

# Update on Cannulation

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## Abstract

- Complications of cannulation can lead to many adverse patient outcomes and can vary from minor to life-threatening. And while the basics of cannulation training remain the same with the goal of developing expert cannulation skills, many devices and practices have been introduced in the hope to reduce cannulation complications. This presentation is designed to review data and practices related to cannulation complications as well as the devices in use such as buttonhole guides and the use of ultrasound guidance and other techniques/practices to enhance successful cannulation and prevent complications.

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## What does “*up to date*” mean?

- Recent? History of Vascular Access/Cannulation (Art and/or Science)
  - 25 years ago it was an art taught in HD facilities
  - Early 90s DOPPS introduced the value of global studies - science
  - 1997 NKF Dialysis Outcomes Quality Initiative (DOQI)
  - 2003 NVAII & 2005 Fistula First Breakthrough Initiative (FFBI)
  - 2006 Revision & renaming – Kidney Disease Outcomes Quality Initiative (KDOQI) – CPGs evidence-based – CPRs best practice recommendations
  - International guidelines and science
  - 2018 KDOQI revision

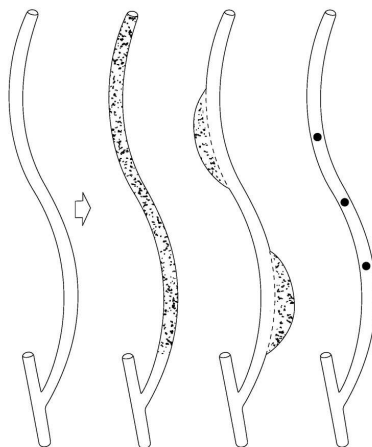
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## What does “*up to date*” mean?

- The biggest change in cannulation the move from AVGs to AVFs
- 2005 - 32% AVFs and ~ 60% AVGs.
- Cannulation techniques very different
- FFBI revolution based on guidelines - AVFs safer, last longer, and cost effective
- resulting in > 60% fistulas and less than 20% grafts
- “Success” at what cost?

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## AVF Cannulation Methods



Twardowski & Kubara 1979

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## What does “up to date” mean?

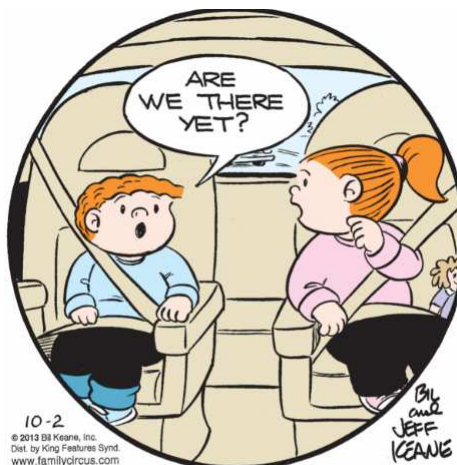
- The latest innovation/s in either technique or technology for difficult cannulation while preserving proven basic practice?
  - Technique/s aka “best practice” to prevent complications
  - Technology that promotes *successful* cannulation and complication prevention
- Sources
  - Literature
  - Practice guidelines
  - “The Buzz”



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## What is *Successful Cannulation*?

- Two needles for an entire treatment of adequate dialysis
- Consistently successful and safe cannulation is the goal of vascular access creation and preservation!



"It depends on where you think we're going."

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## Are We on the Right Track?

- Innovative technology for difficult cannulation:
  - Point of Care ultrasound devices
  - Buttonhole creation devices
  - Needles
- Technique issues and reactions:
  - What is the best cannulation technique?
  - Status of the buttonhole technique
  - Access infections and outcomes

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## The Good, The Bad, & The Ugly



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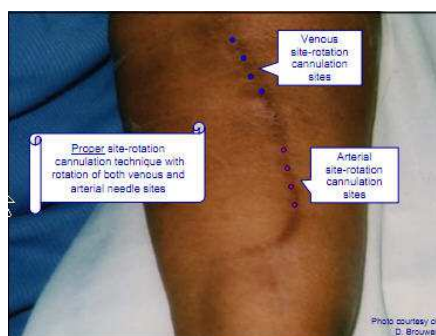
## Cannulation Best Practice

- Site rotation (rope ladder)
- 15 ga. needles that can support flows  $> 400$  mls per min.
- Both needles placed antegrade
- Spaced  $\sim 1.5$  inches (3.6 cm) apart
- Experienced cannulator
- Ideally self-cannulating



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## Rotation of Needle Sites



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## 2014 Study from Europe

To determine “the impact of cannulation technique on arteriovenous fistula and graft survival”

- n = 7058 patients access survival data from nine countries between 4/2009 – 3/2012
- 90.6% AVF and 9.4% AVG
- Same area technique 65.8%, rope-ladder 28.2%, and buttonhole 6%
- Most common needle direction - antegrade for both needles and bevel up (43.1%)

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Parisotto MT et al [Kidney Int.](#) 2014

## 2014 Study from Europe Results

- Retrograde direction of the arterial needle with bevel down was associated with an increased failure risk
- Higher risk of failure associated with venous pressures under 100 or over 150 mm Hg
- Larger needles favored access patency, with 15 G superior to 16 or 17 G.
- As well as QB in the range of 300–350 ml/min
- Application of arm pressure\* favored access longevity compared with no pressure or using a tourniquet.

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Parisotto MT et al [Kidney Int.](#) 2014

## 2014 Study from Europe Results

- Increased risk for access failure:
  - for grafts vs. fistulas,
  - proximal location vs. distal,
  - right arm vs. left arm
  - blood flows below 300 ml/min
  - venous pressure >150 mm Hg
- “*Area* cannulation was associated with a **significantly higher risk of access failure** than rope-ladder **OR** buttonhole.”



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Parisotto MT et al [Kidney Int.](#) 2014

## Button Hole Technique

- Is the “repeated cannulation into the exact same puncture site, and a scar tissue tunnel tract develops. The scar tissue tunnel tract allows the needle to pass through to the (outflow) vessel of the fistula following the same path each time.”

Patt Petersen, NNJ, 4/2001

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## Button Hole Technique

- Cannulation less painful
- Quick and easy cannulation
- Infiltrations and reneedling virtually eliminated
- Infection rate not significantly higher than multi-site cannulation

Twardowski, D&T, 1995

“Infection rate with buttonhole may be underestimated.”

Buttonhole cannulation--an unexpected outcome.

Doss, Schiller, & Moran. NNJ 2008

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## Cannulation Technique RCTs

Hemodialysis patients from three centers in UK, dialyzing with an AVF. Participants randomized to BH (exp. n=28) or RL technique (control n=28)

- Local anesthetic use reduced in 9/22 BH patients compared with 1/25 patients in control ( $P < 0.01$ )
- No difference in presence of pain scores, however the BH group had a higher pain score 2.5 out of 10 vs 1 for the control group
- AVFs in the buttonhole group increased in size by  $1\% \pm 22\%$  compared with  $30\% \pm 7\%$  ( $P < 0.01$ )

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Struthers et al. ASAIO J (2010)

## Cannulation Technique RCTs

- Complications:
  - bleeding from needle sites: 11 in BH group, 17 in RL group;
  - infiltrations: 19 in the BH group, 27 in RL;
  - thrombosis: 1 in each group;
  - fistula infection: 1 in BH group only.
- Strong preference for BH in patients (21/22) and staff (15/23) as opposed to RL technique.

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Struthers et al. ASAIO J (2010)

## Cannulation Technique RCTs

70 Incident and prevalent HD patients randomized to intervention group (BH) or control group (usual practice –RL). Multicentre, Australia lasted 6 mths.

- 17 BH patients experienced 33 complications
- 11 RL patients experienced 14 complications
- 4 patients in the BH group and 1 in the control group infection at the cannulation site (P= 0.11)
- hematomas and pain at the cannulation site more common in the BH group (P<0.05)

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Chow et al. J Ren Care (2011)

## Cannulation Technique RCTs

- RCT - 140 patients with stable AVF rope ladder or buttonhole. Single center, Canada, lasted 14 months.
- pain score similar between the two groups but more patients in the BH group had **excess** pain
- hematoma formation higher P=0.03 in the RL group
- localized infection rate - 22.4 RL compared with 50/1000 HD sessions in the BH group, P=0.003
- 3 BH patients had Staph. aureus bacteraemia and 9 who developed an abscess at the BH site, requiring antibiotics, compared with no episodes of bacteremia or abscesses in the RL group (P=0.003)

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MacRae et al. JASN (2012)

## Cannulation Technique RCTs

RCT of 140 adult HD patients with a stable AVF assigned to either buttonhole (BH)\* or usual practice (UP). Single center, Canada, lasted 12 months.

Results:

- primary outcome measure of AVF survival at 1 year statistically significantly increased in BH - 100% vs 86% with UP. P = 0.005
- In BH group - fewer interventions (19% vs 39% UP)
- less existing\* aneurysm enlargement (23% BH vs 67% UP)
- NO bacteremia events in BH group vs 2 in UP group (0.09/1,000 AVF days).
- No significant differences in bleeding times and lignocaine\* use

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Vaux E. et al. *AJKD* (2013)

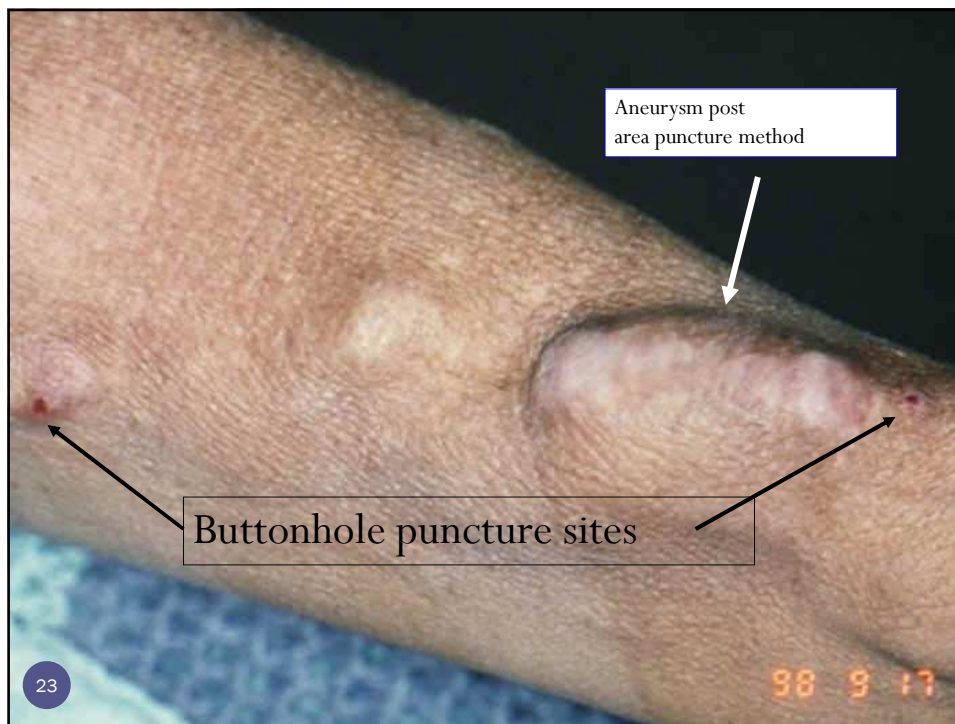
## Cannulation Technique – Other Studies

- van Loon et al, *NDT* 2010
- Nesrallah et al, *cJASN* 2010
- Labriola et al, *AJKD* 2011
- Suri et al, *JASN* 2013
- Lok et al, *Nephron Extra* 2014
- Ludlow V. *Cannt Journal* 2010
- van Eps C.L. *HI* 2010
- Marticorena R et al. *HI* 2006

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Zimmerman D ASN online

Vale E. Et al. CARI Guidelines online 2011



## Buttonhole Cannulation



### My Conclusions from the Science & The BUZZ

#### Pros

- Less BH creation
- Requires proper assessment by the VA IDT
- Requires matching of cannulation skills to difficult cannulation accesses
- Technology/techniques available for difficult access

#### Cons

- Less BH creation – Rx only  
BH **banned** in some facilities in US
- Loss of expert cannulator BH skills
- ?Availability & cost of technology/techniques for difficult access

## Buttonhole Cannulation Conclusions Bottom Line!

“Use of buttonholes should be limited to those patients with difficult cannulation or short segments unless strict infection control measures including topical antibiotics can be assured” Zimmerman D ASN online

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## Technology/Techniques Available for Difficult Access\*

- Surgical lipectomy
- Polycarbonate pegs intradiallytically
- Surgical insertion of Vwing devices
- Ultrasound for assessment and needle guidance
- Needles – longer, shorter, or flexible

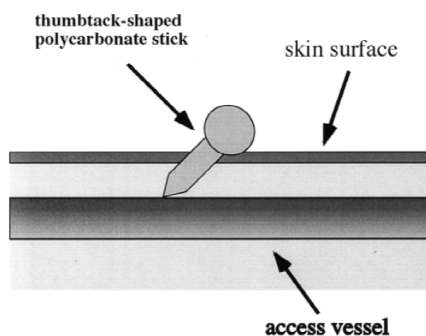
**Successful use of minimal incision superficialization (aka removing the fat) technique for arteriovenous fistula maturation.**

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Inkollu S, et al. J Vasc Surg. 2016.

From: **A timesaving method to create a fixed puncture route for the buttonhole technique**

Nephrol Dial Transplant. 2003;18(10):2118-2121. doi:10.1093/ndt/gfg321


**Figure Legend:**

After withdrawing a puncture needle and stopping bleeding at the end of a standard haemodialysis, the newly developed thumbtack-shaped polycarbonate peg is thrust toward the access vessel along the path of the puncture needle just removed. The peg is short enough so that its tip does not reach the access vessel wall.

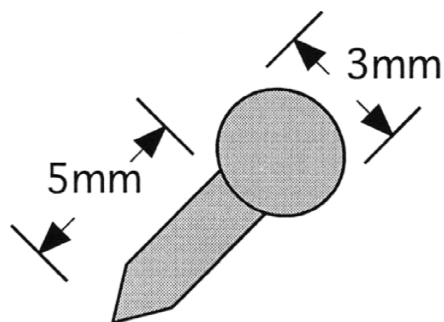
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Date of download: 3/4/2017

Nephrol Dial Transplant 18(10) © ERA-EDTA 2003; all rights reserved

 From: **A timesaving method to create a fixed puncture route for the buttonhole technique**

Nephrol Dial Transplant. 2003;18(10):2118-2121. doi:10.1093/ndt/gfg321


**Figure Legend:**

The indwelling polycarbonate peg. The peg is 5mm in length, and the diameter of its penetrating portion is the same as that of the puncture needle. Its tip is dull, and a spherical stopper (3mm diameter) is provided on the opposite end.

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Date of download: 3/4/2017

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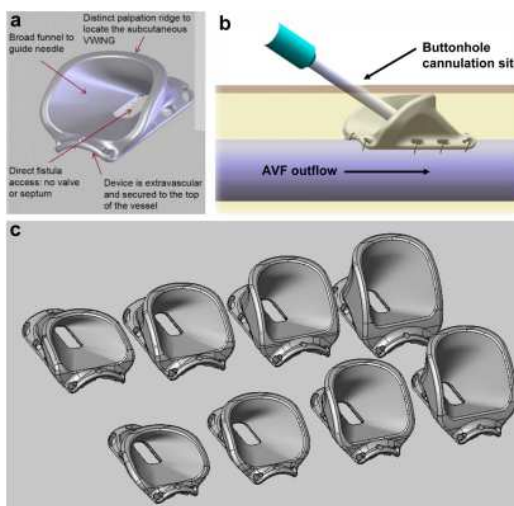
## Cannulation Challenge of The Short, The Deep, and The Squiggly AVF



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## Surgical Insertion of VWING Devices

- “The Venous Window Needle Guide, a hemodialysis cannulation device for salvage of uncannulatable arteriovenous fistulas”
- n=51
- 96% success
- 100% survival 6mths

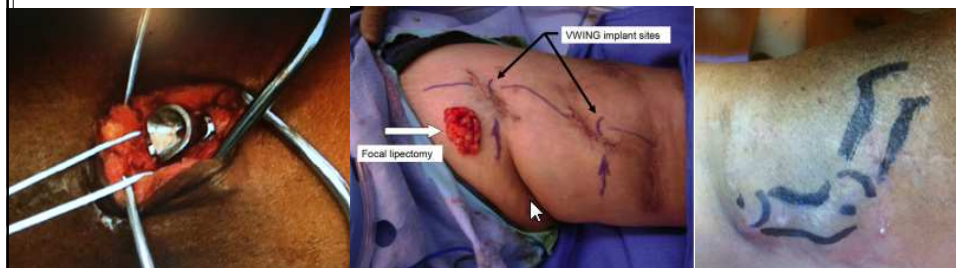


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Save Study - Jennings W et al. JVS. 2014

## VWING Cannulation

- Should be palpable p 2 weeks
- Cannulate after 3 weeks min. (avg 35-40 days)
- If Pt has a CVC use “1&1” technique CVC as venous
- Blunt needles after 4-5\* sharp entries
- Touch technique with the blunt needles



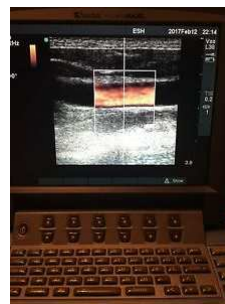
## The Use of Ultrasound for Assessment and Cannulation Guidance



site-rite 6  
ultrasound ...  
\$35,448.26  
Health Produ...



Sonosite Titan  
\$9,000.00  
Ultrasound Sup...  
Free shipping



Sonic Window for Dialysis





## “Ultrasound for Assessment/Cannulation Requires Specialized Training”

- to obtain basic hand-eye coordination, theoretical sessions
- practical sessions using phantom models recommended prior to use in the clinical setting with patients.
- new users of this technology - all competencies can be achieved with *daily* use of ultrasound at the bedside.
- takes approximately 500 guided cannulations to achieve the highest level of competency.

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Marticorena R. et al. [CANNT J. 2015](#)

## The Use of Ultrasound for Assessment and Cannulation Guidance



Sonic Window for Dialysis

### Methods

- From 09/08/2013 to 11/18/2013 at 4 centers, clinicians were trained to use the Sonic Window handheld ultrasound device to capture cannulation characteristics of AVF and AVG, including vessel depth, vessel diameter and recommended needle gauge.
- Cannulation maps were created on paper and maintained in the treatment area for reference, indicating areas for cannulation, areas to avoid, and maximum acceptable needle gauge.
- Cannulation maps were subsequently used by the patient care team for needle placement.
- We collected and analyzed data on 123 patients who were mapped with Sonic Window.

- NKF 2016 poster “Use of hand held Ultrasound Device to identify cannulation characteristics of AVF and AVG” L. Pryor et al.
- Of the 123 patients studied & (mapped):
  - 18 had new cannulation areas ID'd
  - 16 patients referred for IN evaluation
  - 11 of these had interventions
  - 5 had clinical signs

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## The Use of Ultrasound for Assessment and Cannulation Guidance



Sonic Window for Dialysis

- ASDIN 2017 poster  
“Use of hand held  
Ultrasound Device to  
support permanent  
HD vascular access  
cannulation” Sellers, A  
et al. FMC

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### METHODS

- All patients presenting with a new AVF/AVG for dialysis were referred to a trained super-user for US evaluation at two Fresenius Medical Care North America clinics in Ohio from 01/24/2016 to 06/01/2016.
- Clinicians were trained to use the handheld US device, Sonic Window, to capture cannulation characteristics of AVF/AVG including vessel depth, vessel diameter, and recommended needle gauge.
- The US readings either substantiated, or disproved that the access was ready for cannulation, by the “Rule of 6’s” criteria of being at least 6 mm in depth, 6 mm in diameter, could accommodate at least a 17 gauge needle, and had discernible edges.

### RESULTS

- 63 patients were included and there were 48 AVFs and 15 AVGs; 38 of the AVFs and 10 of the AVGs were evaluated using the US (Figure 2).
- 28 patients had successful cannulation of their new AVFs/AVGs.
- 17 patients were referred for intervention based on US findings.
- 4 patients had a new cannulation area(s) identified.
- 2 patients with new AVF were identified as having accessory vessels (Figure 1 and 2) and were sent for follow up and/or intervention.

## The Use of Ultrasound for Assessment and Cannulation Guidance – the Buzz

- “For those who lack experience in cannulating, this tool may be helpful but only if the use of the US is taught with hands on demonstration from an expert RN...It is important to be taught the proper technique .... and to not become dependent on an Ultrasound.” C. Sutton, Hawaii.
- “A fantastic adjunct to physical assessment and has the potential to provide optimal needle placement, decrease miscalculations, and decrease long term issues caused by needle extravasation and backwalling which causes intimal hyperplasia and stenosis” M Schoch, Australia.

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## The Use of Ultrasound for Assessment and Cannulation Guidance

- “50% reduction in missed cannulations the first month that US was available” A Luehr (2016)
- “We do ultrasound guided cannulation on all new AVFs to the unit in the first 2 weeks (we also use plastic cannulae during these 2 weeks). This has improved the cannulation success rate.” personal communication, M Schoch, Australia.
- UNC RRI units using Sonic Window for cannulations and the VAC has one for predialysis maturation assessment.
- ***Will point of care US guidance for initial cannulation become a guideline?***

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## The Use of Ultrasound for Assessment and Needle Selection

- Does ultrasound assessment help with appropriate needle selection?  
“has potential to provide optimal needle placement, decrease miscalculations and decrease long term issues caused by needle extravasation and backwalling” M. Schoch
- gauge?
- length?
- angle?
- plastic vs steel?

NKF Clinical Update <https://www.kidney.org/sites/default/files/Fistula%20Bulletin.pdf>

Martcorena RM, Donnelly SM. [Impact of needles in vascular access for hemodialysis](#)



Figure 3: Fistula cannula needle (also referred to as a fistula catheter needle or a plastic needle)



a) Only the tip of the metal needle is exposed for insertion when the plastic cannula has not yet been deployed.



b) After insertion of the plastic cannula into the vessel, the metal needle is retracted into the automatic safety device; only the plastic cannula remains in the vessel. The photo shows the metal needle partially retracted.

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## Argyle Needle Use

“makes a huge difference when cannulating new fistulas”



**Vicki Smith,**  
Vascular Access  
Nurse, Renal Services,  
Barwon Health, Aust.

- Cannula has a backflow valve – no clamping
- Allows free arm movement & risk of infiltration
- “push the line in and twist just like a leuc lock syringe”
- Cost of backflow valve cannula more expensive

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## The Latest in Graft Technology and “Early” Cannulation

- Two major players:
  - Atrium Flixene
  - Gore Accuseal
- Indicated for no CVC



Figure 2. Tunneling of the graft and bypassing a large infected cannulation site.



Figure 3. This graft is easy to use and malleable in its handling properties. Tunneling with a large clamp/forcep may be less traumatic.



[http://evtoday.com/pdfs/et0614\\_gore%20supp%20sec%202.pdf](http://evtoday.com/pdfs/et0614_gore%20supp%20sec%202.pdf)

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## The Latest in Graft Technology and “Early” Cannulation

- Suggested cannulation guidelines:
  - Atrium Flixene :
    - can be cannulated 1 week po (Berard X et al. JVS, 2015)
    - 24-72 hrs (Schild et al. J Vasc Access. 2011)
  - Gore Acuseal (Glickman M EVToday 2014):
    - sterile gloves
    - 17 gauge dialysis needles for the first three sessions within the first 2 weeks of implantation
    - lower flows up to 250 mL/min as opposed to high flows up to 400 mL/min
    - a low-bleed graft -light pressure needs to be placed on the decannulation site for 10 to 15 minutes
    - graft is then cannulated within 24 hours of placement for patients without CVC access

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## The Good, The Bad, & The Ugly



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## The Steps of Best Practice (routine) Cannulation

- Assessment
- Skin and Patient Preparation
- Cannulation – both rope ladder and buttonhole
- Needle taping and initiating dialysis
- Needle removal
- Post-dialysis assessment

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## Pre-Dialysis Wound Assessment – Needle Punctures

- Inspection:
  - condition of recent needle sites
    - Sufficient rotation of sites?
    - Healing appropriately with scab and no drainage



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“The most dangerous acute problem from aneurysmal change is skin erosion, especially when it is associated with localized sepsis in the conduit.”

J. Kauffman, surgeon, Pg 96 Handbook of Dialysis Therapy 4<sup>th</sup> ed.



## Vascular Access Rupture – An Avoidable Cannulation Complication

- Warning Signs of Impending Rupture:
  - evidence of disruption of access wall;
  - signs of infection;
  - a persistent clot (scab);
  - unhealthy skin over access (shiny and/or discolored);
  - pseudoaneurysms that exceed twice the diameter of the graft or those that are increasing in size;
  - excessive access bleeding after dialysis, around needles, and between treatments



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Sekkarie M. [http://www.kidneynews.org/kidneynews/6\\_2/14/14.pdf](http://www.kidneynews.org/kidneynews/6_2/14/14.pdf)

## Vascular Access Rupture – An Avoidable Cannulation Complication

- The role of access physical examination:
  - best done before cannulating the access where tape and needles are not obstructing the view.
  - look for the warning signs.
  - nurses and patient care technicians should look for these signs at every dialysis session.
  - the examination before dialysis should also be done by the nephrologist periodically.

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Sekkarie M. [http://www.kidneynews.org/kidneynews/6\\_2/14/14.pdf](http://www.kidneynews.org/kidneynews/6_2/14/14.pdf)



## Vascular Access Rupture – An Avoidable Cannulation Complication

- Preventive measures?
    - **Proper cannulation techniques** can prevent the formation of thin walled areas, including aneurysms and pseudoaneurysms.
      - Rotating sites, including the rope ladder technique,
      - make use of the whole length of the access
      - prevent wearing certain areas.
      - **Buttonhole technique in fistulae** may have an advantage but good data are lacking.
    - **Cluster sticking, the tendency to stick in one general area, should be avoided.** Over-anticoagulation should be avoided.
- “Close to 60 percent of patients who die due to a ruptured access experience an access complication event in the 6 months preceding death.”

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Sekkari M. [http://www.kidneynews.org/kidneynews/6\\_2/14/14.pdf](http://www.kidneynews.org/kidneynews/6_2/14/14.pdf)

## Vascular Access Rupture – An Avoidable Cannulation Complication

- How urgent is the need for referral when these warning signs occur?
  - The presence of one or more of the above warning signs constitutes an urgent, and even at times emergent, situation.
  - Direct verbal communications between the nephrologist and surgeon are critical.
  - Active and recurrent bleedings and skin erosion require immediate surgical intervention.

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Sekkari M. [http://www.kidneynews.org/kidneynews/6\\_2/14/14.pdf](http://www.kidneynews.org/kidneynews/6_2/14/14.pdf)

## Vascular Access Rupture – An Avoidable Cannulation Complication

- How should access ruptured be managed?
  - Patients, members of their household, and caretakers should be instructed on how to apply pressure if access bleeding occurs.
  - They should call for immediate help even if the bleeding stops. Immediate surgical consultation in a hospital setting is warranted.
  - All dialysis providers should be familiar with pressure techniques on the bleeding area and its arterial flow.
- What is the prognosis?
  - Severe bleeding in the home setting is probably fatal in most circumstances.

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Sekkarie M. [http://www.kidneynews.org/kidneynews/6\\_2/14/14.pdf](http://www.kidneynews.org/kidneynews/6_2/14/14.pdf)

## Conclusions – Yes We Can Do Better!

- Cannulation of the hemodialysis vascular access is both art and science.
- We must reinforce **the Good!** Start on the right track – use all assessment skills to determine cannulation method using US if possible. Match needles and cannulation skills to the access!
- Deter and correct **the Bad!** Avoid aneurysmal & pseudoaneurysmal areas (use PoC US if you can)
- **Eliminate the Ugly!** Access infection and rupture is 100% preventable! Refer for surgical help early!
- For the *Short, Deep, and Squiggly* AVF we must use our expertise to assess (US) and refer if necessary for surgical help (lipectomy and/or Vwing) – Buttonhole done right is *Good!*

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## Conclusions

- The vascular access team must keep in mind that while the push is to create AVFs, its challenge is to maintain them through appropriate cannulation (all six steps).
- The patient-centered CQI process is essential to assure appropriate assessment and expert cannulation.
- Cannulation is an IDT responsibility but Nurses in partnership with their PCTs are the experts on the *Art and Science of Cannulation!*

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Not yet but now we have a better idea of how to get there!



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## Do's and Don't's of Cannulation

- DO remember that it's always about what's best for the Patient!
- DON'T subject that Patient to anything you wouldn't let someone do to you!

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## Patient quote

“How is it that they have enough time to stick me 2 or 3 times when they miss - but don't have enough time to do it right the first time”

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## Lesley's cannulation tips

- carefully inspect, feel, and listen to access
- thoughtfully choose BOTH needle sites before sticking - take your time
  - which side/end is arterial?
  - where was the previous needle puncture site?
  - is there room above to cannulate again should it "blow"?
  - where will the tip of the needle be?
  - how deep is the vessel?
  - ? needs local - lidocaine versus Emla cream

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## Lesley's cannulation tips cont.

- Remember
  - needles don't bend - accesses do
  - rotate sites
  - *take your time*
  - listen to your patient - he's seen the best and the worst and knows his access best
  - flip needles ONLY if flow is poor
  - tape needles securely not tightly

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## Lesley's cannulation tips cont.

- Remember
  - *take your time*
  - fistulas and grafts are of different composition
  - ALWAYS use a light tourniquet for a fistula or have the patient hold gentle pressure
  - use a tourniquet for a "mushy" graft
  - fistulas not as tough as PTFE - be gentle!
  - if at first you don't succeed - *get expert help!*
  - stick unto others as you would have them stick you

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## Some things just take time!



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Too much  
information!

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