Monitoring and surveillance of the hemodialysis vascular access

To maintain a dialysis patient's access, patency depends on diagnostic accuracy and active and timely interventions

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The patient’s vascular access is often referred to as their “lifeline,” and without it, the life-sustaining treatment of hemodialysis would not be possible.¹ To maintain the access, patency depends on diagnostic accuracy and active and timely interventions. Complications related to the vascular access are the leading cause of hospitalization for the hemodialysis patient. ² Preventing the development of complications can reduce morbidity, improve quality of life, and reduce the costs of health care in the dialysis population.²

The Center for Medicare & Medicaid Services mandates that both monitoring and surveillance of the access be part of the dialysis care provided to the end-stage renal disease patient, with the aim of identifying and intervening at an early stage. Doing so helps control the costs of access care.¹ Various techniques are in use for this purpose; however, no clear consensus has been reached regarding the most optimal surveillance technique to identify a failing access.³
Back to basics

Many of the problems that occur in association with the patient’s vascular access can be detected by physical examination and clinical evaluation. The Kidney Disease Outcomes Quality Initiative work group stated that “physical examination and clinical evaluation are skills that can be as valuable as any surveillance method.” A brief physical examination of the patient’s access should always be performed prior to each dialysis treatment. The physical exam should include, but is not limited to:

- visual inspection of the access (for signs of infection)
- palpation to assess for evidence of stenosis or thrombosis
- auscultation with a stethoscope to identify any changes in the bruit

The patient should also be asked about any abnormal or unusual occurrences specifically involving the access that may have been experienced between dialysis treatments—bleeding, swelling, bruising, redness, drainage, pain, a change in the thrill.

Stenosis

Stenosis is defined as the constriction or narrowing within an orifice or passage. The most common type of stenosis seen in early native AV fistula is juxa-anastomotic stenosis. This is a stenotic lesion that develops in the vein just above the anastomosis. A narrowing occurs that inhibits the inflow of blood to the fistula. If untreated, the result is usually early failure of the fistula.

Juxta-anastomotic stenosis can be identified by physical examination of the access. The thrill at the anastomosis normally is continuous and very prominent. The pulse should be soft and the fistula easy to compress. In the presence of a juxta-anastomotic stenosis the thrill, which is normally continuous, is only felt during systole and a “water hammer” pulse is present at the anastomosis, instead of a pulse in a normal AV fistula. As you move up the fistula, the pulse will disappear at the site of the stenosis. When a juxta-anastomotic lesion is present, above that point, the pulse is usually weak and the vein is poorly developed.

Preventing stenosis

One of the most common complications associated with a mature AV fistula is venous stenosis.

Diagnosis of a venous stenosis can be made during routine access physical examination. Assess the thrill, pulse, and bruit. The thrill should be most prominent at the arterial anastomosis. If there are other areas on the fistula that have a marked thrill, these should be evaluated for the possible presence of a stenosis.
The pulse in the fistula normally is soft and the entire fistula is easily compressible. When the patient lifts the access-arm above his or her head, the entire fistula collapses. A venous stenosis should be suspected in a fistula if it has a water hammer pulse and the veins are firm and pulsatile. Fistulae that have venous stenosis often dilate rapidly like aneurysms. In an AV fistula with venous stenosis, the fistula distal to the stenotic area will remain distended, while the proximal section will collapse. The physical examination will help identify the location of stenotic lesion in the fistula.

There are also detectable changes in the bruit, if there is venous stenosis. The bruit changes from a low pitched and continuous sound, which can be heard during both diastole and systole, to a high pitched, discontinuous bruit that is only heard during systole. The more severe the stenosis, the more pronounced these changes.

See Table 1.

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*Abnormalities listed are for the two extremes: completely normal and severe stenosis. With lesser degrees of stenosis, the changes will be intermediate.

Significant stenosis tends towards the characteristics of a severe lesion.

In a normal functioning AV graft, the thrill should be present only at the arterial anastomosis. The pulse should be soft and easily compressible. The bruit should be low pitched and continuous. The AV graft should be examined as soon as possible after placement or surgical revision to establish baseline access parameters. All clinical findings should be documented and reviewed routinely to identify any developing complications.

Venous stenosis changes the hemodynamics in the AV graft. These changes can be detected with physical anastomosis, a soft compressible pulse, and a low-pitched, continuous bruit should be heard on auscultation. A thrill that is present within the body of the graft, a water hammer pulse, and a high pitched, discontinuous bruit are signs of access problems and should be further evaluated for possible intervention.

Stenosis within the flow path of the graft causes turbulence in the blood flow, resulting in a palpable thrill at the site of the stenosis. As the stenosis becomes more severe, the turbulence increases and the thrill becomes stronger.
When assessing a graft for changes in the bruit, the clinician should be sure to listen to the entire length of the access. Continuing to listen into the upper arm and into the axilla or subclavian area can sometimes reveal a stenosis at that point as a localized bruit or a bruit with an increased pitch.\(^6\)

Intra-graft stenoses are difficult to detect. They do not typically have an abnormal thrill. Often the lesion is diffuse so the change in the pulse is also difficult to assess. If the stenosis is large and diffuse, a change in pulse is not detectable across the affected area or lesion.\(^5\) The graft may appear to be relatively pulseless. Normally, if you were to occlude the outflow of a graft the pulse would be amplified. In the case of a diffuse intra-graft stenosis this does not occur. The bruit changes in this case, however, reflecting the changes in this type of stenosis. The bruit in an intra-graft stenosis is usually high pitched and of short duration.\(^8\)

Central venous stenosis causes swelling of the arm. The presence of scars from catheters or pacemakers over the subclavian can be signs of central venous stenosis. The patient should be referred for further evaluation and intervention.

Other monitoring parameters are:

- **Venous pressure changes.** Venous pressure is of very limited value in AV fistula surveillance. This is because most of the flow-limiting problems in AV fistula are on the arterial end of the venous needle (and of the arterial needle as well) and therefore are not detected by pressure measurements made at the venous (or arterial) needle, which only detects an outflow obstruction downstream of the measuring needle (s). In addition, the fistula has tributaries that can dissipate pressure in the presence of an outflow obstruction. Access pressure measurements are not likely to identify centrally located venous obstructions.\(^8\)

- **Pre-pump arterial pressure.** This indicates the ease or difficulty with which the blood pump is able to draw blood from the access (inflow). A significant restriction of inflow will cause an excessively negative pre-pump arterial pressure. Since most causes of AV fistula dysfunction are inflow problems, an excessively negative pre-pump arterial pressure is often the earliest indication of such a problem.

- **Access recirculation measurement.** An AV fistula may remain patent but not provide enough blood flow to meet the prescribed blood pump flow rate, resulting in underdialysis. If there is any question about adequacy of blood flow for dialysis, and if there is difficulty dialyzing the patient at the prescribed pump rate, a recirculation study will determine if the AV fistula blood flow is sufficient to meet the prescribed blood pump flow rate.

**Patient education**
An important part of patient education is on vascular access care, which should include The Fistula First/Catheter Last One Minute Access Check to assist in monitoring the access. This should be done before each dialysis treatment. Stop to look for signs of a healthy access. Listen for a bruit – a continuous, low pitched sound and feel for the thrill and temperature is the same in both arms and both hands.

**Educate, educate, educate**

Continuing education for staff on vascular access monitoring and physical examination/assessment of the access should be done on a routine basis. Fistula First/Catheter Last One-Minute Access Check assists staff on how to perform a quick access check and what to do to determine if there is a problem – look, listen, feel, and augmentation test.

Clinical signs and symptoms of AV access insufficiency are such things as:

- Access collapse suggesting poor arterial inflow
- Poorly matured fistula
- Loss of thrill
- Distal limb ischemia
- Clinical signs of infection
- Aneurysm or pseudoaneurysm
- Abnormal access function includes such things as:
  - Difficult cannulation
  - Thrombus aspiration
  - Elevated venous pressure > than 200 mm Hg at a 300 mL/min blood pump
  - Elevated recirculation time of 15% or greater
  - Low Kt/V <1.2 or urea reduction rate of less than 60%

**Stenosis surveillance**

Stenosis surveillance is “the periodic evaluation of the vascular access by using tests that may involve special instrumentation and for which an abnormal test result suggests the presence of dysfunction.”

K-DOQI recommends the following methods for stenosis surveillance.

- Color flow doppler
- Static venous pressure
- On-line clearance/Access flow methods

Color–flow Doppler or duplex ultrasound, duplex Doppler study, or Doppler color-flow study are done every three months. This imaging allows identification and localization of abnormalities, which may potentially threaten access function and patency.
Static venous pressure (SVP) is measured and recorded every two weeks. SVP monitoring is preferable to dynamic venous pressure monitoring by the KDOQI work group. This method, requires consistency in measurements and the use of a simple formula to calculate an intra-access pressure ratio.⁸

In-center access flow measurements can be done by reversing bloodlines to induce recirculation. Access flow is then calculated either manually, using a mathematical formula, or via a computer program. The measurements can be done using Transonic, Cardiodynamic, or similar devices or may be done using the hemodialysis machine with access flow measurement capability. Measurements are usually done on a monthly basis.

Some hemodialysis machines have added sensitive conductivity meters at the dialysate inflow and outflow ports to monitor small solute clearance during hemodialysis as a measure of adequacy (OLC). A method was devised to measure access flow using these meters. Altering the proportioning ratio of dialysate concentrate to water during dialysis changes the dialysate sodium concentration. The sodium dilution and the resultant change in conductivity in the dialysate (called conductivity or ionic dialysance) serve as the indicator for measuring access flows. Measuring the dialysance with the bloodlines in their usual position and after reversal allows calculation of access flow (QAC). The dialysance technique eliminates the need for an accurate measurement of blood flow. This technique assumes, however, that there is no recirculation when the bloodlines are in the normal position. It also has been known to underestimate access flow compared with the ultrasound dilution technique at access flows below 1,000 mLs/minute.

Other surveillance methods that are and have been used:

Dynamic venous pressure. Venous pressure is recorded at a pump speed of 200 mLs/min during the first 2-5 minutes of every dialysis treatment, using the same size fistula needle each treatment, usually 15 gauge. While baseline pressures vary with different machines, pressure readings should be close to 125-150 mmHg. Three consecutive readings greater than 150 (or facility specific baseline) are significant and should prompt a fistulogram. This method is not recommended anymore by KDOQI.⁴

The Vasc-Alert access surveillance program works by analyzing treatment data to derive the intra-access pressure at the arterial and venous needle sites. When the pressure trend increases, it is an indication that stenosis may be growing. Weekly reports alert staff to possible issues allowing for quick evaluation and intervention. The continually recorded data from the dialysis center’s EMR for every treatment session is used to calculate the actual pressure in the access. The patient data is automatically tracked and analyzed by the system. If the pressure exceeds a preset threshold for three consecutive treatments, an alert is sent to the center indicating the patient should be examined for possible stenosis. This surveillance system does not require staff to spend time testing the access, nor is the patient’s dialysis session altered while this testing is being performed. The treatment data being recorded in the EMR serves as the raw test input data. No additional data collection steps are required by the patient or staff.¹¹
A major emphasis at our center is on educating the staff to perfect their physical examination skills of the vascular access. The goal is to improve the longevity of the access, reduce the number of thrombosis, and reduce the need for catheters. One of the interventional nephrologists that we work with has taken great interest in staff education. He has done a number of continuing education programs for the staff on physical assessment of the access and he makes rounds on patients periodically with the staff. An access assessment will be done on the patients, which has been very beneficial to both the staff and patients. It provides patients with additional education specifically on their own access.

Summary

The physical exam, the clinical assessment, along with the surveillance tool we use has provided us the ability to identify access problems or potential problems. Abnormal surveillance data is always correlated with physical exam and clinical findings to determine the need for intervention.

Monitoring and surveillance of vascular access are an integral part of the care of the hemodialysis patient. There are different techniques and methods available for identifying access dysfunction. Despite multiple studies that have been performed, there is still no consensus as to the best methodology to use. Physical exam and clinical evaluation remain key in detecting access problems. This along with a surveillance method chosen by the clinic can provide early identification of stenosis allowing for timely intervention of access dysfunction.

**Better management, better outcomes**

In taking steps to improve our approach to access management, we had several goals in mind:

- improve (lengthen) access survival rates
- decrease the number of clotted accesses
- decrease the number of catheters in use > 90 days

We tried a number of different surveillance methods over the years, finally choosing one that gave us the most accurate information on our patient accesses with the least amount of extra staff time, supplies, etc.
We conducted numerous staff in-services on vascular access, from basic A&P, physical exam, and clinical indicators and evaluation. This was done through lectures, discussions, CDs, handouts and hands-on demonstration with the help of an interventional nephrologist.

Staff attended outside conferences and seminars on vascular access and spent a day with the interventional nephrologist doing access evaluations, fistulograms, angioplasties, and thrombectomies. The interventional nephrologist comes to the unit on a periodic basis to help coach staff in cannulating difficult accesses he had worked on. We continue the above on an ongoing basis, trying to perfect staff skills and comfort level doing physical exams and clinical evaluation on accesses.
Patient education regarding access care is done on a routine basis. This includes general care of the access and how to do a basic check—look, listen and feel. Patients have participated in staff education sessions with the interventional nephrologist, which has not only been helpful to the staff, but the patients.

References


11. www.vasc-alert.com

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