

Rope Ladder Cannulation of AV Fistulas and Grafts



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1.0 SCOPE

This guideline makes recommendations about skill levels and procedures with regard to cannulation of AV fistulas (AVFs) and grafts (AVGs) using the rope ladder technique.

This guideline applies to adult patients and a select set of pediatric HD patients. Note that for *pediatric* patients, the needle gauge is matched to the size of the patient's AVF/AVG and the required blood flow as prescribed by the physician.

Related Guidelines:

- BC Provincial Renal Agency. Assessment of Maturation: AV Fistula and Graft.
- BC Provincial Renal Agency. Buttonhole Cannulation of AV Fistulas.
- BC Provincial Renal Agency. Use of Topical Anaesthetics to Ease Cannulation Pain.
- BC Provincial Renal Agency. Provincial Recommendations for VA for Patients with HD as Primary Modality.
- BC Provincial Renal Agency. Use of Topical Anaesthetics to Ease Cannulation Pain.
- Canadian Society of Nephrology Guidelines. Chapter 4: Vascular Access. *Journal of American Society of Nephrology*, 17: S16–S23, 2006.
- 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, *American Journal of Kidney Disease*, 48:S210-S209, 2006 (suppl 1).
- Nephrology Clinical Educators Network (CEN) and Canadian Hemodialysis Access Coordinators Network (CHAC), Nursing Recommendations for Management of Vascular Access in Hemodialysis Patients, Suppl 1 (unpublished DRAFT Aug 2012).

2.0 RECOMMENDATIONS, RATIONALE & EVIDENCE

Recommendation 1: The skill level of cannulators is matched to the degree of difficulty of a specific access to cannulate (opinion).

Cannulation is a learned skill which improves with practice. Without good cannulation skills, an AVF or AVG can be damaged or destroyed. Research suggests that inexperienced dialysis staff have higher rates of access infection, infiltration, and loss.

Cannulation skills of hemodialysis (HD) RNs are assessed by advanced cannulators that have been delegated by the unit manager as “cannulator assessors.” HD RNs may be designated as novice, skilled, or advanced.

The degree of difficulty of a specific access to cannulate is assessed by two nurses (one of which is an advanced cannulator) and designated as easy, moderately complicated, or complicated.

The skill level of the cannulator is matched to the degree of difficulty of a specific access to cannulate in considering patient assignments.

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Skill Level of Cannulator	Access Rating Approved to Cannulate
Novice	Easy
Skilled	Easy & moderately complicated
Advanced	Easy, moderately complicated, & complicated

Recommendation 2: Initial cannulation is attempted only after:

- **If AVF, there are signs that maturation has occurred; or if AVG, there is no longer swelling in the AVG limb; AND**
- **A physician, vascular access (VA) coordinator, or advanced cannulator (opinion) has confirmed the access is ready to cannulate.**

Generally speaking, AVGs should not be cannulated for at least 2 weeks after placement and not until the swelling has subsided enough to allow palpation along of the course of the graft. Exceptions to the 14-day guideline may apply when a patient requires hemodialysis, has no other access, and a physician’s order has been obtained.

Assessing the maturation of an AVF is more difficult than an AVG. Some AVFs may be mature enough to cannulate as early as one month post-creation while others may require several months or may never be mature enough to cannulate. Premature cannulation may result in infiltration with associated compression of the vessel by hematoma and a permanent loss of the AVF.

A study conducted by Robbin et al. reported that experienced dialysis nurses were able to accurately predict the ultimate utility of an AVF 80% of the time through the use of physical assessment skills alone.¹

An AVF is more likely to be usable (or mature) when the following characteristics are present:

- Thrill palpable at the arterial anastomosis only and disappears when AVF or AVG is momentarily occluded.
- Soft, easily compressible pulse within the fistula.
- Low pitch, continuous bruit present.
- Diameter of vein is at least 0.6 cm and vein is no more than 0.6 cm deep and has discernible margins (for initial cannulation, vein diameter needs to be a minimum of 0.4 cm).
- Flow \geq 500 mL/min as measured by Doppler ultrasound (>650 mL/min/1.73² in pediatrics).

¹Robbin, M.L., Chamberlain, N.E., Lockhart, M.E., Gallichio, M.H., Young, C.J., Deierhoi, M.H., and Allon, M. (2002). HD arteriovenous fistula maturity: ultrasound evaluation. *Radiology*, 225(1), 59–64.

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In addition to maturation, it is important there not be signs of infection, aneurysms, hematomas, swelling, skin breakdown, and/or cyanosis in the access limb prior to attempting cannulation. Skin temperature, grip strength (arm) and pedal movement (leg) in the access limb should also be normal.

Although AVFs are associated with fewer complications than AVGs or catheters, the combined early failure/failure to mature rate is estimated to be 25-35% depending upon the location of the AVF.² One study suggested the figure for AVGs is 78% higher than for AVFs.³ AVFs that fail to mature by 6 weeks should be investigated. AVFs or AVGs that are not usable for dialysis or that fail within 3 months of initial use are classified as early failures.

Recommendation 3: Aseptic technique is used for all cannulation procedures (evidence).

Considerable evidence exists that the use of sterile rather than clean aseptic technique for cannulation is impractical and unnecessary. The use of strict dialysis precautions and clean aseptic technique, however, has been shown to be important in the prevention and minimization of access infections. Careful hand washing and donning clean gloves just prior to disinfecting the access site and needling are the minimum accepted standards in the literature; despite general acceptance of the importance of these activities, studies show they are frequently skipped.

Recommendation 4: For arm AVFs or AVGs, regular hand-arm exercises are recommended for several weeks/months prior to and resuming 2 weeks post-access creation (or after the clips or sutures have been removed) (opinion).

Although there is no definitive information in the literature, any intervention that increases blood flow to the extremity has the potential to improve the chances of successful AVF and AVG creation. Therefore, regular hand-arm exercises are recommended for several weeks/months prior to access creation. Continuation of these exercises starting two weeks post-creation (or after the clips or sutures have been removed) while the access matures is also recommended as it may improve muscle tone under the vascular access, which may stabilize the vessel and facilitate cannulation. While such exercises are encouraged, it is important to emphasize to patients with failed accesses that not doing the exercises was not the cause of access failure.

² Lok, C. & Oliver, M. (2003). Overcoming barriers to AVF creation and use (Toronto). *Seminars in Dialysis*, 16(3), 189-196.

³ Gibson, K.D., Capt, M.T., Kohler, T.R., Hatsukami, T.S., Gillen, D.L., Aldassy, M., Sherrard, D.J., Stehman-Breen, C. (2001). Assessment of a policy to reduce placement of prosthetic hemodialysis access. *Kidney Int*, 59(6), 2335-2345.

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Recommendation 5: While not required for the majority of patients, local or topical anaesthetics may be helpful in relieving needle discomfort in a small subset of patients where: (1) cannulation has been attempted and the patient continues to complain of pain; or (2) cannulation has not been attempted because the patient has a severe fear of needles; and in (3) children 19 and under (opinion).

Rationale for limiting the use of local and topical anaesthetics:

Most patients do not report experiencing discomfort with cannulation and do not require a local or topical anaesthetic. There is no published evidence to support widespread or universal use of these agents and, in general, their use is discouraged. They have, however, been shown to be effective in patients where significant pain is a concern and in patients with a fear of needles.

Intradermal lidocaine injections may be considered in cases where the access is well-developed and minimal swelling exists (0.2 mL of 1% or 2% lidocaine should be used, first to arterial and then to venous site, using separate sterile needles). Lidocaine injections should never be used in poorly developed, edematous or deep accesses (including newly developing AVFs and AVGs) because lidocaine causes vasoconstriction and can cause the access vein to become smaller and sometimes go a little deeper, making palpation of the access difficult. Also, a lidocaine injection itself is painful, and there is an added risk of accidental intravenous infusion.

Topical anaesthetics that have been approved for use in Canada are (1) lidocaine 2.5%/prilocaine 2.5% (EMLA®); (2) liposomal lidocaine 4% (Maxilene-4®); and (3) tetracaine (AMETOP™). The first two are funded by BCPRA for patients that meet the specified criteria in an effort to support the goal of “fistula first.” BCPRA does not fund the use of tetracaine (AMETOP™); while it is effective, it is at a higher cost than the other two. Topical anaesthetics are generally applied by the patient at home at least one hour before dialysis. After application, the patient is instructed to cover the access with clear plastic wrap around the arm covering the areas that will be needled.

Recommendation 6: Consider the following principles for needle size and placement and blood pump speed (combination of evidence & opinion):

New AVFs and AVGs:

- For AVFs, start with 17 gauge needle. For AVGs, use 16 gauge needle.
- If have functioning CVC and maturing AVF, start with one needle cannulation. If have an AVG, start with 2 needles. If have a maturing AVF but no CVC, can start with one or two needles.
- Increase needle size and pump speed gradually (see procedure section of this guideline for specific protocols).
- If the needle gauge sizes and blood pump speeds do not achieve the desired clinical effects (Kt/V or PRU), consult the nephrologist about increasing the length or frequency of dialysis treatments. This is recommended over attempting to use larger needles or run dialysis at higher blood pump speeds when the access is not ready.

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- If needling is unsuccessful:
 - Revert back to using the CVC (if present). If no CVC, consult the nephrologist.
 - Try again the next HD session using the sequence at the last successful level (i.e. level reached prior to problem with needling).
- If the AVF/AVG “blows” (infiltration):
 - See recommendation 9 for the treatment of “blows” (infiltration).
 - Revert back to using the CVC (if present) for dialysis. If there is no CVC, consult the nephrologist (may insert a CVC or may suggest temporarily needling above or below the infiltrated area).
 - Once the majority of the swelling/bruising has subsided and the access can be easily palpated (usually takes one to two weeks), resume use of the access and use the sequence at the last successful level (i.e. level reached prior to “blow”).
- After 1–4 weeks (1 week for AVG and 3–4 weeks for AVF) of successful cannulations and assuming blood pump speeds are adequate and arterial and venous pressures are within normal limits:
 - Measure the access flow. If AVG is ≥ 650 mL/min or AVF is ≥ 500 mL/min (≥ 650 mL/min/ 1.73m^2 in pediatrics), consult a physician for removal of the CVC (if present).
 - If there is no capacity to measure access flow but blood pump speeds are adequate and pressures are within normal limits, consult a physician for removal of the CVC.

Established AVFs and AVGs:

Once cannulation has been established, correlate needle gauge, blood pump speed and clinical condition (Kt/V or PRU). Use the smallest gauge needle that will achieve the desired blood pump speed (the larger the needle, the lower the pressures and, therefore, the higher the blood pump speed that can be achieved). See Table 1.

Table 1: Correlating Needle Sizes & Blood Pump Speeds

Desired Blood Pump Speed	Recommended Needle Gauge	
	AVF	AVG
<300 mL/min	17 gauge (smallest needle)	16 gauge
300 – 350 mL/min	16 gauge	16 gauge
350 – 450 mL/min	15 gauge (largest needle)	15 gauge (largest needle)

Note: There is no literature/research/guideline available on the maximum needle size to use for AVGs. It is generally accepted, however, that the principle of using the smallest gauge needle that will achieve the desired blood pump speed applies.

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Recommendation 7: Use the rope ladder technique (rotating sites) for cannulation of AVGs and nurse cannulated AVFs; the rope ladder or buttonhole (constant site) technique may be considered for cannulation of AVFs in patients who self-cannulate (evidence).

The rope ladder technique rotates needle sites upon each HD treatment while the buttonhole technique uses the exact same spot, at the same angle and at the same depth of penetration every time. With time and repeated cannulations, a scar tissue tunnel track develops, enabling the subsequent use of blunt (BH) needles for cannulation and dialysis.

Both techniques have pros and cons. Rope ladder technique tends to have a lower rate of infection while the buttonhole technique has been shown to reduce cannulation discomfort, increase cannulation ease and have fewer incidences of hematomas, access interventions and aneurysm formations. The major disadvantage of the buttonhole technique is that to be effective it requires the same cannulator to cannulate the access each and every time (limiting its feasibility to those who self-cannulate).

Recommendation 8: The maximum number of cannulation attempts at any one session is four (total for both arterial and venous sites) unless ordered otherwise by a physician. All levels of cannulators should consult an advanced cannulator after the first unsuccessful attempt (opinion).

Repetitive attempts to cannulate an infiltrated AVF or AVG carries a high risk of inaccurate cannulation, which may further exacerbate the existing swelling and possibly lead to permanent loss of the access.

If, after four unsuccessful attempts (at least 3 of which will have utilized an advanced cannulator), the physician is notified. If infiltration has occurred, consider resting the access for 1 week or until the infiltration and bruising have resolved (see recommendation 9).

Recommendation 9: If signs of infiltration are present, remove the needle and apply ice to the affected area several times for a 24-hour period. After 24 hours, apply warm compresses. Rest the access until the majority of the swelling/bruising has subsided and the access can be easily palpated (usually takes one to two weeks), resume needling (opinion).

If signs of infiltration are present:

If patient has *not received heparin*, shut off the pump, remove the needle and apply digital pressure to the exit site by placing two fingers along the access for at least one inch in the area of the infiltration. If a back or side infiltration is suspected, use two fingers along the access and a thumb on the backside of the arm to apply posterior pressure (“C-clamp” method). It can be difficult to control back or side wall bleeding because it is not possible to place direct pressure on the puncture site.

If patient has *received heparin*, assess the infiltration site to see if the needle should be pulled out or left in place with ice applied over the site until the dialysis treatment is

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complete. If the hematoma is increasing in size during the treatment, shut off the pump, remove the needle and apply digital pressure as described in the paragraph above. If the hematoma size is stable, it is acceptable to leave the needle in until the end of the treatment.

Apply ice to infiltrated AVF or AVG for 20 minutes and instruct the patient to apply the ice another six to eight times for the next 24 hours to reduce pain and swelling. After 24 hours, instruct the patient to apply warm (not hot) compresses (e.g. warm wash cloth) on the area for 20 minutes several times a day to promote healing.

Assess infiltration at each dialysis treatment and resume use once the majority of swelling/bruising has subsided and the AVF/AVG can be easily palpated (usually takes one to two weeks). In the meantime, revert back to using the CVC (if present) for dialysis. If there is no CVC, consult the nephrologist (may insert a CVC or may suggest temporarily needling above or below the infiltrated area).

When the AVF or AVG is ready for use again, reinstitute the sequence at the last successful level (i.e. if initiating a new access, the level reached prior to the problem arising; if a mature fistula, continue using as before once access deemed usable). If the access appears to be compromised, consider using a smaller gauge needle.

Recommendation 10: If the AVF or AVG has problems and/or has not matured within the appropriate timeframes and/or is difficult to cannulate, a physician or VA coordinator is consulted (evidence).

Examples in which to avoid cannulation and consult a physician or VA coordinator include but are not limited to:

- Signs and symptoms of severe infection.
- Signs and symptoms of a localized, superficial infection that is on or near the needling site.
- Absence or poor quality of bruit and thrill.
- Extreme edema or other factors (e.g. rash or unexplained aneurysm) which would render cannulation inappropriate.

Examples in which to proceed with cannulation but consult the physician or the VA coordinator at the earliest opportunity include but are not limited to:

- Signs and symptoms of a localized, superficial infection that is not on or near the needling site.
- A pulse is palpated instead of a thrill, and is abnormal for the access in question.
- A significant increase in pitch is noted on auscultation.
- Aneurysm (AVFs) or pseudoaneurysm formation (AVGs).
- Difficulties in cannulation, despite the use of advanced cannulators.
- Inability to achieve expected blood pump speeds while on dialysis.
 - For adults, failure to achieve blood pump speeds as outlined in the procedure section for new and established AVFs/AVGs.
 - For pediatrics, failure to achieve a blood flow of 4–5mL/min/kg by week 3, or running less than or equal to 3 mL/min/kg for 2–3 runs in a row.

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- Low arterial or high venous pressures on 3 consecutive runs.
- Unexplained, prolonged bleeding (>10–15 minutes) from cannulation site on 3 consecutive runs assuming appropriate positioning (may be indicative of stenosis).

Recommendation 11: To achieve hemostasis, apply mild, direct pressure, using two fingers over the needle sites. Never use clamps or tourniquets (aka straps or site minder) on new AVFs or AVGs or on AVFs or AVGs that show signs of infiltration, infection or edema. Use only as a last resort on mature AVFs or established AVGs in cases where there are no signs of complications and the flow is adequate.

Hemostasis is best achieved by applying mild, direct pressure, using two fingers over the needle sites. If the patient is unable to do this him/herself, arrange for a family member or, in the absence of a family member, a nurse to perform this function.

Use of clamps or tourniquets on AVFs or AVGs is not recommended because of damage and/or thrombosis that can occur by applying too much pressure. New and developing AVFs and AVGs are particularly vulnerable to hematoma formation, infiltration, and bruising.

If clamps or tourniquets are used on mature AVFs or established AVGs in cases where there are no signs of complications and the flow is adequate (AVFs: ≥ 500 mL/min in adults and ≥ 650 mL/min/1.73m² in pediatrics; AVGs: ≥ 650 mL/min in adults and ≥ 650 mL/min/1.73m² in pediatrics⁴), use only one at a time in order to prevent excessive pressure/thrombosis. Leave the clamp or tourniquet on only until the bleeding has stopped and never for more than 20 minutes. While the clamp or tourniquet is on, palpate for a thrill on both sides of the clamp or tourniquet. If not present or if only a pulse can be felt, lighten the grip on the clamp or tourniquet or remove as blood flow is being occluded. After removing the clamp or tourniquet, confirm the presence of a thrill and bruit.

3.0 PROCEDURE

This procedure describes the steps for cannulating an AVF/AVG using the rope ladder technique. The steps for cannulating an AVF using the buttonhole technique are described in a separate BCPRA guideline, BH Cannulation of AVFs for Self-Cannulation.

This procedure includes steps for the sequencing of cannulating new AVFs and AVGs. These are intended as guidelines only. Some accesses may be able to be sequenced faster, while others will take longer. Clinical assessment and judgement needs to be exercised.

⁴Assumes the ability to monitor flows is available in the unit.

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Preparation for Cannulation

1. Consult a physician, vascular access (VA) coordinator, or advanced cannulator to confirm the access is ready to cannulate.
2. If ready to cannulate and patient is on heparin, contact physician to reassess heparin orders and heparin stop times. Reassess regularly during initial cannulations.
3. Plan for “advanced” cannulators to cannulate the access for at least the first 4 weeks.
4. If patient is highly anxious regarding needle discomfort, discuss the option of injecting/ applying a local/topical anaesthetic prior to needling.
5. Instruct the patient to wash their access with antibacterial soap or scrub and water using friction.

Pre-Cannulation Assessment

6. Assess patient and access prior to cannulation:

Inspection (Look):

- Expose and position the limb (“sleeves up” if arm access and “pants down” and “shoes/ socks off” if leg access) with the access parallel to the floor. Expose the contralateral limb for comparison.
- Observe the limb and access site for signs of infection (redness, discharge, and/or swelling), aneurysms, hematomas, swelling, and/or cyanosis in the access extremity. Compare to contralateral limb.
- If AVF, vein should be well-developed and have adequate straight areas suitable for repeated cannulations. If arm AVF, vein should partially collapse when arm is elevated above the head (slow emptying or bulging of the fistula is an indicator of stenosis at the venous end).
- If AVF, place in dependent position and observe for collateral veins. There should not be multiple collateral veins present (may require ligation if fistula has failed to mature). It could also indicate a venous end stenosis in a mature fistula and when corrected the collaterals usually diminish in size without ligation). If not possible to get limb dependent, apply a tourniquet (or B/P cuff pumped up to 80–90 mmHg) just below the axilla (upper arm fistula) or midpoint of the upper arm (lower arm fistula) tight enough to dilate the veins but being careful not to occlude the flow to observe for accessory veins).
- If AVG, it should be uniform in size and in a loop or straight configuration.
- Expose the upper chest and observe for abnormalities such as dilated neck veins, accessory veins in the arm or neck above the access, and/or the presence of edema (may indicate a central vein stenosis).

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▶ **Key points:**

- Redness, discharge and/or swelling of the access limb may indicate infection.
- Cyanosis of the access limb extremity may indicate steal syndrome.
- Multiple collateral veins or poorly defined cannulation areas may indicate poor maturation.

Auscultation (Listen):

- Using a stethoscope, listen for several pulsations in the sound of the bruit at the anastomosis. A low pitch, continuous (i.e. present on systole and diastole) “whooshing” sound is a normal bruit.
- Continue to auscultate along the access path, noting any changes in the pitch or amplitude of the bruit.

▶ **Key point:**

- A high-pitched, discontinuous (i.e. present on systole only) whistling sound at the venous end may indicate outflow stenosis and at the arterial end an inflow stenosis. Absence of a bruit usually indicates clotting of the access.

Palpation (Feel):

- Assess the temperature of the skin along the access for abnormal warmth, paying particular attention to the site of the anastomosis. Compare the temperature of fingers/toes in access and non-access hands/feet.
- Assess grip strength and hand movement (arm access) or pedal movement (leg access).
- Using a two to three finger approach, roll fingers across the AVF to determine the diameter and depth of the access. For initial cannulation, the diameter should be at least 0.4 cm in diameter (and preferably 0.6 cm).
- Palpate the entire length of the access. A strong thrill should be palpable only at or near the arterial anastomosis. A pulse may be felt throughout the entire outflow vein with the strength normally decreasing along the outflow vein pathway. Vein should be easy to compress.
- For AVFs (not AVGs), apply a tourniquet (or B/P cuff pumped up to 80–90 mmHg) just below the axilla (upper arm fistula) or midpoint of the upper arm (lower arm fistula) tight enough to dilate the veins but being careful not to occlude the flow. Repeat the steps of palpation as outlined above, identifying any collateral veins and/or areas of concern such as decreased size of vessel, or decrease in flow.

▶ **Key points:**

- **Tourniquets should normally not be used on AVGs to assess the veins** due to the risk of thrombosis.
- Abnormal warmth along the graft may indicate infection.
- Abnormal temperature, grip strength, range of motion, and/or complaints of pain may indicate steal syndrome.
- Strong thrill and/or water-hammer pulse may indicate an area of stenosis.
- Multiple collateral veins or poorly defined cannulation areas may indicate poor maturation.

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7. If any of the concerns identified in recommendation 9 are noted, *avoid cannulation* and consult the physician or the VA coordinator or *proceed with cannulation* but consult the physician, VA coordinator at the earliest opportunity (if the physician is consulted, please notify the VA coordinator of the problem and ensure follow-up).

Cannulation

8. If a new access, refer to step 25 for the number of needles, needle gauge and blood pump speed.
9. Identify the direction of blood flow at the access site.

AVFs:

- Locate the arterial anastomosis engorgement prior to placement of the tourniquet.
- Most AVFs flow from the distal end of the limb toward the venous return.

AVGs:

- Review the operative note for anatomical position.
- Listen to the bruit and palpate for the thrill at both ends of the AVG – the end with a stronger bruit and thrill is assumed to be the arterial limb. To confirm this assumption, lightly compress the mid-graft area to impede the blood flow for a few seconds and listen and palpate on both sides of this mid-point; again the stronger bruit and thrill can be considered to be the arterial limb.

10. Visualize the site(s) and plan for needle placement taking into account the following:
 - Plan for alternate sites in case unable to thread needle or infiltration occurs.
 - Place venous needle antegrade (with the blood flow – i.e. facing venous end of AVF or AVG). Place arterial needle antegrade or retrograde (against the blood flow – i.e. facing the arterial end).
 - Place needles so tips are 7.5 cm (3 in) apart and are at least 4–5 cm (1.5–2 in) away from the arterial or venous anastomosis.
11. Ensure clean gloves prior to cleansing and cannulating the site. Change gloves if contaminated at any time during the cannulation procedure.
12. Cleanse the site with a cleansing solution using a back and forth rubbing motion. Allow skin to dry thoroughly.

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Preferred cleansing solutions in order of preference on allergic reaction basis are:

Solution	Contact Time ⁵	Cannulation
1 Chlorhexidine 2% ⁶ with alcohol 70%	30 seconds	When dry
2 Chlorhexidine 2% with alcohol 4% (aqueous)	2 minutes	When dry
3 Sodium hypochlorite 0.11% [ExSept Plus [®] or Amuchina 10%]	2 minutes	When dry
4 Povidone iodine 10% [Betadine [®]]	3-5 minutes	When dry
5 Chlorhexidine 2% with no alcohol	3 minutes	When dry

Note: Contact time is based on manufacturer’s recommendations, where available.

13. For AVFs, apply a tourniquet (or B/P cuff pumped up to 80–90 mmHg) to the access arm just below the axilla (upper arm fistula) or midpoint of the upper arm (lower arm fistula) tight enough to dilate the veins but being careful not to occlude the flow.
14. If patient meets the criteria outline in recommendation 5, inject the local anaesthetic (if using topical anaesthetic, will have already been applied by patient at home).
15. Taking the needle in one hand, place the thumb and forefinger of the other hand on either side of the AVF or AVG and thread the needle down the centre of the AVF or AVG using approximately a 25 degree (AVF) or 45 degree (AVG) angle. Use either the pinky or ring finger of the needle-holding hand to pull the skin taut in the opposite direction of needle insertion. Leave the last 2 mm of metal part of the needle exposed (prevents the hub of the needle from touching the entrance sites). Assess the depth of the access and adjust the cannulation angle accordingly.

⁵Contact times were pulled from a variety of sources including:

- Manufacturer’s instructions (where indicated)
- Safer HealthCare Now (June 2012). Prevent Central Line Infections: Getting Started Kit. [Link here.](#)
- DeBaun, B. (2008). Evaluation of the antimicrobial properties of an alcohol-free 2% chlorhexidine gluconate solution. *AORN*, 87(5), 925–933.

⁶Recommendations in this document regarding the use of chlorhexidine are for children >2 years of age; the literature makes no recommendations for infants <2 years of age (unresolved issue; CDC, 2011, p. 13)

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16. Once the needle has been advanced through the skin, subcutaneous tissue, and the wall of the AVF or AVG, blood flashback should be visible. Once flashback is visible, level the needle to skin level and slowly insert the needle to the hub. Flipping needles is not recommended (needles being manufactured today have back eyes; flipping needles can cause tearing of the AVF).

If blood flashback is not seen, confirm needle placement by assessing blood flow into the tubing. Some AVFs will have less flashback than others. If no blood returns, carefully adjust needle.

Key points:

- If resistance is felt at any time during needle advancement or needle position change, pull the needle back and redirect the angle. When in doubt, seek assistance from a colleague.
- If the first cannulation attempt at any session is unsuccessful, consult an (other) advanced cannulator. Cannulation should never be attempted more than four times (total for both arterial and venous sites) in a session unless ordered otherwise by a physician.
- If have one needle in, do single needle cannulation.

17. Assess carefully for signs of infiltration (i.e. pain, swelling, or discoloration). Infiltrations can occur before dialysis, during dialysis with the blood pump running, or after dialysis with the needle removal.

Refer to the steps in recommendation 9 if signs of infiltration are present.

18. Secure the wings of the needle at the same angle of advancement. Apply adhesive device to prevent any movement of the needles during the dialysis treatment. If required, a 2x2 gauze pad may be placed under the needle wings to correct the angle of the needle.
19. Repeat steps 15–18 for the second needle. Always start with arterial needle. Never venous.
20. Once cannulation has been established, correlate needle gauge, blood pump speed and clinical condition (Kt/V or PRU). Use the smallest gauge needle that will achieve the desired blood pump speed with consideration to the guidelines on the next table (the larger the needle, the lower the pressures and, therefore, the higher the blood pump speed that can be achieved). See Table 2.

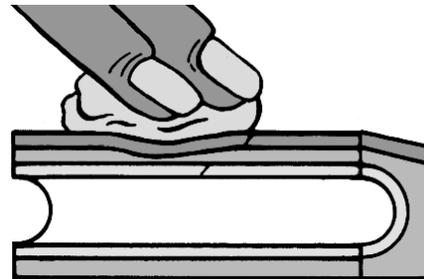
Table 2: Correlating Needle Sizes & Blood Pump Speeds

Desired Blood Pump Speed	Recommended Needle Gauge	
	AVF	AVG
<300 mL/min	17 gauge (smallest needle)	16 gauge
300 – 350 mL/min	16 gauge	16 gauge
350 – 450 mL/min	15 gauge (largest needle)	15 gauge (largest needle)

Note: There is no literature/research/guideline available on the maximum needle size to use for AVGs. It is generally accepted, however, that the principle of using the smallest gauge needle that will achieve the desired blood pump speed applies.

Needle Removal

21. Remove adhesive device and then remove the needle slowly and at the same angle that was used for insertion. To prevent damage to the vessel wall, **never apply pressure until the needle is completely out.**
22. After the needle is completely out, apply mild, direct pressure for 10–15 minutes to each needle site, using sterile gauze and a two digit technique.
 - One finger at the vein site (internal)
 - One finger at the skin exit site (external)



Key points:

- To ensure that compression is not excessive, check that a pulse is palpable above and below the compression site. If not, reduce the digital pressure (there is a fine balance between enough pressure to prevent needle hold bleeding and excessive compression which may lead to access thrombosis).
 - Excessive bleeding post-dialysis can be a sign of venous outflow stenosis in a patient with normal bleeding times. If prolonged hemostasis is ongoing, reassess heparinization, review dynamic venous pressure readings, and perform access flow studies to rule out stenosis as a cause.
23. Place an adhesive or gauze pad on the cannulation site or ensure dressing used is secure.
 24. Prior to the patient leaving the unit, assess and document the quality of the bruit and thrill.

Rope Ladder Cannulation of AV Fistulas and Grafts

Cannulation Sequence for New Fistulas and Grafts

25. When initiating a new AVF or AVG, select the appropriate cannulation sequence:
- (a) AVF with functioning CVC in place; or
 - (b) AVF with no functioning CVC in place:
 - i. One needle
 - ii. Two needle.
 - (c) AVG regardless of whether there is a functioning CVC in place.

(a) AVF with functioning CVC in place:

Week	1			2			3		
Treatment	1	2	3	4	5	6	7	8	9
Needle location	Arterial (CVC for venous)	Arterial (CVC for venous)	Arterial (CVC for venous)	Venous (CVC for arterial)	Venous (CVC for arterial)	Venous (CVC for arterial)	Arterial & venous	Arterial & venous	Arterial & venous
Needles	1	1	1	1	1	1	2	2	2
Needle gauge	17 g	17 g	17 g	17 g					
Max blood pump speed	200	200	250	200	200	250	200-250	200-250	200-250
See notes below.									

Week	4-6	7-9	10+
Treatments	10-18	19-27	28+
Needle location	Arterial & venous	Arterial & venous	Arterial & venous
Needles	2	2	2
Needle gauge	17 g - 16 g	16 g - 15 g	15 g
Max blood pump speed	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle
See notes below.			

Notes:

1. For all runs, start with slow pump (50 mL/min) and increase 50 mL/min every 30 sec to desired mL/min; if pump speed is not tolerated, reduce to 200 mL/min.
 - For pediatrics 200 mL/min is equivalent to 3-4 mL/min/kg and 250 mL/min is similar to 4-5 mL/min/kg.
2. Arterial pressures should never be lower than -250 mmHg and venous pressures never higher than 250 mmHg (same for adults and pediatrics).
3. If the needle gauge sizes and blood pump speeds listed do not achieve the desired clinical effects (Kt/V or PRU), consult the physician regarding increasing the length or frequency of dialysis treatments. This strategy is recommended over attempting to use larger needles or run dialysis at higher blood pump speeds when the access is not ready.

Rope Ladder Cannulation of AV Fistulas and Grafts

4. If needling is unsuccessful:
 - Revert back to using the CVC. If no CVC, consult the nephrologist.
 - Try again the next HD session using the sequence at the last successful level (i.e. level reached prior to problem with needling).

5. If the access “blows” (infiltration):
 - Revert back to using the CVC (if present) for dialysis. If there is no CVC, consult the nephrologist (may insert a CVC or may suggest temporarily needling above or below the infiltrated area).
 - Once the majority of the swelling/bruising has subsided and the access can be easily palpated (usually takes one to two weeks), resume use of the access and use the sequence at the last successful level (i.e. level reached prior to “blow”).

6. After 1–4 weeks of successful cannulations and assuming blood pump speeds are adequate and arterial and venous pressures are within normal limits:
 - Measure the access flow. If AVF is ≥ 500 mL/min (≥ 650 mL/min/1.73m² in pediatrics), consult a physician for removal of the CVC (if present).
 - If there is no capacity to measure access flow but blood pump speeds are adequate and pressures are within normal limits, consult a physician for removal of the CVC.

(b) AVF with no functioning CVC in place:

(i) One needle cannulation (for facilities with machines that have this capability)

Week	1			2			3		
Treatment	1	2	3	4	5	6	7	8	9
Needle location	Single needle	Single needle	Single needle	Single needle	Single needle	Single needle	Arterial & venous	Arterial & venous	Arterial & venous
Needles	1	1	1	1	1	1	2	2	2
Needle gauge	17 g	17 g	17 g	17 g	17 g	17 g	17 g	17 g	17 g
Max blood pump speed	See notes under cannulation sequence for AVFs with functioning CVC in place.								

Week	4-6	7-9	10+
Treatments	10-18	19-27	28+
Needle location	Arterial & venous	Arterial & venous	Arterial & venous
Needles	2	2	2
Needle gauge	17 g - 16 g	16 g - 15 g	15 g
Max blood pump speed	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle
	See notes under cannulation sequence for AVFs with functioning CVC in place.		

Rope Ladder Cannulation of AV Fistulas and Grafts

(i) Two needle cannulation

Week	1			2			3		
Treatment	1	2	3	4	5	6	7	8	9
Needle location	Arterial & venous								
Needles	2	2	2	2	2	2	2	2	2
Needle gauge	17 g								
Max blood pump speed	200	200	250	250	250	250	250-300	250-300	250-300
See notes under cannulation sequence for AVFs with functioning CVC in place.									

Week	4-6	7-9	10+
Treatments	10-18	19-27	28+
Needle location	Arterial & venous	Arterial & venous	Arterial & venous
Needles	2	2	2
Needle gauge	17 g - 16 g	16 g - 15 g	15 g
Max blood pump speed	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle	Recommended pump speed for gauge of needle
See notes under cannulation sequence for AVFs with functioning CVC in place.			

(c) AVG regardless of whether there is a functioning CVC in place.

1. Use two 16 gauge needles (one as the arterial source and one as the venous source) and a blood pump speed of 300 mL/min.
2. After 1–4 weeks of successful cannulations and assuming blood pump speeds are adequate and arterial and venous pressures are within normal limits:
 - Measure the access flow. If AVG is ≥ 650 mL/min, consult a physician for removal of the CVC (if present).
 - If there is no capacity to measure access flow but blood pump speeds are adequate and pressures are within normal limits, consult a physician for removal of the CVC.

4.0 REFERENCES

Ball, L. (2006). The buttonhole technique for arteriovenous fistula cannulation. *Nephrology Nursing Journal*, 33(3), 299–305.

Beathard, G. (2003). A practitioner's resource guide to physical examination of dialysis VA. *ESRD Network 13, Fistula First Project*.

Beathard, G. (2004). A practitioner's resource guide to HD AVFs. *ESRD Network 13, Fistula First Project*.

Cannulation of a new fistula policy and procedure. *Fistula First National VA Improvement Initiative*. February 2002.

Care of a HD fistula and graft. *University Health Network Policy Procedure Manual*. June 2000.

Fistula First. (July 2011). Cannulation of New Fistula Policy and Procedure. [Link here](#). Accessed Dec 19, 2012.

Gray, R. & Sands, J. (Eds.) (2002). *Dialysis access: A multidisciplinary approach*. Philadelphia et al. Chapters 15. Schanzer, H. Overview of Complications and Management after VA Creation, 93–98) and 18. Beathard, G. Physical Examination: The Forgotten Tool, 111–119).

Improving arteriovenous fistula cannulation skills. (2005). *Nephrology Nursing Journal*, 32(6), 611–617.

Initial cannulation & assessment of AV fistulae with and without a central venous catheter, *Fraser Health Authority* [DRAFT, not dated].

Lok, C. & Oliver, M. (2003). Overcoming barriers to AVF creation and use (Toronto). *Seminars in Dialysis*, 16(3), 189–196

Procedure for cannulating a VA: AV fistula and synthetic graft, *London Health Sciences Centre* (not dated).

Rostoker, G., Griuncelli, M. and Loridon, C. (2009). Improving the efficiency of short-term single-needle hemodialysis. *J Med Assoc Thai*, 89(s2), S196–206.

Rostoker, G. et al. (2009). The efficacy of single-needle versus double-needle hemodialysis in chronic renal failure. *Renal Failure*, 31(4), 261–266.

Wilson, B. et al. (2009). Impact of single-needle therapy in new chronic hemodialysis starts for individuals with arteriovenous fistulae. *The CANNT Journal*, 19(2), 23–28.

5.0 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 providers from across BC, the guideline was approved by the BC Renal Educators Group (BC REG), Home Hemodialysis Nurses Group, Provincial Vascular Access Services Team (PVASt) and the BC Provincial Renal Agency Medical Advisory Committee. It has been adopted by BCPRA as a provincial guideline.

6.0 EFFECTIVE DATE

- Effective date: May 11, 2007/ Updated May 23, 2013.
- This guideline is based on scientific evidence available at the time of the effective date; refer to www.bcrenalagency.ca for most recent version.