PROVINCIAL VASCULAR ACCESS GUIDELINE

Selection of Permanent Hemodialysis Vascular Access

BCRenal
an agency of the Provincial Health Services Authority

TABLE OF CONTENTS

1.0 SCOPE

An arterio-venous fistula (AVF) is the recommended access for chronic hemodialysis patients. This guideline outlines recommendations for selection of permanent vascular accesses and the preferred order of placement.

Related Guidelines:

BC Provincial Renal Agency Guidelines (www.bcrenalagency.ca):

- Assessment of Newly Created AV Fistulas and AV Grafts.
- Chronic Kidney Disease: Vein Preservation.
- Insertion and Removal of Tunneled Hemodialysis Catheters.
- Provincial Vascular Access Guideline for Patients with Hemodialysis as Their Primary Modality.

National & International Nephrology Guidelines:

- Canadian Society of Nephrology Guidelines. (2006). Chapter 4: Vascular Access, *Journal of American Society of Nephrology*,17, S16-S23.
- National Kidney Foundation. KDOQI Clinical Practice Guidelines and Clinical Practice Recommendations for 2006 Updates: Hemodialysis Adequacy, Peritoneal Dialysis Adequacy and Vascular Access. Guideline 3: Cannulation of Fistulae and Grafts and Accession of HD Catheters and Port Catheter Systems and Guideline 4: Detection of Access Dysfunction: Monitoring, Surveillance, and Diagnostic Complications, *American Journal of Kidney Disease*, 8(Suppl. 1), S201-S233.

2.0 RECOMMENDATIONS & RATIONALE

Recommendation 1: The order of preference for HD access for patients requiring chronic hemodialysis is AV fistula, then AV graft, then catheter (evidence).

A **Fistula First** philosophy is paramount and every effort should be made to create a native AV fistula (AVF) for patients requiring chronic hemodialysis access. It is recommended that nephrologists refer patients to surgeons for "AVF only" evaluation.

Referrals for AVF creation should be made when the glomerular filtration rate (GFR) is approximately 15 mL/min/1.73m^2 or the GFR is 15-20 mL/min/1.73m^2 and the patient is expected to require dialysis within 12-18 months.

This timeline assumes that the anticipated surgical wait time for fistula creation is consistent with the BCPRA guideline "Indications & Urgency Criteria for Surgical Hemodialysis Procedures[1]" at www.bcrenalagency.ca/professionals/VascularAccess/ProvGuide.htm.

- For CKD patients whose anticipated dialysis start is within 3 months, the target wait time between decision date and surgery date is 4 weeks.
- For CKD patients whose anticipated dialysis start is within 3 to 6 months, the target wait time from decision date and surgery date is 6 weeks.

Of the three types of accesses, AVFs have the lowest rate of thrombosis and require the fewest interventions, resulting in longer access survival rates. As well, the costs of implantation and access maintenance of AVFs are lower than for AV grafts (AVGs) or catheters. The thrombosis and infection rates are reported to be approximately one-sixth and one-tenth respectively for AVFs in comparison to AVGs and the difference is even more dramatic when compared to catheters. AVFs are associated with increased survival and fewer hospitalizations.

Consideration should be given to creation of an AVF in the first instance as well as after any access failure.

Limited circumstances in which an AVF or AVG may not be appropriate include:

- Life expectancy ≤ 6 months.
- Expected duration of therapy ≤ 6 months.
- AVF maturity is not likely to occur.
- No sites left for creation/insertion of AVF/AVG.

[1] Waiting times in the BCPRA guideline are the same as those listed on the Vascular Surgery Provincial List of Patient Condition, Diagnosis Descriptions & Priority Levels (2010; Surgical Patient Registry).

Recommendation 2: To facilitate patients having a functional permanent HD access upon initiation of dialysis, target the following timelines for HD access creation/placement (evidence):

- **AVFs: >3-4 months prior to the anticipated start of HD.**
- **AVGs: 3-6 weeks prior to the anticipated start of HD.**
- **Catheters: as close as possible to the anticipated start of HD.**

Ideally, patients will have a functional permanent access (preferably AVF) at the time of dialysis therapy initiation. Timely attempts to create a primary fistula before the anticipated need for dialysis therapy allows enough time for the AVF to mature and sufficient time to perform another VA procedure if the first attempt fails. The latter minimizes the chances that a temporary access will be required.

While AVF maturation time varies among patients, most agree AVFs should not be used within the first month after creation because premature cannulation may result in greater incidences of infiltration, with associated compression of the vessel by hematoma and permanent loss of the AVF. AVGs should not be cannulated until the swelling has subsided (may take up to 6 weeks).

Recommendation 3: Prior to placement of a permanent HD access, undertake a thorough evaluation, including (1) a history and physical examination; and (2) mapping of vessels using ultrasound and/or venography in all patients (evidence).

History and Physical Examination:
Emphasis should be placed on aspects of the patient history and physical examination that might affect placement of the access. Highlights are listed in Appendix 1.

Mapping of Vessels:
As per the K/DOQI guidelines, vessel mapping (both arterial and venous) should be performed as part of the preoperative HD access evaluation on all patients. Preoperative vascular mapping has been shown to increase the proportion of patients dialyzing with fistulae.

While ideal, time and resources may limit the ability to perform vessel mapping on all patients. Vessel mapping, however, needs to be available at sites where AVF and AVG surgery is performed.

Patients who fulfill ALL of the criteria below are at lowest risk of fistula failure. If a patient meets all of these criteria and a fistula is planned by the surgeon, vessel mapping may not be required.

- Normal blood pressure with a differential of <10 mm Hg between the two arms
- Normal Allen Test
- Absence of edema or collateral veins (chest, breast, and upper arms)
- No difference in arm sizes
- Visible vein, easily palpable, ≥2.5 mm in diameter for AVFs or ≥4.0 mm for AVGs, and with a straight segment (enough to allow rotation of cannulation sites) which lies within 1 cm of the surface
- No evidence of previous catheter insertions
- Non-diabetic

Vessel mapping should be performed on all patients who do not meet all of the criteria listed above.

The use of duplex ultrasound is the preferred method for vessel mapping, especially for complex cases. Such mapping is performed in radiology by trained radiologists and/or ultrasound technologists.

At a minimum, vessel mapping via portable ultrasound is recommended. Such mapping may be performed by trained nephrologists, vascular surgeons, and nurses that have been authorized to do so by the College of RNs of BC (CRNBC). If portable ultrasound is used, duplex ultrasound needs to be available for more detailed mapping as indicated.

There is no generally accepted "standard" for what constitutes vessel mapping. The *arterial* evaluation should include pulse examination, differential blood pressure measurements, and assessment of the palmar arch for patency, arterial diameter, and the presence of arterial calcification. Studies suggest a minimum arterial diameter of 1.6 mm (preferably 2.0 mm) is required for successful fistula creation. *Venous* evaluation should include a luminal diameter of ≥2.5 mm, continuity with the proximal central veins, and absence of obstruction.

Central veins may be assessed indirectly using duplex ultrasound or magnetic resonance angiography (MRA) or directly using venography. Compared with venography, duplex ultrasound had a specificity of 97% and sensitivity of 81% in detecting central vein occlusion (no statistics available for MRA). For patients not yet on dialysis, the benefits of venography must be weighed against the risks associated with exposure to contrast media.

Again, weighing the benefits against the risks associated with exposure to contrast media for patients not yet on dialysis, venography is indicated prior to access placement in patients with any of the following:

1. Edema in the extremity of a planned access site;
2. Collateral vein development in a planned access site;
3. Subclavian vein catheter (current or previous) in the venous drainage of a planned access site (aka PICC lines);
4. Transvenous pacemaker (current or previous) in the venous drainage of a planned access site;
5. Previous arm/neck/chest trauma or surgery; and/or
6. Multiple previous accesses in the extremity of a planned access site.

Recommendation 4: If the vessels are adequate, use the non-dominant arm for creation/ placement of a permanent HD access; if not, use the dominant arm (evidence).

The non-dominant arm is generally preferred to the dominant arm for the creation of VAs because it (1) allows patients to continue to use their dominant arm during hemodialysis; and (2) is less likely to be inadvertently traumatized through the use of the arm in daily activities (dominant arm is used more often). If the vessels in the non-dominant arm are not adequate for a permanent HD access, use the dominant arm.

Recommendation 5: For AV fistulas, the preferred order of creation is (evidence):
(a) Radio-cephalic fistula (RCF) (wrist, forearm or elbow)
(b) Brachio-cephalic fistula (BCF) (elbow)

When planning permanent access placement, the most distal site (i.e. wrist) should be considered first in an effort to permit the maximum number of future access possibilities.

Wrist, forearm, and elbow AVFs are preferred because of superior patency rates in comparison to other accesses, lower complications rates, and early signs of flow increases (first week). Wrist and forearm AVFs maximize the options for future accesses but have lower blood flow rates and are more difficult to cannulate when compared to elbow AVFs. Elbow AVFs are more difficult to create and are associated with higher incidences of steal compared to wrist and forearm AVFs.

Recommendation 6: If an AV fistula created in the wrist/forearm/elbow fails, attempt to move up the same arm for the second AV fistula if the vascular anatomy is favorable (evidence).

Recommendation 7: If a RCF or BCF is not possible, second line options include the following fistulas, in alphabetical order (evidence):
(a) Radio-basilic with vein transposition
(b) Transposed brachio-basilic fistula (tBBF)
(c) Transposed brachio-cephalic fistula

If a wrist, forearm, or elbow AVF cannot be created, consider a transposed fistula. The disadvantage of this type of fistula is a higher incidence of steal and arm swelling than other types of AVFs and more technically challenging to create.

The second line options listed above are not exhaustive and will depend on the local vascular surgeon's expertise and the vascular anatomy of the patient. It is recommended that surgeons become skilled in vein transposition techniques as that will support the creation of native AVFs in a larger proportion of patients.

Recommendation 8: If a native fistula is not possible, an AV graft is acceptable and is preferred to a catheter (evidence).

If all potential AV fistula sites have been exhausted, a polytetrafluoroethylene (PTFE) graft is acceptable and preferred over bovine grafts. There is no evidence available yet on the efficacy of newer synthetic materials.

The preferred site and type of graft is a forearm curved looped radiocephalic graft. This is followed by an upper arm straight graft. The least preferred sites and types of grafts are forearm straight radial cephalic and looped thigh grafts. The configuration and location of the graft needs to be at the discretion of the surgeon taking into account each patient's specific anatomic restrictions. The temptation to construct AVGs using larger more proximal vessels should be resisted. Although these have higher flow and better initial function and/or patency, they limit potential sites for future AVF placement.

Recommendation 9: In patients with AV grafts, consider secondary AV fistulas placement (evidence).

Successful conversion of functioning AV grafts to AV fistulas has been reported and is recommended.

Recommendation 10: Use tunneled cuffed catheters as a last option for chronic hemodialysis access; if used, the preferred site is the right internal jugular vein (evidence).

An AV fistula is the recommended access for chronic hemodialysis patients. Despite this recommendation, tunneled cuffed hemodialysis catheters are required to be used in select groups of patients.

Other options than the right internal jugular vein include:

- Left internal jugular vein
- Subclavian veins – only when jugular options are not available
- Femoral veins
- Translumbar access to the inferior vena cava

Notes regarding site selection:

- Tunneled cuffed catheters should not be placed on the same side as a maturing or planned AV access, if possible.
- If a femoral vein is chosen, the length of the catheter must be at least 20 cm to avoid recirculation.

Fluoroscopy is advised for insertion of all cuffed dialysis catheters with the catheter tip adjusted to the level of the caval atrial junction (evidence).

Recommendation 11: In patients with advanced kidney disease (eGFR <30 mL/min/1.73m^2), make every effort to preserve forearm and upper arm veins (evidence).

Preservation of veins in patients with advanced kidney disease not currently on dialysis is important as these veins will be needed if the patient requires hemodialysis (HD). Similarly, preservation of veins in patients currently on PD or with a functioning kidney transplant is important as failure of either modality may result in the need for HD. Finally, preservation of veins in patients currently on HD is important in the event a new access is required.

If peripheral venipuncture is required in patients with advanced kidney disease, the location, in order of preference, is:

Access in place:

1. Dorsal veins of the hand of the arm without the access.
2. Dorsal veins of the hand of the arm with the access.
3. Forearm veins of the arm without the access.
4. Forearm veins of the arm with the access.

No access in place:

1. Dorsal veins of the dominant hand.
2. Dorsal veins of the non-dominant hand.
3. Forearm veins of the dominant arm.
4. Forearm veins of the non-dominant arm.

If a central line is required:

1. Try to avoid the use of peripherally inserted central catheters (PICCs); PICCs are associated with high incidences of upper-extremity venous thrombosis.
2. Try to avoid the use of the subclavian veins (associated with high incidences of central venous stenosis).

The plan for vein preservation can be further refined once the access site has been determined (the sooner the site is selected, the better). If needed, venipuncture, blood pressure readings, insertion of catheters, etc. should be done using the non-access arm.

Educating patients about veins and how to preserve them is important. Providing them with a vein preservation wallet card and purple wristband labelled "I'm a Renal Patient: Use Hand Veins Only" (to be worn on the arm that is to be used for bloodwork) helps to reinforce the message.

3.0 REFERENCES

Allon, M. (2007). Current Management of Vascular Access. *Clin J Am Soc Nephrol*, 2, 786-800.

Davidson, I., Chan, D., Dolmatch, B. et al. (2008). Duplex ultrasound evaluation for dialysis access selection and maintenance: a practical guide. *J Vasc Access*, 9, 1-9.

Hakim, R.M., Himmelfarb, J. (2009). Hemodialysis access failure: a call to action-revisited. *Kidney Int.*, 76(10), 1040-1048.

Lee, T., Roy-Chaudhury, P., and Thakar, C.V. (2011). Improving incident fistula rates: a process of care issue. *Am J Kidney Dis*, 57(6), 814-817.

Mendelssohn, D. et al. (2011, Jan/Feb). Report of the Canadian Society of Nephrology Vascular Access Working Group. *Seminars in Dialysis*, 25(1), 22-25.

Sidawy, A. et al. (2008). The Society for Vascular Surgery: Clinical practice guidelines for the surgical placement and maintenance of arteriovenous hemodialysis access. *J Vasc Surg*, 48(Suppl. 5), 2S-25S.

Tordoir, J. et al. (2007). EBPG on Vascular Access. *Nephrol Dial Transplant*, 22(Suppl. 2), ii88-ii117.

4.0 SPONSORS

This provincial guideline was developed to support improvements in the quality of vascular access care delivered to patients with chronic kidney disease in BC. Based on the best information available at the time it was published, the guideline relies on evidence and avoids opinion-based statements where possible. When used in conjunction with pertinent clinical data, it is a tool health authorities and health professionals can use to develop local guidelines.

Developed by a Vascular Access Working Group of multidisciplinary care provides from across BC, the guideline was approved by the provincial vascular access services team (PVAST) and the BC Provincial Renal Agency medical advisory committee (MAC). It has been adopted by BCPRA as a provincial guideline.

5.0 EFFECTIVE DATE

- Effective date: May 11, 2007; updated April 16, 2013.

This guideline is based on scientific evidence available at the time of the effective date; refer to **www.bcrenalagency.ca** for the most recent version.

Appendix 1: Key Elements of a Patient History and Physical Examination Prior to Access Placement

BCRenal an agency of the Provincial Health Services Authority

Table 1: Key Elements of a **Patient History** Prior to Access Placement

HISTORY	RELEVANCE
History of: • Previous CVC • Pacemaker use	Associated with higher likelihood of central venous stenosis.
History of: • Arterial or venous peripheral catheter • Diabetes mellitus • Previous vascular accesses • Previous arm, neck, or chest surgery/trauma	Potential damage to target vasculature limiting viable access sites.
History of severe CHF	Access may impact hemodynamics and cardiac output.
History of anticoagulant therapy or any coagulation disorder	May cause clotting or problems with hemostasis of access.
History of heart valve disease or prosthesis	Rates of infection of access types may influence choice of access.
Presence of co-morbid conditions that may limit life expectancy (e.g. malignancy)	Short life expectancies may not justify the use of certain accesses.
Anticipated kidney transplant from living donor	Depending upon the timing of the transplant, catheter access may be sufficient.

Table 2: Key Elements of a **Patient Physical Examination** Prior to Access Placement

PHYSICAL EXAM		EXPECTED FINDINGS/RELEVANCE
Arterial system	Quality of peripheral pulses, supplemented by hand-held Doppler evaluation when indicated	Normal (vs. diminished or absent) pulses (axillary, brachial, radial, and ulnar pulses) are indicative of the suitability of arterial access.
	Differential BP measurements between the two arms	• Normal: differential of <10 mm Hg. • Marginal: differential of 10-20 mg Hg. • Problematic: differential of >20 mm Hg.
	Results of Allen Test (assessment of palmar arch pressures to predict arterial sufficiency in the hand)	• Normal: colour returns to the blanched palm upon release of arterial compression. • Abnormal: blanching persists for ≥5 sec after release of the ulnar and/or radial artery. • May contraindicate creation of a radial-cephalic AV fistula (risk for steal syndrome is high if abnormal Allen Test).
Venous system	Edema or collateral veins (chest, breast, and upper arms)	Indicative of venous outflow problems.
	Comparison of arm sizes	Different arm sizes may indicate inadequate veins or venous obstruction.
	Tourniquet venous palpation with vein mapping using colour flow Doppler ultrasound	Venous requirements for AVF include: • Luminal diameter ≥2.5 mm at the anastomosis. • Straight segment of vein (enough to allow rotation of cannulation sites) which lies ≤1 cm of the surface • Continuity with the proximal central veins
	Evidence of: • Previous CVC or peripheral venous catheterization • Arm, chest, or neck surgery/trauma	• Previous CVC increases likelihood of central venous stenosis. • Previous peripheral venous catheterizations or arm/chest/neck surgeries/ trauma increases likelihood of potential damage to target vasculature thereby limiting viable access sites.
CV	Evidence of heart failure	Access may alter cardiac output.

Sources: K/DOQI Guidelines, Guideline 1: Patient Preparation for Permanent HD Access, page S190 and Beathard, G. (2003). Physical Examination of Dialysis Vascular Access, Fistula First Initiative.