# Improving Arteriovenous Fistula Cannulation Skills

*Lynda K. Ball*

Continuing Education

***Cannulation of arteriovenous fistulae is technically more challenging than cannulation of arteriovenous grafts. With the advent of the National Vascular Improvement Initiative, Fistula First, the United States has seen an increase in the number of arteriovenous fistulae. The problem we now face is how to refocus and reeducate nurses to the intricacies of arteriovenous fistula cannulation. Through evidenced-based practice and current best-demonstrated practices, this article will provide the tools needed to improve arteriovenous fistulae cannulation skills.***

**Goal**

Cite evidence-based, best demonstrated practices to utilize in improving individual cannulation technique.

**Objectives**

1. Describe the assessment process of auscultation, palpations, and inspection for an AV fistula.
2. List five clinical indicators that would indicate a stenosis.
3. Explain the differences between the rope ladder and buttonhole techniques.

The National Vascular Access Improvement Initiative, Fistula First, sponsored by the Centers for Medicare & Medicaid Services (CMS), has contributed to an increased number of arteriovenous fistulae (AVF) in the prevalent hemodialysis population throughout the country from 32% in December 2002 to 37.4% in December 2004. The individual ESRD Network increases can be seen in Figure 1.

As different as individuals are on the outside, it should not be a surprise that individuals are also different on the inside. If we could see within the body, we would see blood vessels of varying sizes – some straight as arrows, some tortuous, and still others undulating up and down. Because of this variation, cannulation of AVFs is technically more challenging than cannulation of AV grafts (Allon & Robbin, 2002). We also have to take into consideration the co-morbidities of each individual patient, such as cardiac disease, diabetes, and peripheral vascular disease, because these can affect blood flow through the access, fistula development, and the quality of vessels available for access creation. More challenging accesses require an increased level of expertise of patient care staff for successful cannulation. Some dialysis facilities are experiencing a high turnover of trained individuals which may negatively impact the level of cannulation skills available (Hemphill & Allon, 2003). The assessment process, cannulation problems, and different cannulation techniques will be discussed in an effort to assist patient care staff, old and new, to identify areas of improvement in their cannulation practices.

## Assessment

Nurses can think of themselves as detectives, looking for clues of problems that could negatively impact the patients' vascular accesses. Different problems have different sets of clues. Recognizing these clues helps provide successful dialysis treatments.

Assessment of vascular access involves inspection, palpation, and auscultation. It is necessary that vascular accesses be evaluated prior to every cannulation using these three aspects of nursing care.

### Inspection

Initially, a cursory inspection should include comparing one arm to the other looking for ecchymosis, discoloration, breaks in the skin, and erythema. Closely inspect the arm containing the access, looking for

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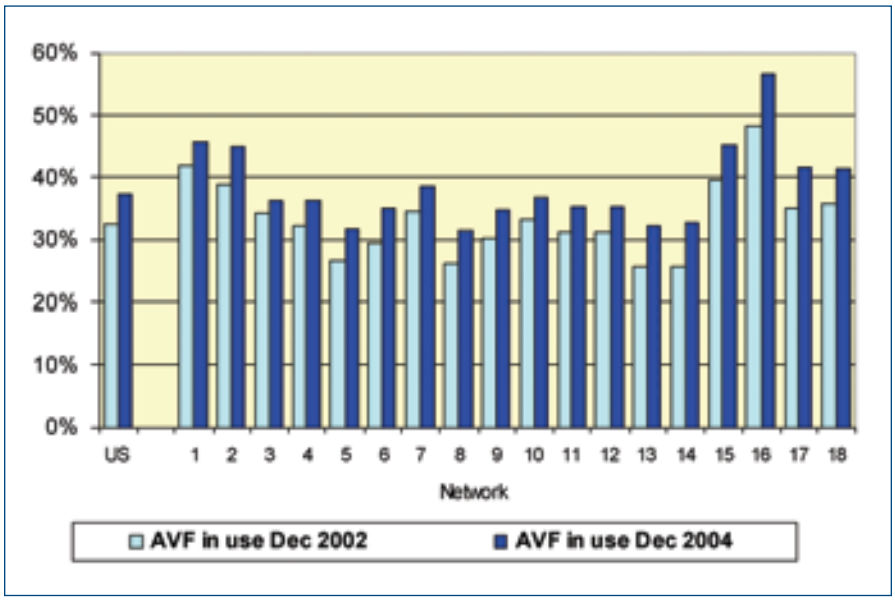
The Nephrology Nursing Certification Commission (NNCC) requires 60 contact hours for each recertification period for all nephrology nurses. Forty-five of these 60 hours must be specific to nephrology nursing practice. This CE article may be applied to the 45 required contact hours in nephrology nursing.

**Figure 1**
**Fistula First Outcomes Dashboard**




aneurysm or hematoma formations, curves, flat spots, prior cannulation sites, hand or arm swelling, discoloration of nail beds, and the presence of accessory veins (American Nephrology Nurses' Association, 2005).

### Palpation

Palpation is the next assessment process. Palpation enables one to determine the patency of the fistula by assessing the thrill. A thrill is the sensation that is felt over the anastomosis – where the vein and artery have been surgically joined together. The vibration or purring that is felt is turbulence of the blood flow that is created by the high pressure arterial system merging with the low pressure venous system. According to Dr. Gerald Beathard (2000), an interventional nephrologist who writes extensively on vascular access assessment, the thrill is usually only felt at the anastomosis and, if it is felt in any other area of the access, it could be an indication of a venous stenosis. Some individuals with very strong blood flow will have a thrill the entire length of their accesses, so it will be important to make sure the thrill is continuous, indicating that no interruption of flow is occurring. If there is no thrill present, no needles should be placed until further evaluation with a stethoscope is completed and the physician is notified.

Another reason to palpate the access is for evaluation of needle placement. Tourniquets should always be used on fistulae, both old and new, to help visualize potential cannulation sites, to get a better feel of the access in order to determine the depth and proper angle of insertion, and to stabilize the vein to keep it from rolling during cannulation.

Palpate the entire length of the access, checking for constant vein diameter, flat spots, and aneurysms. Palpation should also be used to check skin temperature. Warm skin can be indicative of infection, which is usually accompanied by increased temperature, redness, and drainage or site tenderness. Cold skin could indicate a decreased blood supply to the extremity, and, if present, the radial pulse should be checked for decreased circulation and the nail beds examined for discoloration and capillary refill of greater than 3 seconds. Always compare the access arm temperature to the temperature of the contralateral extremity.

### Auscultation

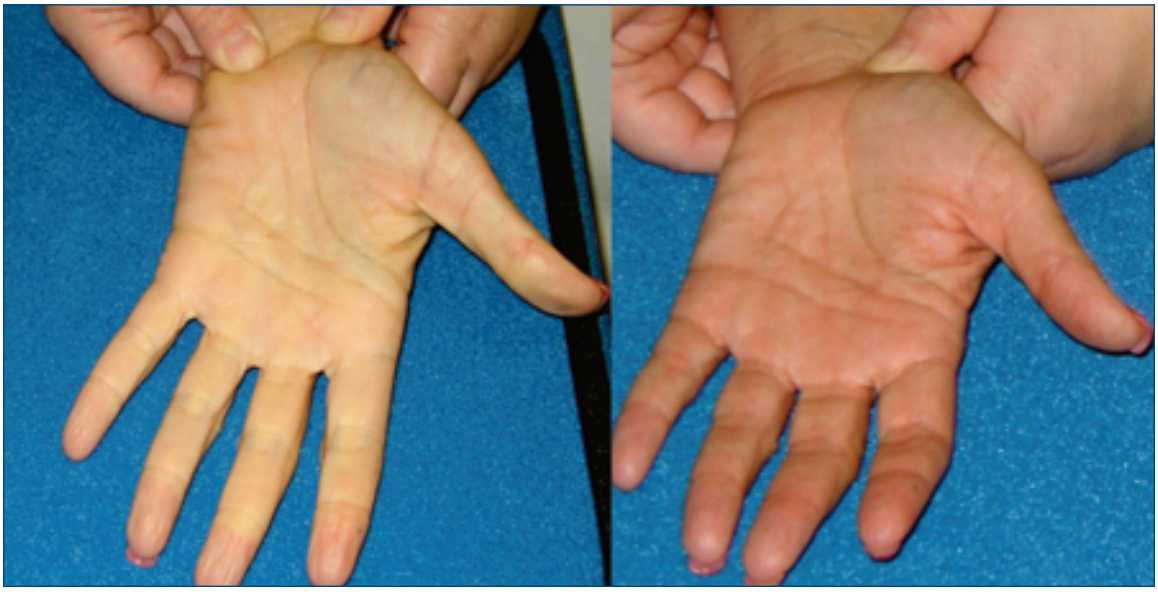
Auscultation is the third evaluation process that should be used for a vascular access assessment prior to every treatment. There must always be baseline information before beginning any procedure. Listening for the sound and character of blood flow through a fistula is vital – remembering that the access is the patient's lifeline and it must remain patent. Listen for the bruit – the whooshing sound created by the turbulence at the anastomosis. The sounds should be continuous, one sound blending into the next.

## Steal Syndrome

Steal syndrome is one reason for decreased blood supply to the hand. Steal syndrome causes hypoxia and lack of oxygen to the tissues, resulting in pain that can range anywhere from mild to severe. The majority of cases of steal syndrome will resolve themselves over several weeks as a result of collateral circulation development, but approximately 5% of patients with AVFs will need immediate intervention due to severe symptoms (Henriksson, 2004). Patients with diabetes with existing neuropathy and patients with preexisting vascular disease have the greatest risk for developing the most severe case of steal syndrome, Ischemic Monomelic Neuropathy (IMN), which is characterized by severe pain, sensory and functional loss, and weakness in the distal extremity (Schanzer & Eisenberg, 2004).

In steal syndrome, the extremity will be cold, capillary refill will decrease, and the radial artery will not be palpable. If not treated, ulcer formation will occur with the possibility of amputation. Nurses can perform the Allen Test to check for arterial circulation of the hand (see Figure 2). This is done by compressing both the radial and ulnar arteries simultaneously while having the patient open and close the hand, allowing the blood to drain via the venous system

**Figure 2**
**The Allen Test**



– causing the hand to blanch. Have the patient open the hand, palm up, and release one of the arteries, evaluating how fast refill occurs to the hand. Repeat the procedure again, this time releasing the other artery while timing the refill. Refilling of less than 3 seconds is considered a negative test and indicates there is adequate blood flow in the palmer arch (Beathard, 2003). A very slow refill should alert the multidisciplinary team to develop a plan for access placement, if one is not already in place, or a revision of the current access, particularly if symptoms are present. Typically, grafts and upper arm fistulae are responsible for most of the cases of steal syndrome.

## Stenosis

The major vascular access problem impacting our practice is venous stenosis. Stenosis formation decreases adequacy of dialysis from recirculation, can cause vessel wall damage, can prevent an access from maturing and can lead to clotting of the fistula. It is important to look for clues of venous stenosis. Edema is an indication that there may be a problem with the drainage system of the extremity, but it could also be caused by a central venous stenosis. Collateral circulation can form in the area near the central venous stenosis, with blue or purple veins becoming visible in the upper arm and chest wall. When a stenosis is present, the continuous sound of the bruit will change to a choppy, distinctly separate sound. At the site of the stenosis, the bruit may be higher pitched because of the narrowing or it may be louder than it is at the anastomosis. The pulse, which is usually soft, will change its character and become a harsher, water hammer sound (Beathard, 2003).

Recirculation studies are warranted if some or all of the following clues are present: a decrease in adequacy from month to month, decreased blood pump speeds, increasing venous pressures, difficulty threading needles or having blood squirt out around needles during cannulation, and/or increased bleeding times postdialysis.

The process of what is occurring during recirculation can be illustrated by comparing blood vessels to a highway. Visualize a four-lane highway with an accident that closes two lanes so that the traffic will have to merge into the open two lanes. Not only does this slow the traffic down, but also causes the traffic to back up. The same scenario applies to a vein that has a stenosis present. The blood will be slowed down on the sides where the stenosis is present and will have to merge with the faster moving blood, which will cause turbulence as well as a back up of blood into the fistula. Because the blood pump is returning blood through the venous needle at a constant speed, the "backed-up" blood gets pulled into the arterial needle and into the extracorporeal circuit where re-cleaning or recirculation occurs. Furthermore, this back up of blood creates increased pressure within the fistula, which will make it harder for the blood in the extracorporeal circuit to get back into the blood vessel, thereby increasing the venous pressure in the extracorporeal circuit. As the machine pressure increases, it may be necessary to decrease the blood pump speed to prevent hemolysis and/or vessel wall

damage. This increased pressure can also make needle insertion more difficult, causing blood to squirt out around the needle during cannulation. Also, upon removing the needles postdialysis, the time to clot formation starts to increase due to this increased pressure within the fistula. Clotting of the extracorporeal circuit can occur, especially if the blood is just sitting in the access. It cannot be assumed that just because the system clots off that it is an anticoagulation issue; rather, look for the many clues that have just been discussed as indicators of stenosis. A noninvasive way to check a patient's fistula is to have the patient hold the arm down while pumping the hand to allow the fistula to engorge, and then have the patient raise the arm straight up in the air while keeping the fist clenched. If there is no stenosis present, the fistula should flatten out and drain. If there is a stenosis present, not only will the fistula not drain completely, it will remain engorged and firm when palpated, instead of soft and easily compressible.

## Preparing the Access for Cannulation

Now that the assessment is complete, it is necessary to prepare the cannulation sites and insert the needles. Preparation of the needle sites is probably the most important aspect of cannulation. The Centers for Disease Control and Prevention (CDC) states that, in patients on dialysis, infection is the second leading cause of death (15%) with vascular access infection being the number one cause. *Staphylococcus aureus* (staph) is the leading culprit (CDC, 2001). Patients on dialysis also have more staph on the skin and in the nares than the general population (Kaplowitz, Comstock, Landwehr, Dalton & Mayhall, 1988), making it all the more important for patients on dialysis to wash the arm with the access prior to coming to the chair. Staph on staff and patient skin is normal flora, but when it enters the patient's sterile blood stream, it can cause sepsis. There is often a lot of patient resistance to arm washing prior to dialysis, but there are many facilities where this is an expectation and has become standard procedure. To minimize the possibility of infections, facilities should have a policy and procedure for patient access washing. Once the patient has washed the arm with the access, staff members need to use the facility-approved antimicrobial prep. The proper cleansing technique is a circular, rubbing motion – not the old back and forth "paint brush technique." There are now clinical practice guidelines available to us that have been proven over time to be best-demonstrated practices. K/DOQI Guideline 14 states that a circular, rubbing motion should be used when prepping the access site (National Kidney Foundation, 2000).

## Anesthetics for Needle Insertion

There are several different anesthetics available for needle insertions – intradermal lidocaine, Ethyl Chloride® spray, and topical anesthetic creams.

Intradermal lidocaine is a vasoconstrictor, so it will cause the vein to become smaller and sometimes make it a little deeper. Intradermal lidocaine causes a bee sting-type burning sensation that can be minimized by injecting the lidocaine more slowly. There are no studies citing scarring from lidocaine use, however, certain ethnic groups form keloid scars that can make cannulation through them very difficult.

Ethyl Chloride® spray freezes the surface tissue causing temporary numbing. Because Ethyl Chloride® is not sterile, it must be applied prior to the antimicrobial prep, not after. If the patient's access is deep, this may not be the most effective product to use.

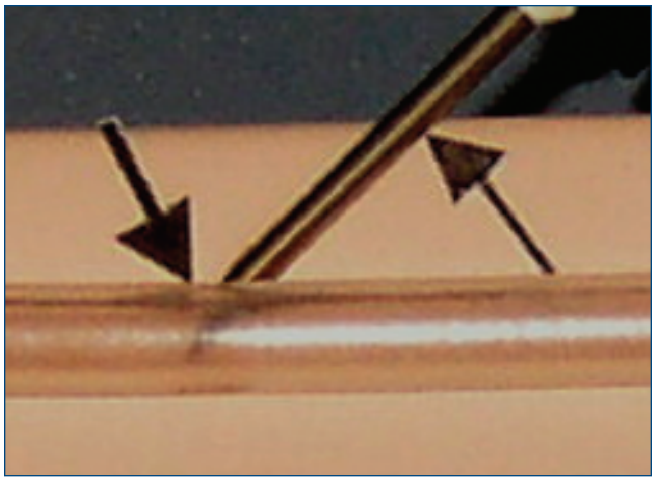
The use of topical anesthetics in the United States is increasing and that means all patient care staff must know about proper application and side effects, even though patients will be applying the medication before coming to the unit. The package insert or the Physician's Desk Reference (PDR) should be consulted for contraindications and side effects, and the patient should be asked about any allergies or particular health issues. A study by Suriti and Suraj (2002) indicates that depth of anesthesia with topical anesthetics depends on the contact time. In order to reach a maximal depth of 3 mm, the topical anesthetic cream has to remain on the skin for 60 minutes and to reach a depth of 5 mm the cream has to be on the skin for 120 minutes. Topical anesthetics contain lidocaine or a combination of lidocaine and prilocaine and need to be applied by the patient at home. After application, the patient should cover the access with saran wrap to protect clothing and ensure that the medication is not wiped off prematurely.

## Cannulation

There is probably nothing more anxiety provoking for patients on hemodialysis than having very large needles inserted into their accesses. Staff members need to be cognizant of the pain, whether psychological or physical, that accompanies cannulation. The three-point technique (Ball, 2003) is a method for inserting needles that provides for accuracy and has little pain associated with it (see Figure 3). First, the thumb and forefinger of the nonneedle hand are placed on either side of the fistula to eliminate rolling, preventing a sidewall infiltrate, as well as serving as a guide when threading the needle. Threading the needle down the center of the fistula will eliminate the need for flipping, a hazardous practice due to the potential for infiltrations, coring, and damage to the intimal lining of the vessel wall. The access should not be squeezed or pinched as this will cause a temporary stenosis and increase pressure within the fistula that could cause an infiltrate. The third point of the three-point technique uses either the pinky or ring finger of the needle hand, which is used to pull the skin taut thus enabling the needles to slide into the skin with less resis-

**Figure 3**
**Three-Point Technique**

**Figure 4**
**One Needle-Two Hole Illustration**



tance. Additionally, by compressing nerve endings when you are pulling the skin taut, it is possible to interrupt the "pain-to-brain" sensation for approximately 20 seconds making cannulation less painful (National Institutes of Health, 1997).

Distraction is another good technique to use during cannulation. Have another patient or staff person engage the patient in conversation while you insert the needles, remembering to always let the patient know when you are inserting the needle so the patient doesn't flinch or pull the arm away. Patients may also benefit from visualization, various breathing techniques, or listening to music.

Needle removal is just as important as needle insertion. When an access is cannulated, there are two holes that are created from each needle, one through the skin and another through the blood vessel wall (see Figure 4). It is important to remember that both holes must be compressed when needles are removed in order to ensure that bleeding stops from both sites. If the site into the blood vessel wall is not covered adequately, there will be leakage of blood into the tissues – causing bruising and hematoma formation – and can put an access at risk for difficult cannulation, limitation of cannulation sites, and access failure due to increased pressure or stenosis formation. Therefore, two fingers should be used to hold each site – one covering each hole. Not using two fingers per site may be one of the reasons for breakthrough bleeding, which usually occurs soon after the patient leaves the chair.

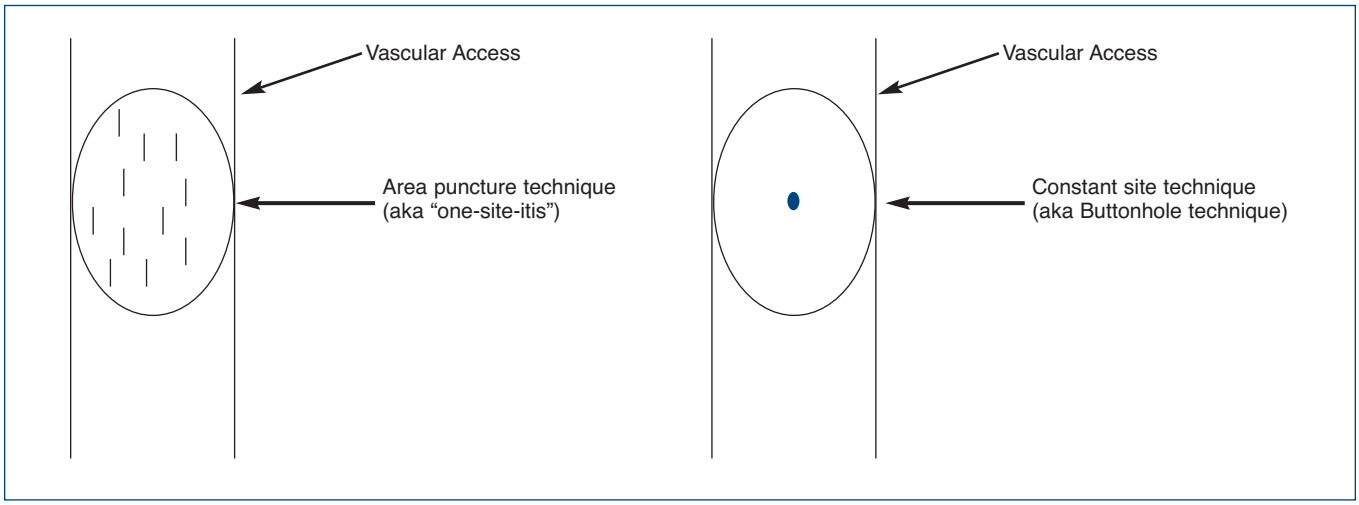
## Cannulation Site Techniques – Rope Ladder and Buttonhole

The Rope Ladder Technique is the predominant cannulation technique used in the United States. It is usually referred to as site rotation – every time the patient comes in for dialysis, two new sites are chosen for needle placement. Cannulation rules for the Rope Ladder Technique include keeping the needles at least 1.5–2 inches apart, 1.5 inches from the anastomosis, and avoiding the previous sites. There are some fistulae where maintaining these rules are all but impossible – primarily due to the limited length access, whether it is all the vein that is available, or the vein becomes too deep to cannulate.

There is another cannulation technique called the Buttonhole Technique, which has been in use in Europe for over 25 years with much success. The buttonhole technique is for native AV fistulae only and requires inserting the needle into the same site and at the same depth and angle for each and every cannulation, creating a tunnel or track that is very similar to a pierced earring hole. It is important that patients understand the need to rotate sites – to prevent "one-site-itis," but this is a misnomer that causes confusion with patients as we try to educate them about the buttonhole technique (see Figure 5). There is fear that cannulating a constant site, which was the original term for the buttonhole technique, will cause aneurysm formation. Aneurysm formation is a ballooning out of a weakened blood vessel wall forming that all-to-familiar gumdrop shape. This weakening typically occurs in fistulae due to repeated cannulations in the same general area as opposed to one site (Ball, 2004).

Kronung (1984) compared three cannulation techniques – rope ladder, area puncture and buttonhole – to identify their effects on Cimino fistulae. Results of his studies indicated that the area puncture technique was the only technique that developed aneurysms, so there is little reference to this technique in today's literature. Several methods have been used to

**Figure 5**
**Repeated Cannulation in a General Area Vs. One Site**




show that no aneurysm formation occurs with the buttonhole technique, including ultrasound (Goovaerts, 2005), excision of a buttonhole fistula segment from a deceased patient (Toma, 2005), and contrast injection (Kronung, 1984). Advantages of the Buttonhole Technique include: fewer infections, infiltrations, and missed sticks; decreased hematoma formation; and less pain, eliminating the need for anesthetic (Twardowski, 1979). The major disadvantage for the use of the Buttonhole Technique has to do with staffing patterns, because buttonhole requires the same cannulator until the track has been formed. This will vary by patient, but on average, facilities in the Northwest are reporting track formation has taken approximately 3 weeks for patients who do not have diabetes and 4 weeks for patients who do have diabetes (almost twice as long as the European literature indicates).

## Conclusion

Whether you are new to dialysis or a veteran of many years, there are always areas of your practice that can be improved upon. Just because "that's the way we've always done it," does not necessarily mean it is still relevant to today's practice or that it is the best technique. Machines, dialyzers, needles, and patients' accesses have greatly changed over the last several decades, so we need to make sure we are doing everything we can to improve the quality of care delivered to our patients. Look at your cannulation practice to see if there is an opportunity to provide better care to your patients. They will thank you for it.

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