failure to mature
NO
Upper Arm AVF
YES
Forearm AVF
All vascular options exhausted
Tunneled Dialysis Catheter