Vascular Access Monitoring and Surveillance: An Update

Amanda Valliant and Kathryn McComb

Vascular access in dialysis patients remains both a critical link to survival and a significant source of morbidity. Currently, the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) vascular access guidelines recommend routine vascular access monitoring and encourage dedicated surveillance techniques to be used for early detection of access stenosis and prevention of thrombosis. There is a paucity of clear evidence supporting 1 surveillance technique over another. The purpose of this review is to describe the benefits and limitations of various surveillance techniques commonly used in the care of dialysis patients. Further studies in this area will be useful to determine the most appropriate combination of aggressive clinical monitoring and additional surveillance data to strike a balance between graft thrombosis and unnecessary vascular interventions.

Key Words: Vascular access, Monitoring, Surveillance

Vascular access in dialysis patients remains both a critical link to survival and a significant source of morbidity and cost. There are more than 600,000 ESRD patients in the United States, with more than $49 billion spent on treatment annually.[1,2] Up to 30% of hospitalizations in hemodialysis patients are related to vascular access complications, and there are significant outpatient resources allocated to maintenance and surveillance of access.[3] Hemodialysis vascular access procedures and associated costs represent approximately 25% of total ESRD medical spending. The most common problems are stenosis, infection, and thrombosis.

The fistula first initiative has successfully increased the prevalence of arteriovenous fistulas (AVFs) and decreased prevalent catheter use in the ESRD population.[4] This has many benefits for patients, most notably reducing rates of bacteremia and other infectious complications of catheter use. Complications such as stenosis, thrombosis, and distal hypoperfusion ischemic syndrome (DHIS) continue to burden this patient population and result in substantial morbidity and cost. Underdialysis related to access dysfunction is also an important issue; every 0.1 drop in measured *Kt/V* values has been associated with 11% higher rate of hospitalization, longer hospital stays, and a $940 increase in Medicare payments in the inpatient setting.[5] As a response to these expenditures, the Center for Medicare and Medicaid Services has mandated that monitoring and surveillance care of vascular access in ESRD patients be a part of routine care with the focus on identifying and treating access dysfunction to prevent additional costs and morbidity associated with delays in treatment.[6] In addition, the current Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines recommend prospective monitoring and surveillance of AV fistulas and grafts for hemodynamically significant stenosis, largely in response to data that demonstrate decreased patency after thrombectomy in comparison with elective angioplasty. The best approach to access monitoring, however, remains controversial; some authors have argued that aggressive monitoring, while increasing rates of angioplasty, has never been shown to extend AVF/arteriovenous graft (AVG) life or improve secondary patency rates.[7]

DEFINITIONS

Access "monitoring" is defined by KDOQI in their Clinical Practice Guidelines and Recommendations as the examination and evaluation of the vascular access by means of physical examination to detect signs that suggest the presence of dysfunction, which includes changes in *Kt/V* measurements and other changes in clinical parameters. Alternatively, "surveillance" can be defined as the periodic evaluation of the vascular access through the use of testing that may involve special instrumentation and for which an abnormal test result suggests the presence of dysfunction.[8] Medicare mandates that vascular access monitoring occur monthly to include physical examination and incorporation of clinical observation, auscultation, and palpation of access and changes in *Kt/V*. Data should be evaluated by an access team and reported for each dialysis unit. Medicare also recommends that the KDOQI clinical practice guidelines be followed in terms of surveillance but does not absolutely mandate surveillance per se, presumably because of the paucity of clear evidence supporting surveillance protocols and lack of consensus regarding the best approach.

There have been many different types of surveillance techniques in use in the past 2 decades to detect early access dysfunction, ranging from various access flow measurements, duplex ultrasound (US) flow surveillance, both static and dynamic venous pressure measurements and ultrasound dilution (UD) techniques and other dilution techniques using measurements of hematocrit, and measurement of conductivity and temperature, to detect changes in flow and recirculation. The ongoing debate about the utility of surveillance techniques in vascular access largely stems from the fact that the methods used are often criticized for not being particularly reproducible

From the Division of Nephrology, University of Wisconsin Hospitals and Clinics, Madison, WI.

Financial Disclosure: The authors declare that they have no relevant financial interests.

Address correspondence to Amanda Valliant, MD, 1685 Highland Avenue, 5th Floor MFCB, Madison, WI 53705. E-mail: avalliant@wngpa.com

1548-5595/$36.00

http://dx.doi.org/10.1053/j.ackd.2015.06.002

or predictive of access thrombosis.[9-11] Conversely, some experts argue that surveillance and aggressive intervention and elective repair of subclinical stenosis may reduce the risk of thrombosis and access loss and being cost effective. An interim analysis of a previously performed randomized controlled trial (RCT) by Tessitore and colleagues[12] found that elective repair in fistulas with *Qa* more than 500 mL/min resulted in statistically significant decreases in thrombosis and access loss. Most clinical nephrologists who manage ESRD patients would likely agree that there is not 1 preferred access surveillance technique that is clearly superior or more efficacious than others. In addition, the literature in this area can be confusing at times with many of the surveillance methods known by multiple terms without a single clear designation. With continued cuts in Medicare reimbursement, it becomes increasingly important to identify a surveillance method that is effective, easy to implement, and cost-effective.

FISTULA VS GRAFT—DIFFERENCES IN SURVEILLANCE APPROACH

Grafts and fistulas have key differences when considering type, location, and likelihood of stenosis and, therefore, ideally should not be treated the same when access monitoring is considered. Grafts are much more likely to have multiple stenotic sites identified when referred for angioplasty and, specifically, tend to have stenosis at the venous anastomosis, and in a prospective study done by Maya and colleagues[13] comparing fistulas and grafts, there was also frequent stenosis within the graft itself, whereas the fistula group was more likely to have stenosis in the venous outflow tract or at the arterial anastomosis. This study also demonstrated that the positive predictive value for clinical suspicion of access stenosis based on physical examination and monitoring parameters was much higher for grafts than fistulas. Abnormalities in static venous pressures or access flow rates have not been shown to be worthwhile predictors of graft thrombosis, particularly because of the fact that when graft flows decrease below the surveillance threshold of 600 mL/min, the graft is at significant risk for thrombosis at that point.[13-15] In general, flow through a graft is typically around 1000 mL/min with flows in forearm fistulas averaging around 500 to 800 mL/min and upper arm fistulas often quite a bit higher. Many flow measurement parameters measuring upper arm fistulas are unable to quantify flow more than 2000 mL/min that can make it difficult to determine a change from baseline.[16] Although fistulas may remain patent at flows as low as 200 mL/min, the flow rates at which grafts begin to clot are much higher, typically between 600 and 800 mL/min and can be much more difficult to detect using clinical signs and physical monitoring alone. Currently, the 2006 KDOQI recommendation is to refer for further evaluation if the access flow is less than 600 mL/min or if it is less than 1000 mL/min and has decreased by more than 25% over the previous 4-month time frame.[8] This can be problematic for AV graft surveillance as the graft is already at significant risk for thrombosis at this level of flow velocity. Surveillance strategies that assess for recirculation can also be less than useful in patients with AV grafts as recirculation is commonly detected when flows are in the 350 to 500 mL/min range, again a point at which the graft is very likely to thrombose. AV fistulas, conversely, can have widely varied sites of stenosis with juxta-anastomotic lesions not uncommon and other sites of stenosis largely dependent on the location of the fistula (wrist, elbow, and upper arm).[17]

CLINICAL SUMMARY

- Monitoring and surveillance of fistulas and grafts has been poorly understood with a wealth of conflicting data to support or discourage routine surveillance.
- At this time, there is no mandate in the existing guidelines to compel dialysis providers to establish a surveillance program.
- Based on an in-depth review of the many techniques available for surveillance and conflicting data regarding improvements in access outcomes with surveillance programs, there is no clear evidence that routine surveillance is better than access monitoring with physical exam and clinical signs when done by qualified personnel.

PHYSICAL EXAMINATION

One of the cornerstones of access monitoring is physical examination of the access, both in use and at rest. A thorough physical examination, in combination with other clinical signs, such as prolonged bleeding at cannulation sites after dialysis, difficulty with cannulation or aspiration of clot during the cannulation process, infiltration, or inability to achieve target blood flows on dialysis, are very predictive of access dysfunction, and when these signs and symptoms are present further access surveillance measures may not be needed. Any of these clinical signs and symptoms in the setting of a decreased dialysis delivery dose (*Kt/V* drop >0.2 units) should prompt further evaluation of the access with imaging. In prospective studies, abnormalities of the physical examination alone are predictive of hemodynamically significant stenosis in 80% of patients with 69% and 66% positive predictive value for decrease in *Kt/V* of more than 0.2 units and symptoms with dialysis, respectively.[18] Physical examination can be performed by multiple staff members when trained appropriately and is essentially free, outside the cost of their time; however, this does require vigilance and education about the appropriate examination methods and physiology behind the examination findings (Table 1). When effectively trained personnel perform physical examination routinely to assess for signs of access dysfunction, it has been shown that stenosis can be detected much of the time with examination skills alone.[19]

DIRECT ACCESS FLOWS

Currently, the recommended practice guideline for surveillance of AV grafts is the measurement of intra-access flow through either direct or indirect means. For fistula