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# Challenges and Solutions for Optimal Arteriovenous Access Maintenance

## With Ari Kramer, MD, and Jeffrey Hull, MD

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The emergence of endovascular technologies to treat dysfunctional arteriovenous (AV) fistulas has resulted in a marked shift in practice over the past 20 years. In this article, two physicians discuss how they began work in the AV space, their current algorithms of care, and their focus on patients throughout the life cycle of dialysis access.

### What was your exposure to AV access in your early training as a physician, and how have things changed since then?

**Dr. Kramer:** I trained as a general surgeon, and my exposure as a resident was fairly limited. My residency didn't offer vascular specialty training. As a result, my skill set was rudimentary. I could tie together arteries and veins or grafts to veins, but I had no working concept of the downstream consequences of fistula creation or how to prioritize care of a renal failure patient in general. Even now, most vascular fellows only perform 10 to 15 AV cases during their 1- to 2-year program. This is understandable given the range of procedures performed as a vascular surgeon, but it does not provide nearly enough training to effectively manage access-related challenges.

**Dr. Hull:** I trained as an interventional radiologist in the 1980s, and there was minimal exposure to dialysis access.

### After your training, how did you start to focus on maintaining AV fistula patency?

**Dr. Hull:** Once I started practicing in San Diego, California, I worked with Dr. Joseph Bookstein at the University of California San Diego and started thrombolysis of clotted dialysis grafts, which were very common at that time. Declotting grafts became a big part of most interventional radiology practices in the 1990s and 2000s, until "fistula first" shifted the emphasis away from grafts. In the mid-2000s, outpatient dialysis access centers began to open, and most of the dialysis work moved out of hospitals. In 2011, my surgical colleagues and I opened up an office-based lab to provide a continuum of care for our patients based on best practices for vascular access in and out of the hospital. This outpatient center made sure patients could choose to receive care from our integrated team with the convenience typically found at the outpatient centers.

**Dr. Kramer:** After my training, I was urged by another health care professional (HCP) to work with Dr. John Ross. Visiting his program was eye-opening. He provided a template of how you could take care of dialysis access patients from intake and care coordination and through the entirety of the fistula life cycle. His approach was patient-centric,

and all of the HCPs worked together as a team. He didn't just think about access maintenance; his focus on successful dialysis was front and center.

Back at my community hospital, we had 30 surgeons who contributed to AV access care, and I persuaded them to allow me to be the primary access surgeon. I was fortunate that my hospital's administration was willing to grant me a pilot program dedicated to developing a renal care service line, which evolved into the successful program we have today. Renal care is something that, broadly speaking, is poorly understood and seems less urgent or emergent than a more obvious event like heart attack or stroke. However, I would say it's no less urgent, and the patient care plan can become far more complex and costly if not well scripted. A patient who is "crashing" into the hospital with kidney failure, gets started on dialysis with a catheter and is stabilized, and is then scheduled for a permanent access days to weeks later means the care plan is already months behind; both the patient and the hospital system will have poorer outcomes. To really get ahead of these circumstances, you need a system of well-mapped processes to coordinate and communicate among the several levels of providers to address these patients' needs far sooner.

### What's the process by which a patient in your region is referred to you/your facility for AV access maintenance?

**Dr. Kramer:** In Spartanburg, South Carolina, our facility works hard to be the central nexus and safety net for these patients. Our goal is to hire, train, and retain those HCPs who care about offering the best experience possible to our renal patients. We want to do the most good with the resources we have invested in. We are always interfacing with our partners at the dialysis centers, specifically those who do the cannulating, to ensure our work is meeting or improving patient outcomes. Still, the hardest part is getting the at-risk patient identified and sent to the referring nephrologist in the first place. One of the most frustrating things about renal care is that it seems to be the last piece of the puzzle for patients. Patients are typically seen as a series of diagnoses: a hypertensive, a diabetic, a vasculopath working to control their HbA1c. Seldom does one encounter a plan of care that has a comprehensive view of the patient with thoughts to send a consult to a nephrologist or for predialysis education on renal preservation strategies. If we had more rigorous preventive medicine that identified these patients earlier and developed a well-coordinated kidney care life plan, it would make a world of difference for retaining renal function. It's important to remember that AV access maintenance optimization really begins before the creation of an access. History has shown that if we are in a hurry to create an access because a patient with a central venous catheter has crashed into the emergency room, getting the patient educated and optimal access selected for successful dialysis is going to be challenging.

**Dr. Hull:** Patients are directly referred to our outpatient office by nephrology or are referred for dialysis access care at the hospital. We provide patients with a range of dialysis options, including catheters, peritoneal dialysis, and vascular access. When a patient is referred to us, we follow them continuously for their dialysis needs. Patients with ongoing problems are evaluated by physical exam and Doppler ultrasound and treated as needed.

### If you create fistulas as part of your practice, what factors do you take into consideration to create a fistula and ensure it is usable long term?

**Dr. Kramer:** I focus on understanding the patient: their lifestyle, education, physical attributes, abilities and disabilities, and access plan. Does the patient already have a catheter? What do their vessels look like? Do they have cardiac or diabetic comorbidities? What's their age and body habitus? How is their skin integrity? Most importantly, what do they want? From there, I think about the best options for creation that would provide successful dialysis long term. None of the current life-extending access therapies can overcome poor technical decisions and poor surgical access creation.

**Dr. Hull:** In a recent publication of more than 10,000 patients in the United States Renal Data System, 46% of fistulas were never used for dialysis.[1] A poorly planned and executed fistula is unlikely to provide adequate dialysis. Without proper creation, a mature fistula will not be reliably cannulated at the patient's home or intended dialysis center. Because there is a wide range of cannulation expertise by region and country around the world, ensuring a fistula can be cannulated is an important thing to consider in the planning process. Next, I want to make sure that there is an adequate artery and vein to create a fistula without complications of ischemia and an accessible vein (ie, is transposition required?). Once I know the options, I communicate with the patient to prioritize their access life plan. There are always trade-offs when creating fistulas, and patients need to understand that. Do you create a fistula with a smaller vein conduit to preserve the vein for future use but potentially subject the patient to fistula failure? Or, do you create the fistula that is most likely to provide successful dialysis? I am a proponent of creating fistulas endovascularly and find that I can create fistulas without sacrificing other alternatives. A minimally invasive procedure can lead to a cephalic, basilic, or brachial artery fistula depending on how the veins respond to arterialization.

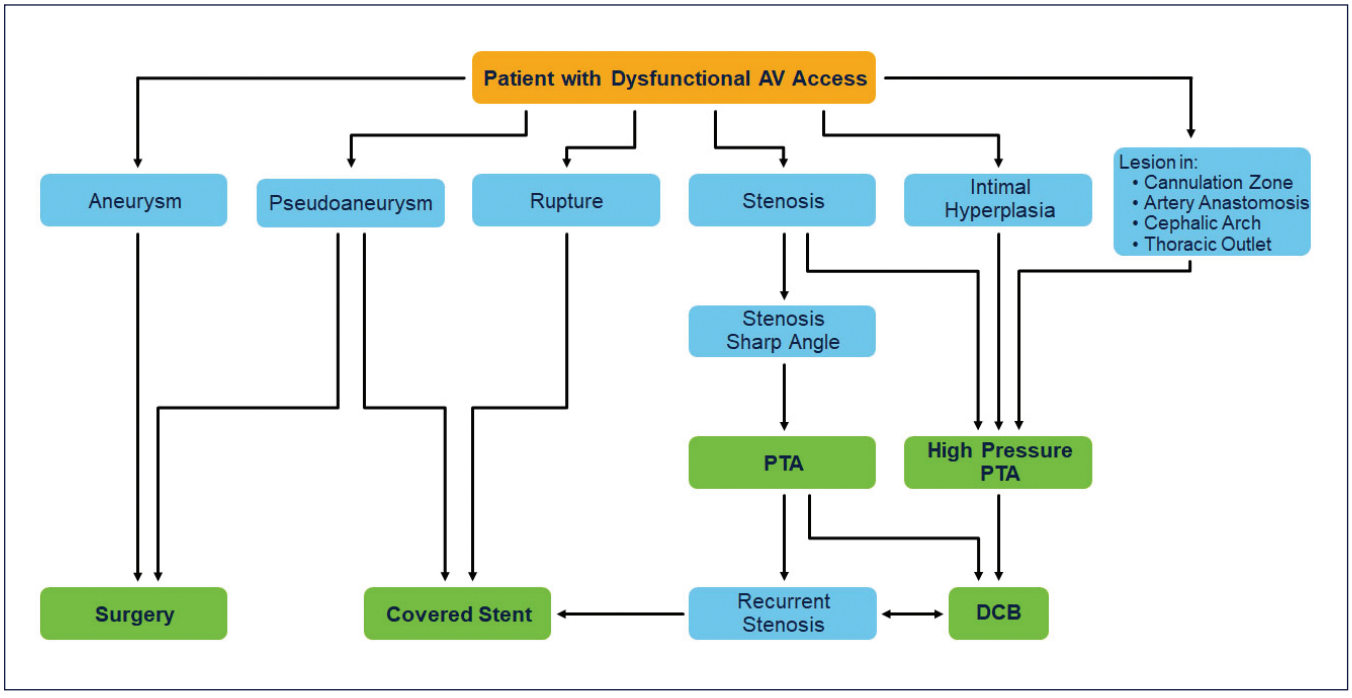


**Figure 1. Dr. Hull's algorithm for AV access maintenance.**

## What factors do you feel most often lead to fistula failure?

**Dr. Hull:** In terms of patient demographics, comorbidities that influence fistula failure include obesity, diabetes, hypertension, hypercoagulability, and smoking. For forearm fistulas, I see issues with proximal disease and low blood flow, as well as inadequate maturation and collaterals. For upper arm fistulas, I see issues primarily in the cephalic arch, proximal and distal swing segments, cannulation injuries, and central stenosis.

**Dr. Kramer:** In my experience, late identification stenosis is the predominant reason why hemodialysis access fails. Each access type has particular areas where stenosis tends to occur. Understanding the estimated likelihood of where an access is most likely to fail helps guide the clinical and ultrasound exam and then shapes my thinking and directs my operative approach. In radiocephalic fistulas, I typically see that 65% of failures are in the inflow/perianastomosis/swing segment, 20% are in the median cubital vein, and 15% are in the cannulation zone. In brachiocephalic fistulas, 75% of failures are in the cephalic arch, 10% are in the swing segment, and 15% are in the cannulation zone. In brachiobasilic fistulas, 70% of failures are in the swing segment, 10% are in the cannulation zone, and 20% are in the inflow segment. In AV grafts, 70% of failures are in the anastomosis, 20% are in the cannulation zone, and about 5% to 10% are at the arterial anastomoses. In terms of patient demographics, patients with poorly-controlled diabetes and accelerated hypertension are often the most likely to have fistula failure.

## What factors make a fistula easier or harder to treat?

**Dr. Hull:** Fistula location doesn't make much of a difference. However, we have seen that using arterial access can simplify the approach ergonomically for the operator while giving access to the whole fistula.[2] In terms of location, from most difficult to easiest to treat, I would say thoracic outlet and cephalic arch, proximal lesions including the anastomosis, swing segments, and mid fistula.

**Dr. Kramer:** Size and maturity are the primary determinants. Irregularity, tortuosity, and aneurysmal anatomy create additional challenges. Fistula location is less relevant. Tight central venous lesions can be challenging and entail the highest degree of risk. Calcification of the AV access wall and high-grade in-stent stenosis are particularly difficult. Treatment is particularly challenging in patients who are hypotensive and hypercoagulable and have a low-flow state and poor cardiac ejection fraction.

## What is your treatment algorithm for AV access maintenance?

**Dr. Hull:** First, I typically ask whether this is something I can treat as a radiologist or if the patient needs to be referred for surgery. From there, I focus on the type and location of the lesion. In terms of stenting, I keep stents out of the cannulation zone, although I am interested to

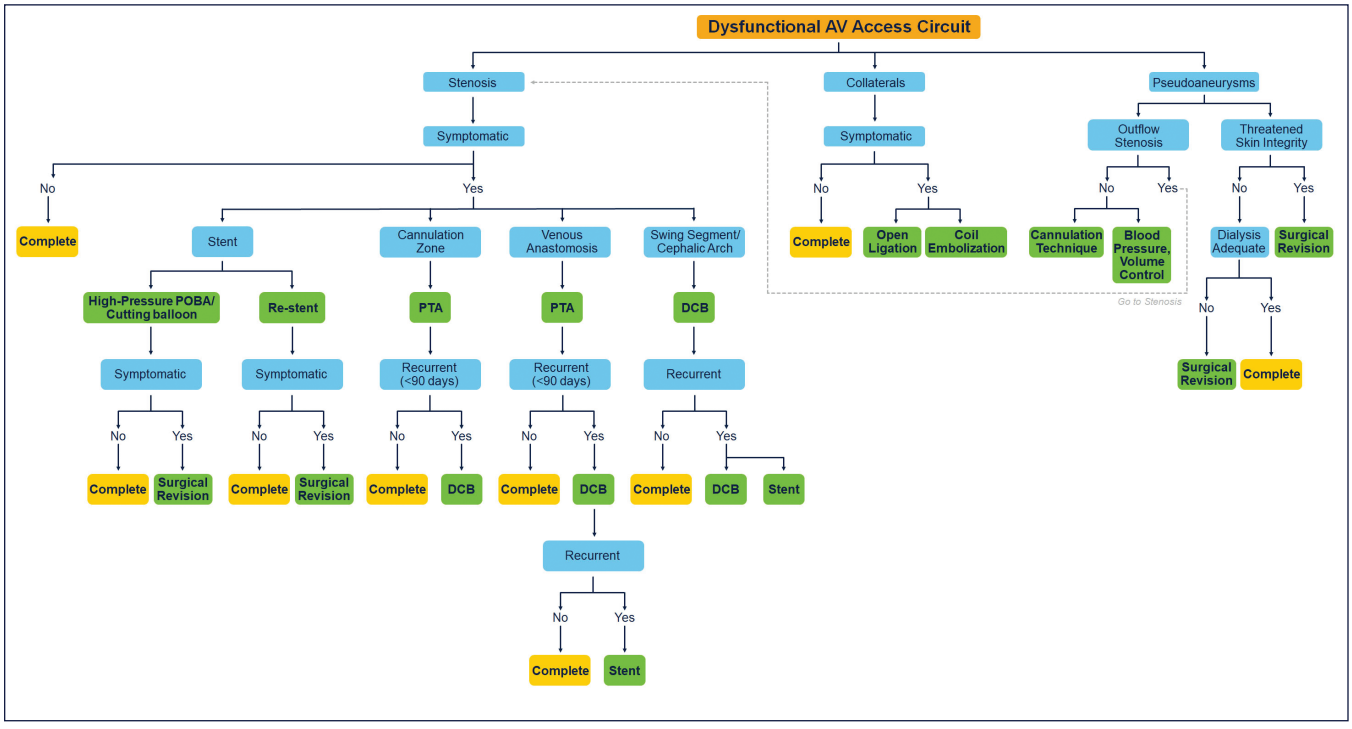


**Figure 2. Dr. Kramer's algorithm for AV access maintenance.**

see further research about the Smart stent™* (Cordis, a Cardinal Health company) in cannulation zones, as first reported by Aslam et al.[3] I also avoid stents in the artery and anastomosis to avoid compromising distal flow. Although stents in the cephalic arch are initially effective, they commonly cause subclavian vein stenosis, and stents in the subclavian veins only make things worse.[4] My current algorithm is shown in Figure 1.

**Dr. Kramer:** It's true; when you think about treating and optimizing care for any given condition, you're bound to get it wrong sometimes. It's challenging to keep up with the nuances of all the newest randomized controlled trial results and apply them to clinical practice. That doesn't even touch on how these technologies interact with running a successful practice or your part in the hospital system. Reimbursement and cost containment play a powerful role in maximizing the value proposition of what is available on the shelves. I certainly do think a lot about the technologies we have access to and how they fit into the complex system that is improving outcomes for our patients and ensuring they have successful dialysis. When it comes down to it, if you're not profitable, then your clinic closes and then you help no one. It's a constant balance to do the best that you can with the resources that are available.

Another way to look at it is with the idea that it comes down to products, patients, and techniques. Even if you have the same products, if you don't have the same technique (for example, high-quality vessel preparation), you may not get the same outcomes.

My algorithm is shown in Figure 2. Percutaneous transluminal angioplasty (PTA) is a workhorse for me. Stents can both extend and salvage AV access, and I typically try to avoid cannulation zone placement of stents in an effort to avoid or reduce stent fracture, pseudoaneurysm changes, and infection. The biggest shift in my algorithm recently happened after seeing the IN.PACT AV Access clinical trial results, especially the 56% reduction in reinterventions through 6 months compared with PTA.[5] Our institution has seen more enduring results with drug-coated balloon (DCB) than PTA alone, which helps increase access lifespan and the normal cycle of maintenance, salvage, and eventual abandonment, without the drawback of foreign body, device failure, and fatigue. Being able to leverage a technology that reduces interventions and keeps the patient out of the hospital longer has always been the goal, but I would add that it's especially important now given the current situation with the COVID-19 pandemic. DCB increases the time between reinterventions for our dialysis patients at high risk, which reduces their time in the hospital.

## Do you have any concluding remarks to share about AV access maintenance?

**Dr. Hull:** The maintenance of dialysis access is a complex and costly part of vascular access that exposes a

vulnerable population to significant morbidity and mortality.[6] When done well, there is an opportunity to improve the quality of life for our patients. The cornerstones of good maintenance are proper noninvasive surveillance and evaluation of access problems, prompt and easy access to facilities, and effective and durable procedures to maintain functional access. Vascular access has increasing numbers of bona fide subspecialists who are providing scientific evidence to improve the care of dialysis patients.

**Dr. Kramer:** Providing compassionate, efficient, effective, and durable extremity dialysis is the bedrock principle of any successful access program that is focused on patient-centered care. Leveraging promising and emerging technologies with an awareness of favorable data trends and outcomes analysis should continue to guide us forward and guard us against our biases, ensuring that our compass keeps us oriented not only philosophically to meet these aims but rationally in developing and evolving our care plans by expanding our options and our selection of products that are consistent with those efforts. ■

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