# Vascular Access in hemodialysis

# Vascular Access❑

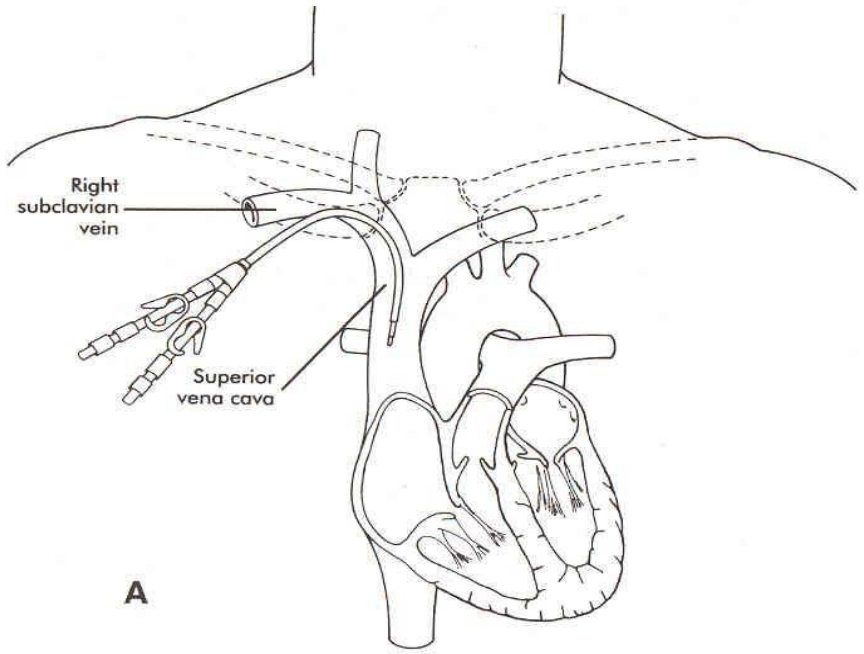
## ❑Temporary :

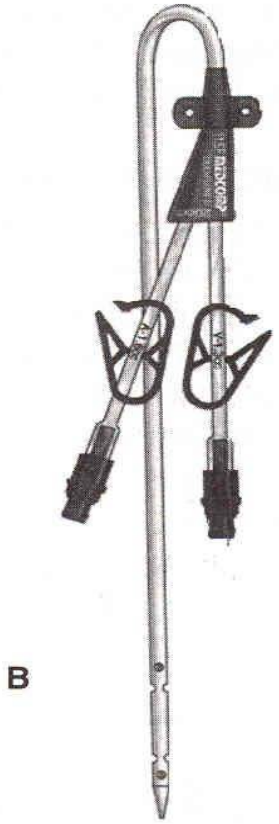
- ❖Shunt
- ❖Central Venous Catheter :
  - ✓ Subclavian Vein
  - ✓ Internal Jugular Vein
  - ✓ Femoral Vein

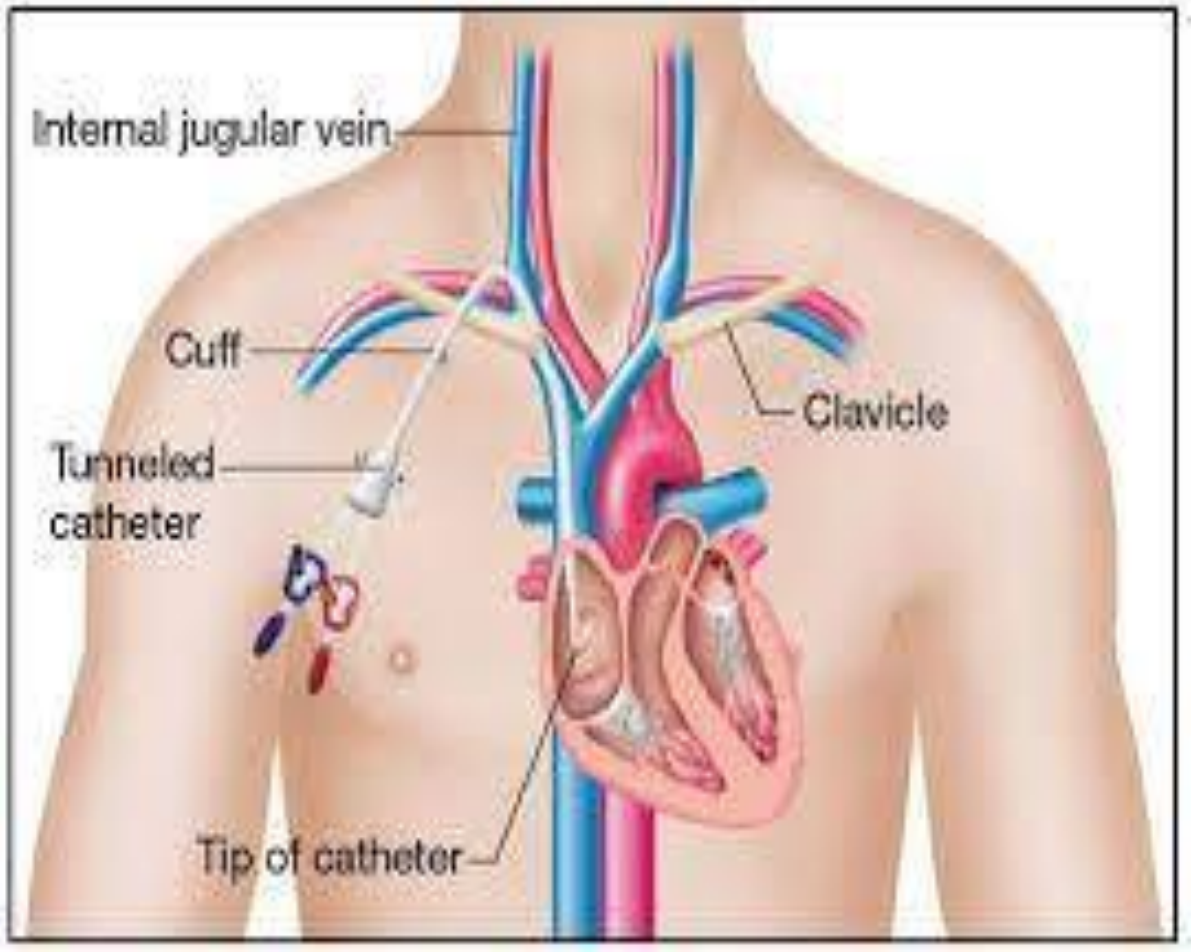
## ❑Permanent:

- ❖Arteriovenous Fistula (AVF)
- ❖Grafts
- ❖ Permanent Catheter

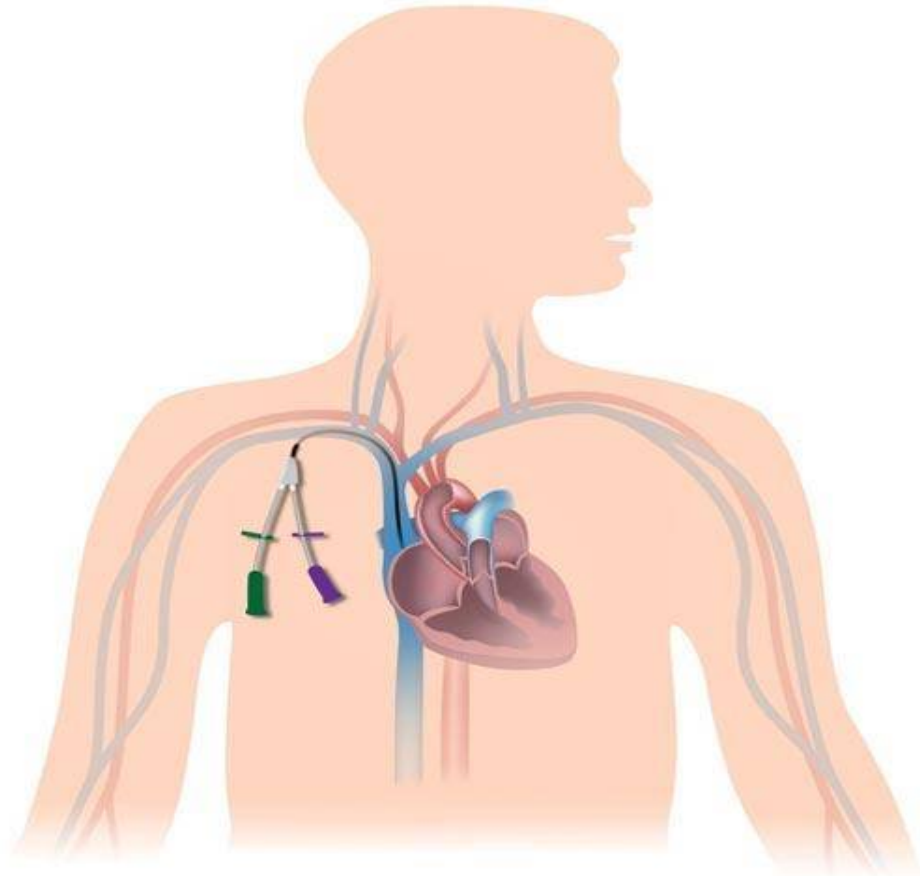
# Central Venous Catheter



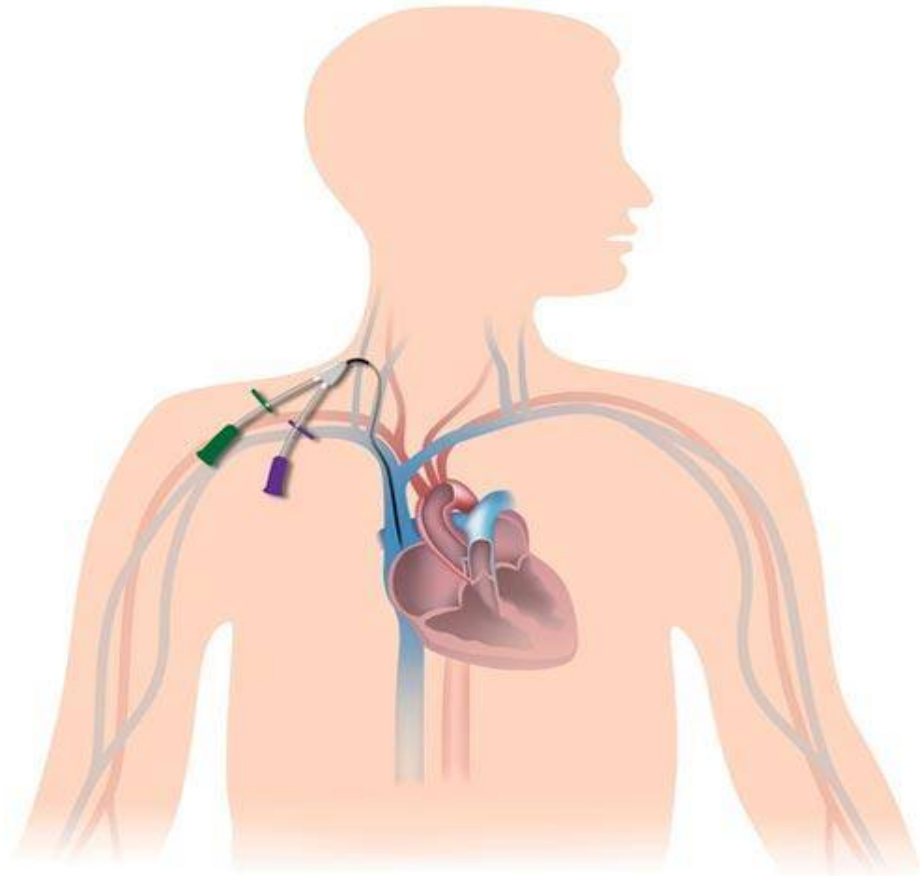



# Central Venous Catheter



Subclavian vein insertion



Internal jugular vein insertion

# Indications for vascular catheter:

- Acute renal failure.
- Dialysis for overdose.
- ESRD with no access.
- ESRD with failure of access.
- Peritoneal dialysis with complications.
- Transplant patients require HD.
- ESRD who lost all possible access.
- Heart failure patients.
- Plasmapharesis and Hemoperfusion.

# Acute Hemodialysis Catheters

## Site of catheter Insertion

can be inserted into the jugular, subclavian, and femoral veins

## Routine use-life of catheters

The limits on use-life are caused by infection internal jugular catheters are suitable for 2 to 3 weeks of use

femoral catheters are usually used for a single treatment (ambulatory patients) or for 3 to 7 days in bed bound patients

# Double lumen cuffed tunneled catheters

- Are principally constructed of silastic/silicone and other soft flexible polymers, which are less thrombogenic than polymers used in acute catheters.

- Require fluoroscopy for insertion due to their larger size and to the confirmation of tip location.

# Double lumen cuffed tunneled catheters

- Allow faster blood flows than acute catheters, Usually blood pump speeds of 400 mL/min

  Actual blood flow rates are almost always lower than those reported by the blood pump(20%-30%)

- Compare to fistulas or arteriovenous grafts, most patients require an increase in treatment time of approximately 20 percent to achieve equivalent urea removal.

- Cuffed tunneled catheter survival

  is highly variable, 74 percent 1-year and a 43 percent 2-year catheter survival

# Early and immediate complications

- Arterial puncture.
- Venous perforation.
- Bleeding & hematoma.
- Pneumothorax.
- Hemothorax & Hemomediastinum.
- Air embolism.
- Arrhythmia and cardiac arrest.
- Cardiac chamber perforation.
- Pericardial Tamponade.
- Injury to adjacent structures: Nerves, Trachea,..etc.

Schwab SJ, Beathard G: The hemodialysis catheter conundrum: Hate living with them, but can't live without them. *Kidney Int* 56: 1–17, 1999.
Walsh SB, Ekbal N, Brookes J, Cunningham J: Tinnitus after hemodialysis catheter placement. *Kidney Int* 74: 688, 2008.
Muthuswamy P, Alausa M, Reilly M: The effusion that would not go away. *N Engl J Med* 345: 756–759, 2001.

# Late Complications

- Thrombosis.
- Fibrin sheath formation.
- Infection.
- Vascular thrombosis and stricture.
- AV fistula.

Agarwal, Anil K, Asif Arif. NephSAP. Interventional Nephrology, ASN. 361-375. 2009.

# Double Lumen Catheter Complications

## Central vein thrombosis and stenosis

- occur more often with subclavian (40 to 50 percent of cases in some studies) than with internal jugular insertions (up to 10 percent)

- The K/DOQI guidelines therefore recommend avoiding placement in the subclavian vein, unless no other options are available

# CATHETER (CVC) DYFUNCTION INTERVENTIONS

- Flush each lumen with 10 ml of normal saline
- Reverse lines using aseptic technique
- If flow problem persists, likely thrombus in lumens, on the wall of the vessel or a fibrin sheath. Use thrombolytic agent per MD order
- May need to change the catheter

**All catheters "locked" with some anticoagulant to prevent thrombus.**
**Firmly infuse to the volume of the lumens, then quickly reclamp lumen to prevent negative pressure in catheter pulling blood in the side holes.**

# Double Lumen Catheter Complications

**Recommendations:**

- All personnel should be adequately trained in aseptic techniques and about the importance of routine hand hygiene before and after patient contact.

- topical use of povodone-iodine on the catheter hubs

➢We recommend that the catheter exit site should be cleaned with Chlorhexidine 2%.

- nurses or technicians routinely wear nonsterile gloves and a mask when dialysis catheters are accessed

# Fibrin Sheath

# Hemodialysis catheter infection

Rate of uncuffed cath. infection:

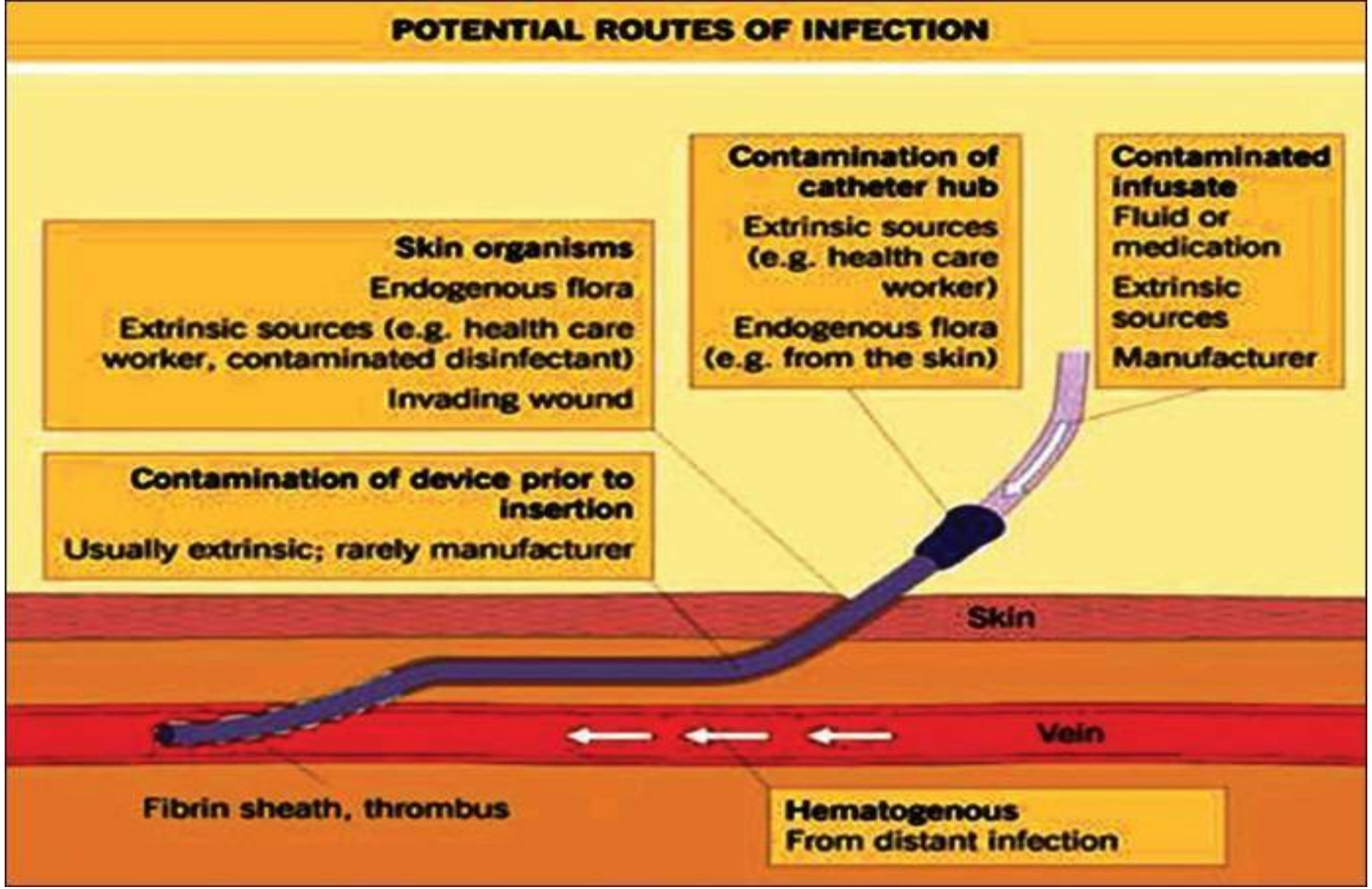
- 8% by 2wks.
- 25% by 1 month.
- 50% by 2 months.

Catheter related septicemia is 2 -20%.

Agarwal, Anil K, Asif Arif. NephSAP. Interventional Nephrology, ASN. 361-375. 2009.

Tunnel infection

Exit-site infection


POTENTIAL ROUTES OF INFECTION
Skin organisms
Endogenous flora
Extrinsic sources (e.g. health care worker, contaminated disinfectant)
Invading wound
Contamination of device prior to insertion
Usually extrinsic; rarely manufacturer
Contamination of catheter hub
Extrinsic sources (e.g. health care worker)
Endogenous flora (e.g. from the skin)
Contaminated infusate
Fluid or medication
Extrinsic sources
Manufacturer
Skin
Vein
Fibrin sheath, thrombus
Hematogenous
From distant infection

Format: Abstract

Full text links

Wolters Kluwer

ASAIO J. 2000 Nov-Dec;46(6):S13-7.

# Staphylococcus aureus infections in dialysis patients: focus on prevention.

Piraino B[1].

Author information

## Abstract

Staphylococcus aureus infections are a major cause of morbidity and hospitalization in dialysis patients. The risk of infection relates to the type of access. Patients with acute hemodialysis (HD) catheters are at the greatest risk of S. aureus bacteremia, followed by tunneled HD catheters, and grafts. Patients with a fistula have a rate similar to that of peritoneal (PD) patients. In PD patients, however, S. aureus is the second most common cause of peritonitis, is often associated with a catheter infection, and frequently requires catheter removal for resolution. S. aureus infections in dialysis patients are much more common in nasal carriers. S. aureus moves from the nasal reservoir to the hands and skin, and from there to infect the access. Therefore, prevention of infection can be aimed at treating the carriage or in applying antibiotics at the catheter exit site, thus preventing colonization and subsequent infection of the catheter. For HD patients with a permanent access (either fistula or graft), intranasal mupirocin, twice a day for 5 days followed by a once weekly application, is effective in reducing the risk of S. aureus bacteremia. Cost analysis indicates that treating all patients would result in more cost savings than treating just carriers. For patients with acute HD catheters, exit site mupirocin applied as part of routine care during each HD treatment, reduces the risk of S. aureus exit site infection and bacteremia. For PD patients, S. aureus infections can be diminished by using mupirocin at the exit site as part of daily exit site care. Prophylaxis against S. aureus is under utilized in dialysis patients and, if implemented, could lower the rate of these serious infections.

PMID: 11110288

[Indexed for MEDLINE]

PROCEDURE:

## A. INITIATING DIALYSIS:

1. Perform hand hygiene.

2. Mask (patient and nurse).

3. Don clean gloves.

4. Change the dressing as per Procedure

## KEY POINT:

- Recommendations from the CSN(Canadian society of nephrology) and KDOQI clinical practice guidelines.

- Exit site MUST be visualized prior to initiating dialysis.

- Dressing changes are preferentially done prior to initiating dialysis to assess catheter position and to verify sutur es are intact. Notify physician if indicated.

PROCEDURE:

## A. INITIATING DIALYSIS:

5. Open drape and place under catheter.

6. Confirm that cannula clamps on catheter are closed.

7. Remove one luer-lock cap from the catheter and using a rotating motion, scrub the hub with a new 2% CHG with 70% Alcohol wipe for 30 seconds.

## KEY POINT:

- The drape is utilized to provide a clean (not sterile) field.
- The use of the clamp on the silastic portion of the catheter ensures that the line is not open to atmospheric pressure during any of the connections and disconnections.
- For practical reasons, pads or similar products might be preferred over other forms of antiseptics (e.g. swab sticks) for disinfecting the catheter as they are pliable and allow for vigorous cleaning of small spaces.

PROCEDURE:

## A. INITIATING DIALYSIS:

8. Allow the hub to dry completely while continuing to hold the catheter lumen.

## KEY POINT:

- Always handle the catheter hubs aseptically. Once disinfected, do not allow the catheter hubs to touch non-sterile surfaces. During this time ensure that the catheter remains clamped.
- Allow to air dry for at least one minute. No wrapping, no fanning, no blowing.
- Antiseptics should be allowed to dry for maximal effect.
- If hub is not dry, it may be difficult to disconnect blood line at the end of the treatment.

PROCEDURE:

## A. INITIATING DIALYSIS:

## KEY POINT:

9. Attach an empty sterile 10 mL syringe.

10. Open cannula clamp and aspirate 3-5 mL of blood to confirm patency and to withdraw previously instilled locking solution. Close clamp. Discard syringe.

- ❑ Dark blood should freely enter syringe. Occasionally clots may be aspirated.
- ❑ Blood specimens may be drawn following aspiration of locking solutions. Never aspirate with a syringe less than 5 mL.

PROCEDURE:

## A. INITIATING DIALYSIS:

11. Attach a new sterile syringe containing 10 mL 0.9% NaCl. Open clamp and instill into the catheter port. Close clamp.

12. Open sterile 10x10 gauze and place under catheter port.

13. Repeat Steps 9-13 for the other lumen of the catheter. If patent, give heparin prime as per physician's order.

## KEY POINT:

- Blood should never be allowed to dwell in the catheter lines. Repeat flush with saline if necessary.

PROCEDURE:

## A. INITIATING DIALYSIS:

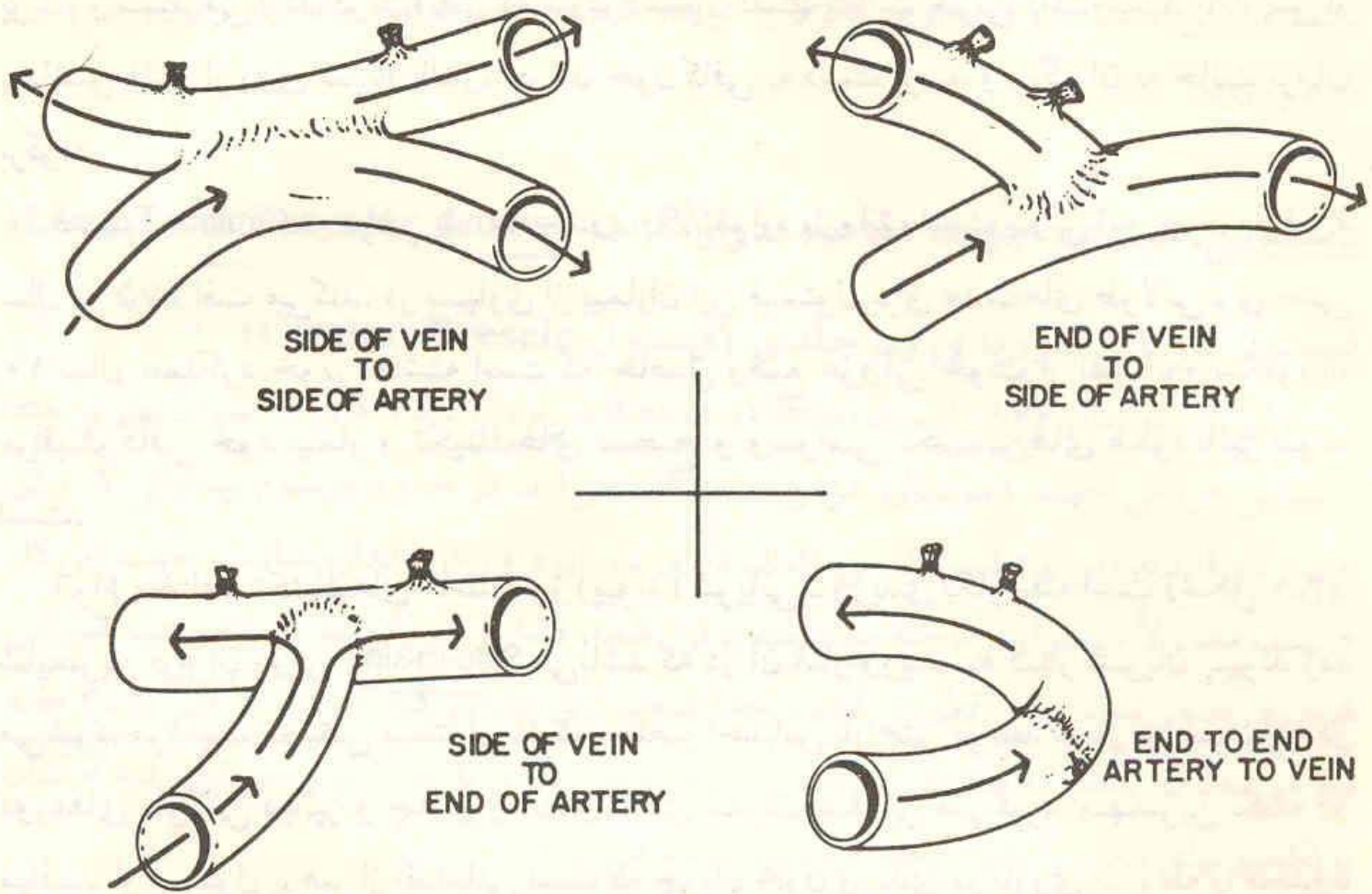
14. Instruct patient to keep catheter connections exposed during treatment.

## KEY POINT:

- To observe for accidental disconnect

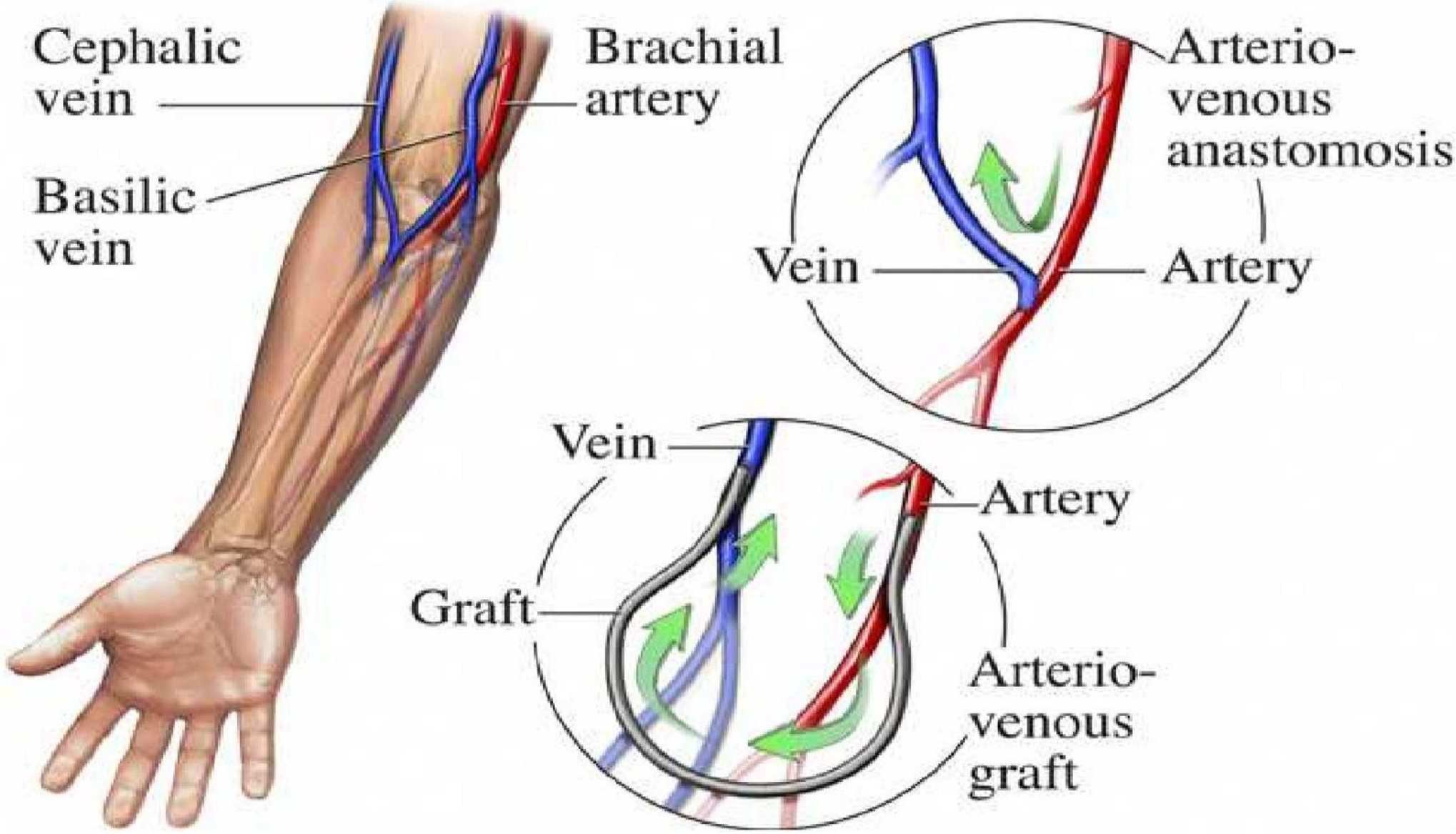
# Catheter Dysfunction signs

- Qb < 300ml/min.
- Art. Pressure <-250.
- Ven. Pressure > 250.
- URR < 65, Kt/V < 1.2.
- Unable to aspirate blood freely. (Late sign).
- Frequent pressure alarms.




شکل ۱ـ۳. چهار نوع فیستول *Cimino-Brescia*

**Transposed Basilic vein Arteriovenous Fistula & Graft**



# Grafts

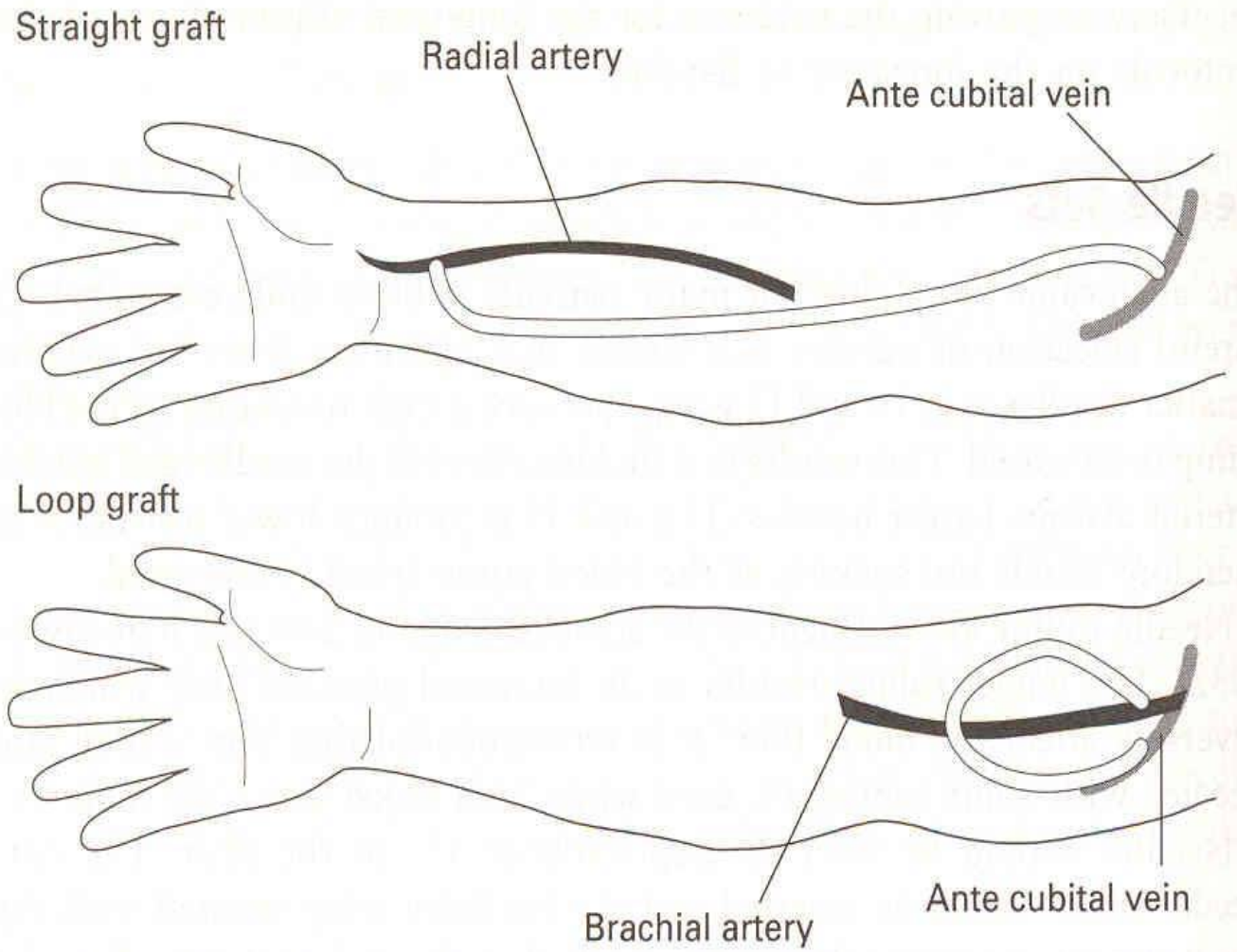
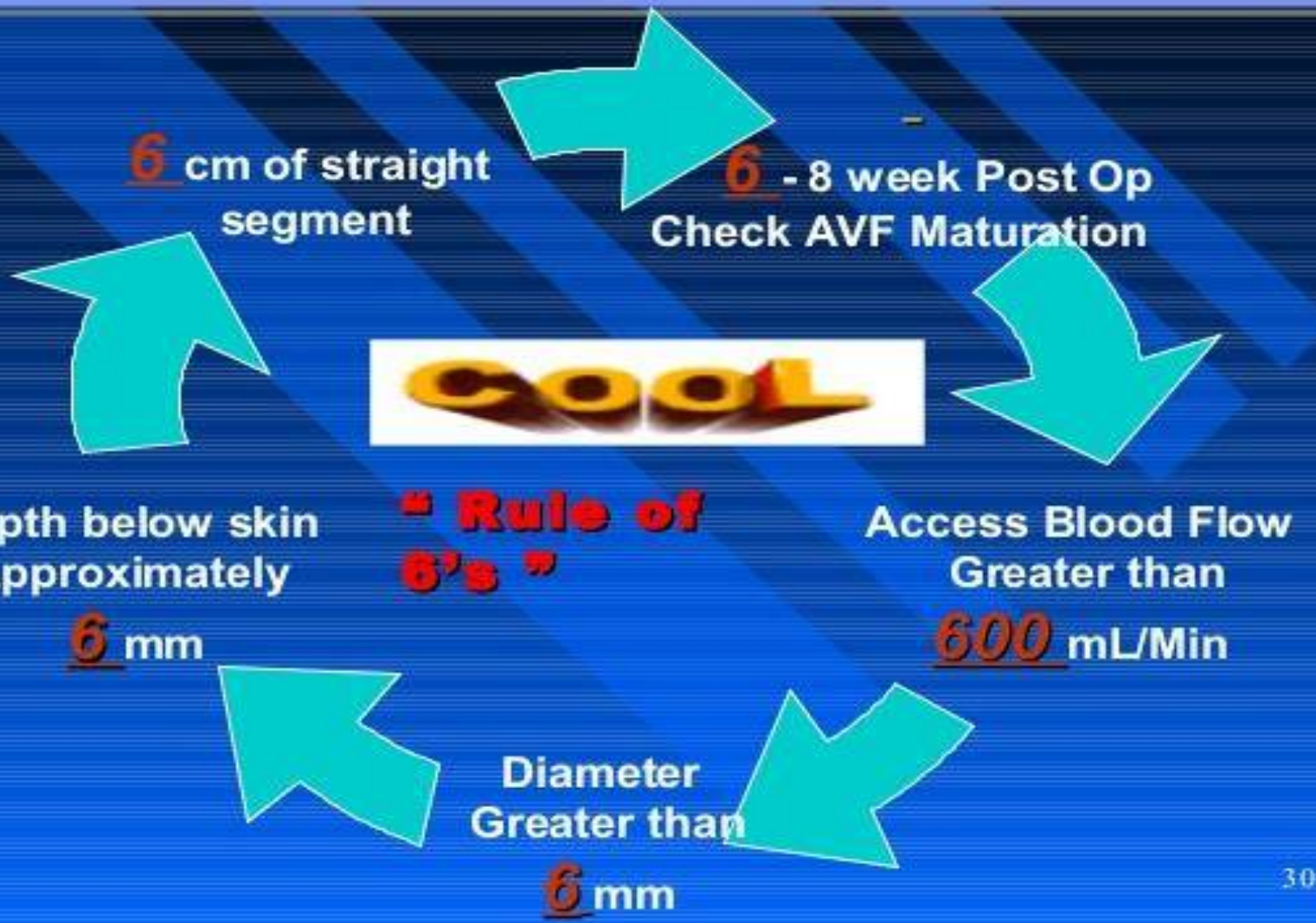



*Fig. 7.3 Arteriovenous graft configuration.*

# Protocol for *New* AVF Cannulation

# Is New AVF Mature? Use the KDOQI "RULE of 6's"

**Vein *MUST* Mature *PRIOR* to the *FIRST* cannulation**



# Preliminary Considerations

- Reduce the patient's fear of the initial cannulation
  - Words alone can either cause or reduce fear, so choose your words wisely! (Don't use words like "stick" or "puncture.")

- May need to adjust dialysis time to avoid rushing by the staff (eg, midweek or midshift treatments might be best)

# Preliminary Considerations (cont'd)

- Ask physician if heparin dose should be modified
- Use 17-gauge needles initially
- Use saline-filled fistula needles with syringes attached (optional)
- Use a tourniquet

# Consider Optional Use of "Wet" Needles

- Prime the fistula needle with normal saline solution (NSS) and leave a 10-cc syringe attached to the needle
- Check/aspirate for blood return
- Then flush carefully with NSS to check for any evidence of infiltration (with and without the tourniquet constricting the AVF)

  Rationale: Since blood return alone is not enough to show good needle placement, flushing with NSS will be less traumatic than flushing with blood, should an infiltration occur



National Kidney Foundation. *Am J Kidney Dis.* 2006;48(suppl 1):S1-S322.

# “Wet” Needle

# Needle Selection

- If patient has a catheter, use 1 lumen of the catheter and 1 needle in the fistula
- When using 1 needle for first cannulation of the AVF, which needle should you use?
  - Arterial needle?
  - Venous needle?

ANSWER:

(Arterial needle)

# Arterial Needle: First Use

- Arterial needle in the AVF, at least for the first use

  Rationale:

  - If an infiltration occurs, blood is not being forced back into the needle via the blood pump = smaller hematoma
  - Also, permits pre–pump arterial pressure (AP) monitoring,

    which will help to determine if the fistula has a good access

    flow. The pre–pump AP should be ≤ –250 mm Hg at a 200 blood flow rate (BFR) with a 17-gauge needle.

  Excessively negative pre–pump AP = poor AVF inflow

- Thus, lower risk of complications with arterial needle used as the first needle



National Vascular Access Improvement Initiative Web site. Available at: www.fistulafirst.org. Accessed April 21, 2006.

# Determine Direction of Access Flow

**Check Direction of Flow by:**

- Looking
  - Inspect access for incisions/location of anastomosis
- Feeling
  - Palpate access
    - Gently compress access midpoint
    - Arterial inflow will "pulse with flow"
    - Venous outflow will have diminished or no pulse
- Listening
  - Auscultate access
    - Gently compress access midpoint
    - Arterial inflow will have pulsatile sound
    - Venous outflow will have minimal or no sound

# Needle Gauge

- 17-gauge needle is strongly recommended for initial cannulation
- A fistula may appear and feel ready to cannulate, but the vessel wall may still be fragile and unable to tolerate the needle puncture
- The smaller needle gauge helps to decrease injury to the vessel and prevents a large infiltration, hematoma, compression of the vessel, and possible clotting of the AVF should any cannulation complication occur (ie, infiltration)

# Match Needle Gauge to Blood Flow Rate (BFR)

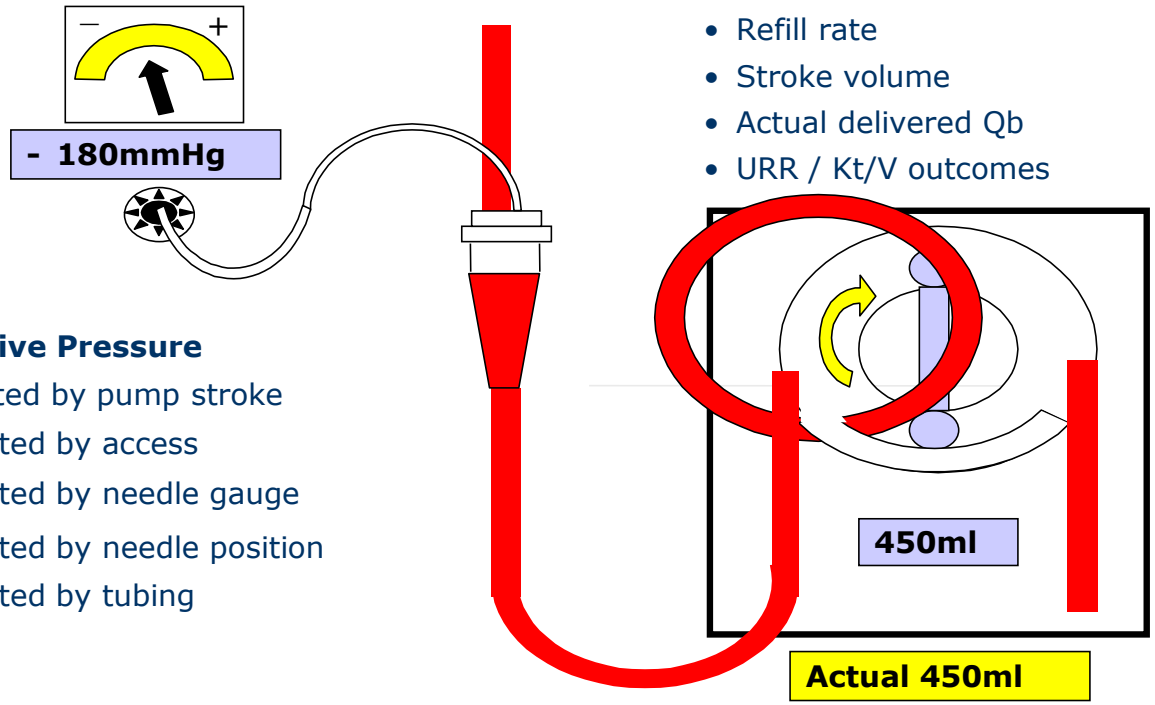
| Needle Gauge | Maximum BFR |
|---|---|
| 17-gauge | < 300 mL/min |
| 16-gauge | 300-350 mL/min |
| 15-gauge | 350–450 mL/min |
| 14-gauge | > 450 mL/min |

# When to Advance to 2 Needles

- Only after the arterial needle functions without:
  - Infiltration or hematoma
  - Cannulation difficulties
  - Access blood flow problems
  - Excessively negative pre–pump arterial pressures
  - Bleeding around the needle during dialysis
  - Prolonged bleeding post-dialysis
- At least 3–6 treatments tolerating one 17-gauge needle for arterial inflow

# Pre-pump Arterial Monitoring

## Normal Range*




**Effect on Delivered Blood Flow**

- Refill rate
- Stroke volume
- Actual delivered Qb
- URR / Kt/V outcomes

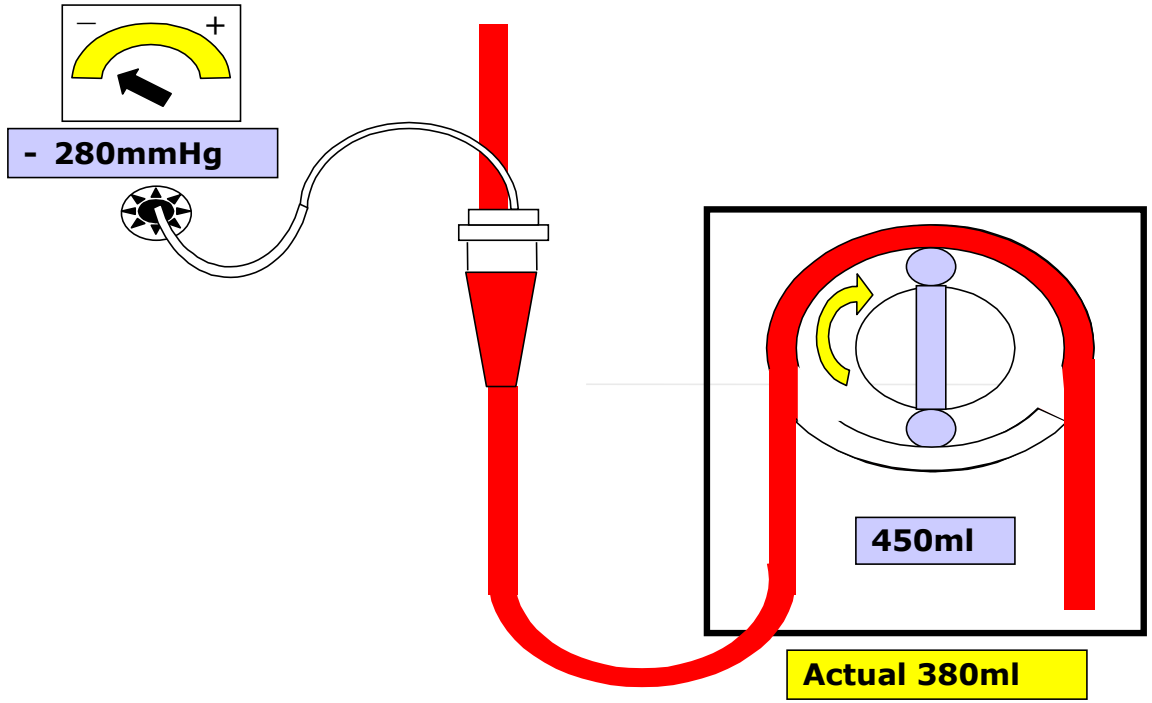
**Negative Pressure**

- Created by pump stroke
- Affected by access
- Affected by needle gauge
- Affected by needle position
- Affected by tubing

***Shows the effect of a normal pre-pump arterial pressure on delivered flow**

# Pre-pump Arterial Monitoring

**Excessively negative pre-pump arterial pressure***




***Shows the effect of an excessively negative pre-pump arterial pressure on delivered flow (ie, reduction)**

# What Actions Should Be Taken if Pre–Pump AP Is Too Negative?

- If pre–pump negative pressure is extreme (≥ –300 mm Hg), or rises rapidly during dialysis, act quickly; reduce blood pump speed until pressure falls into acceptable range, check blood lines for kink, and notify physician

# Catheter Removal

- Once the patient has had 6 successful treatments with the AVF, the registered nurse (RN) should obtain an order to have the catheter removed

- Successful = getting 2 needles in, no infiltrations, and reaching the prescribed BFR throughout the treatment for 6 treatments

# New AVF Cannulation: Additional Points

- On removal of needles, for hemostasis:
  - Use 2-finger compression
  - Never use clamps
  - Hold sites for 10 minutes—no peeking

# Education for Patients

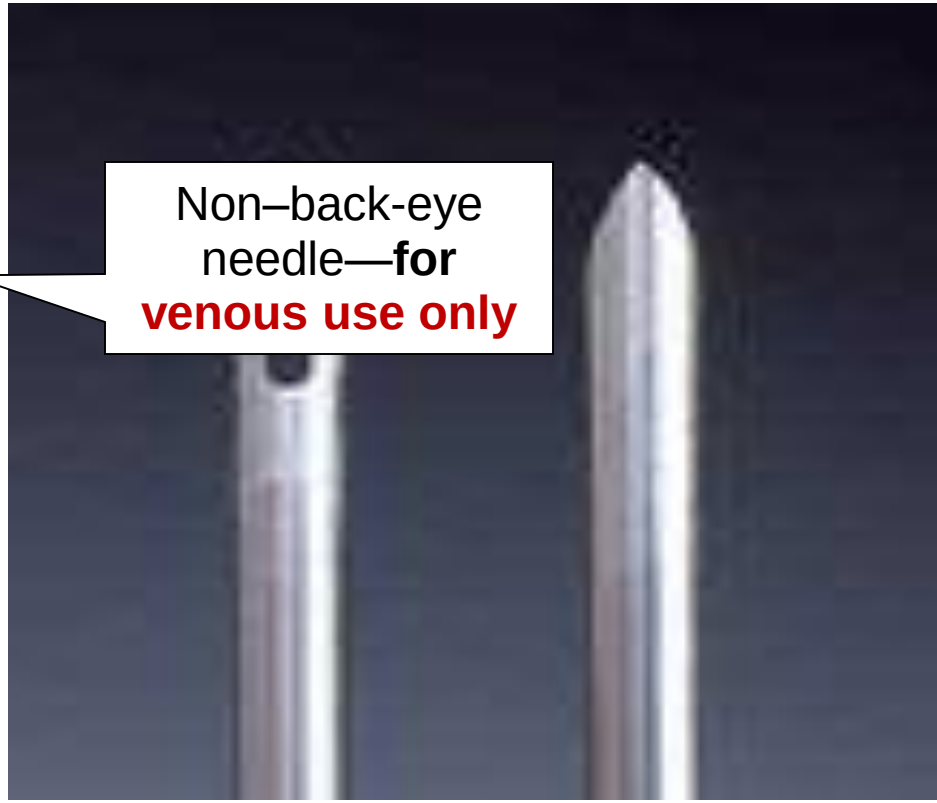
- Check fistula daily for a thrill and bruit
- Check for signs and symptoms of infection or other complications
- Write instructions for infiltrations

# Call the Nephrologist/Physician

- Thrill is undetectable
- Patient becomes feverish, dehydrated, or experiences low blood pressure

# Use Back-Eye Needles

Back-eye opening allows blood intake from both sides of the needle; can be used as arterial or venous needle




Arterial needle

Venous needle

# Needle Direction

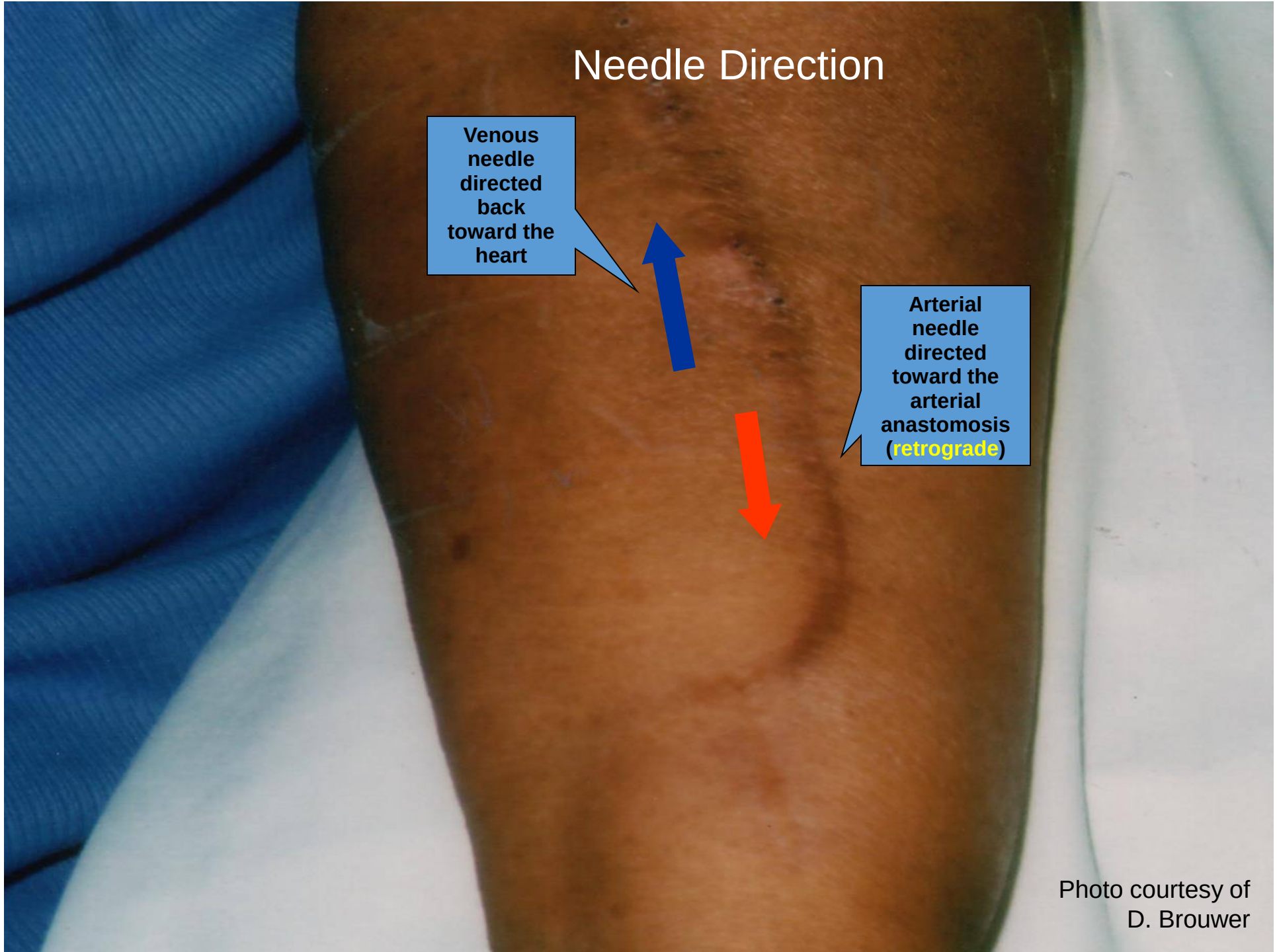



Photo courtesy of D. Brouwer

# Needle Direction

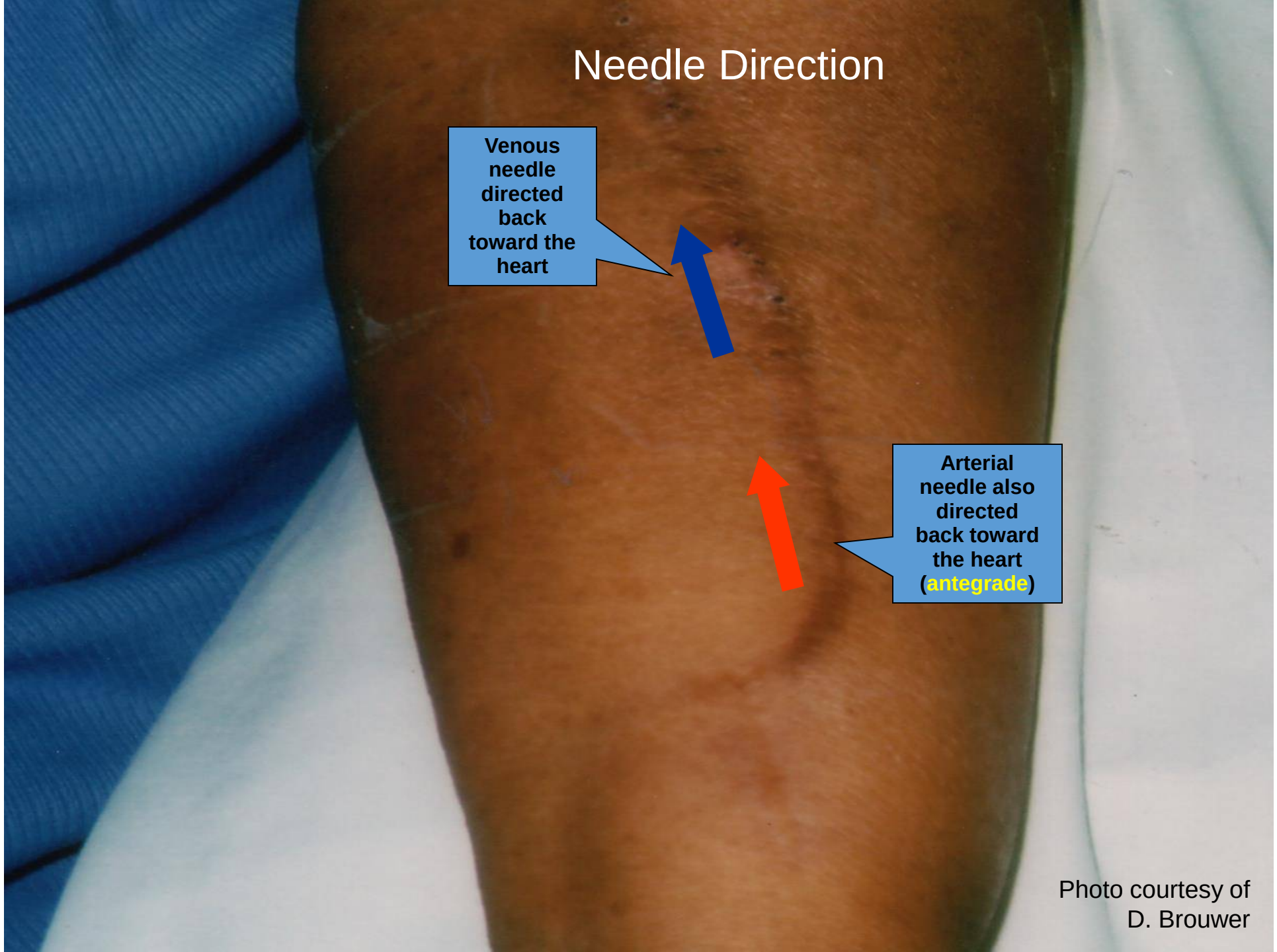
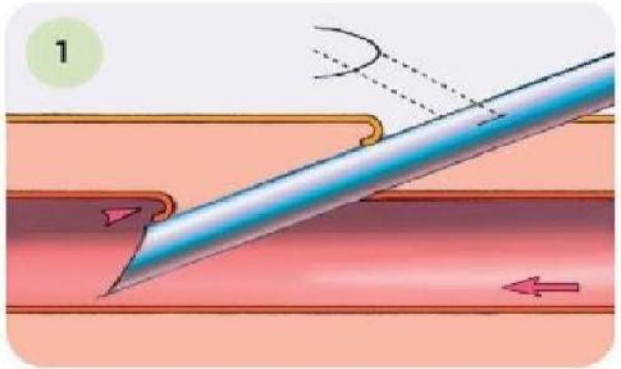
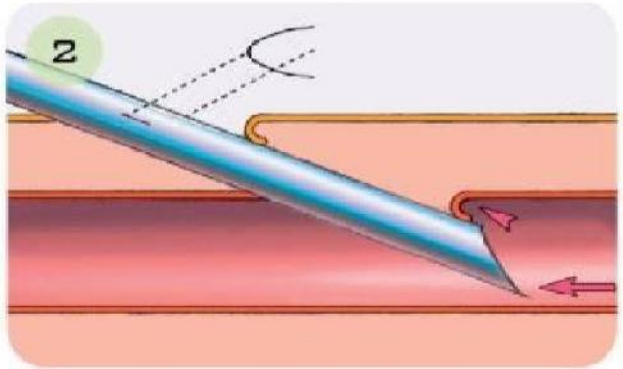
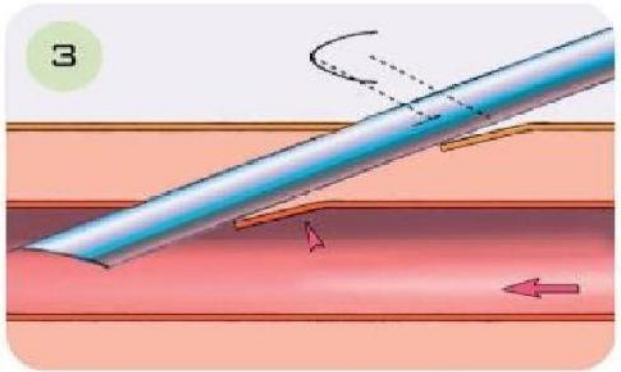
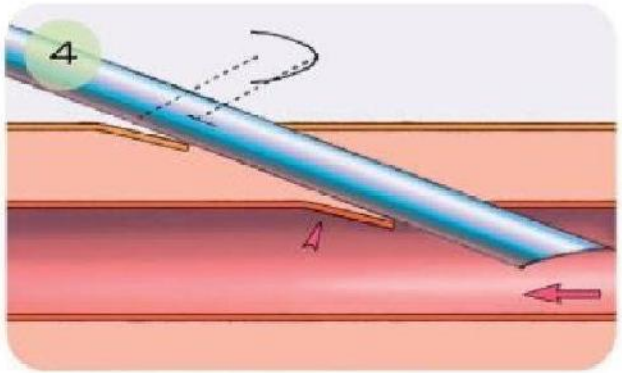



Photo courtesy of D. Brouwer

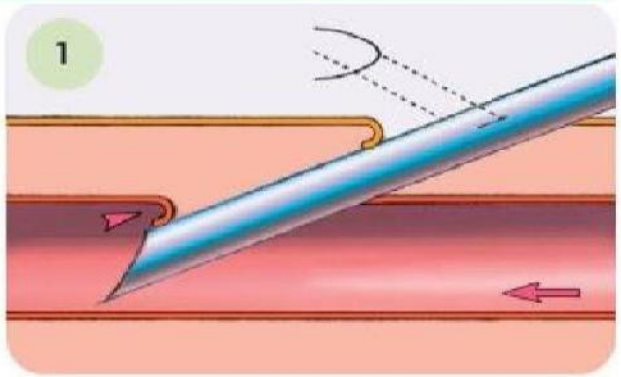
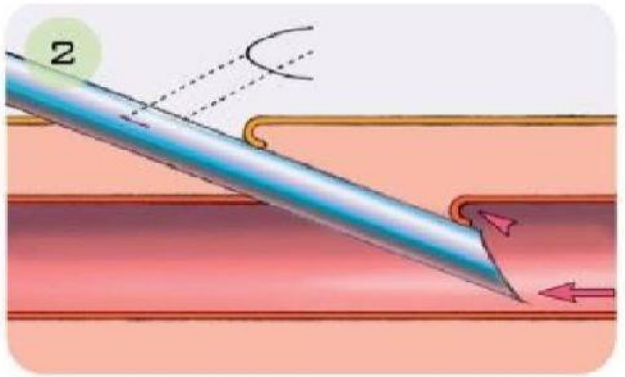
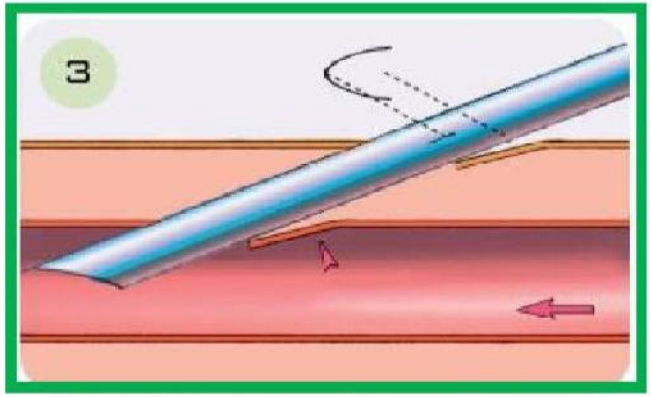
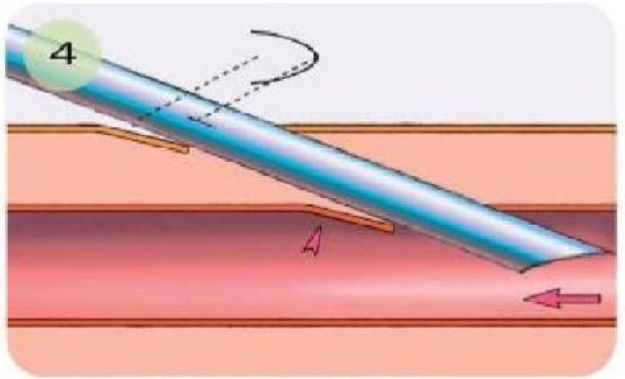

Elbow
Former aneurysmatic dilatation

# Effect of bevel direction in the arterial needle position (antegrade/retrograde)

| | Antegrade | Retrograde |
|---|---|---|
| Bevel Up |   |   |
| Bevel Down |   |   |

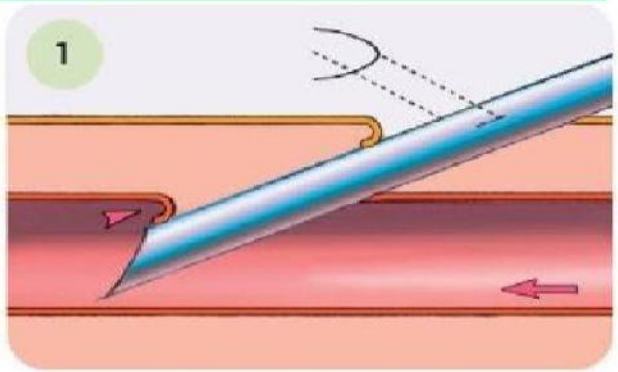
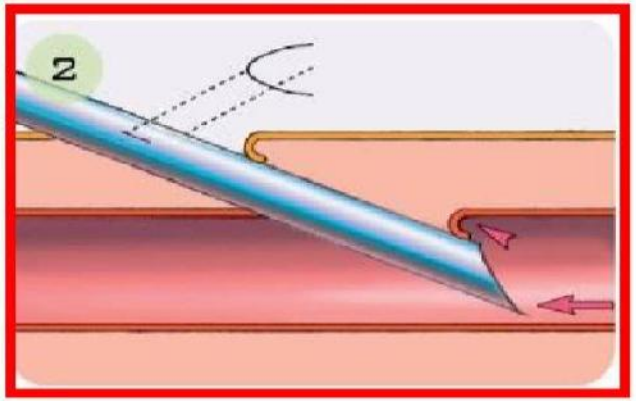
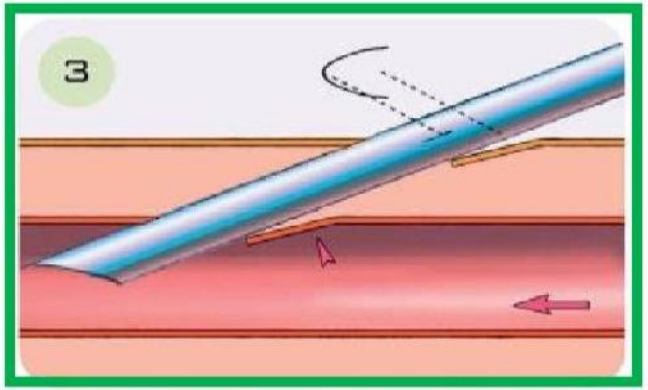
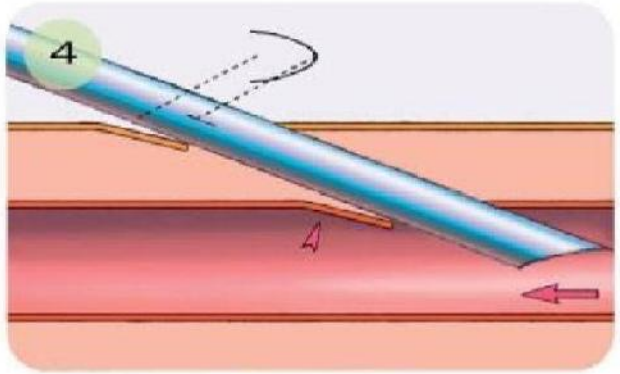
Bionic Medizintechnick GmbH

# Effect of bevel direction in the arterial needle position (antegrade/retrograde)

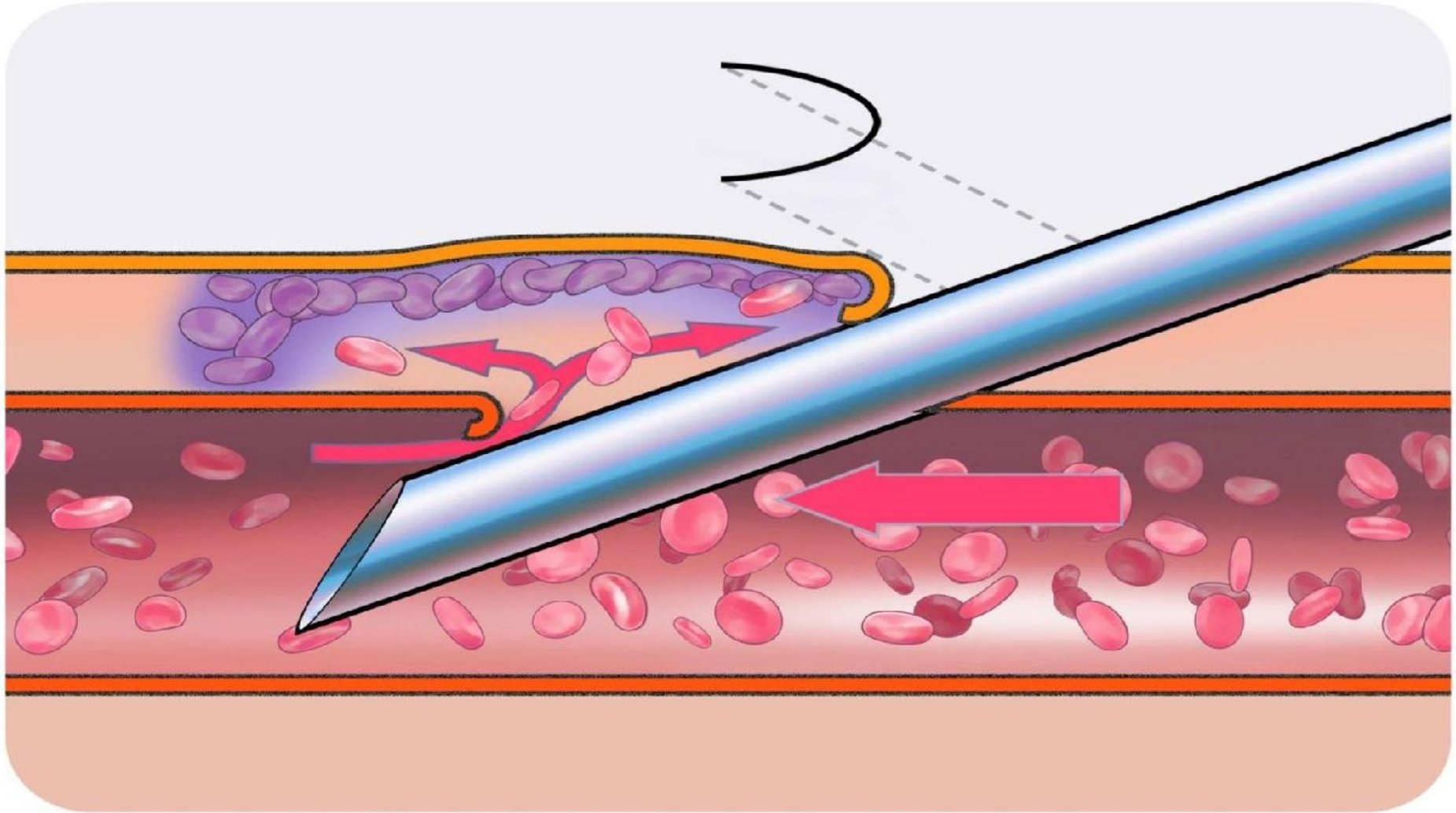
| | Antegrade | Retrograde |
|---|---|---|
| Bevel Up |   |   |
| Bevel Down |   |   |

Bionic Medizintechnick GmbH

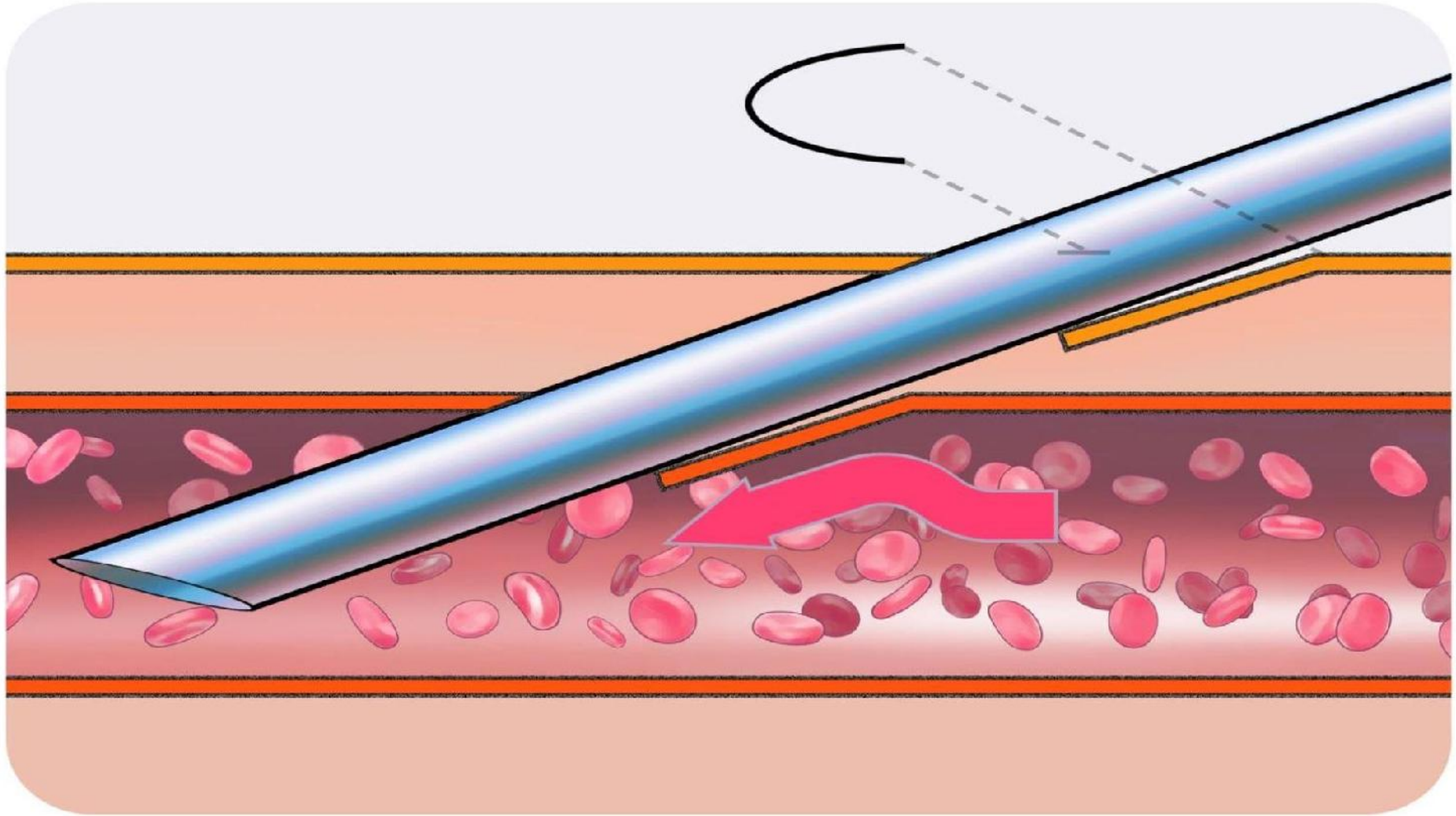
# Effect of bevel direction in the arterial needle position (antegrade/retrograde)

| | Antegrade | Retrograde |
|---|---|---|
| Bevel Up |   |   |
| Bevel Down |   |   |

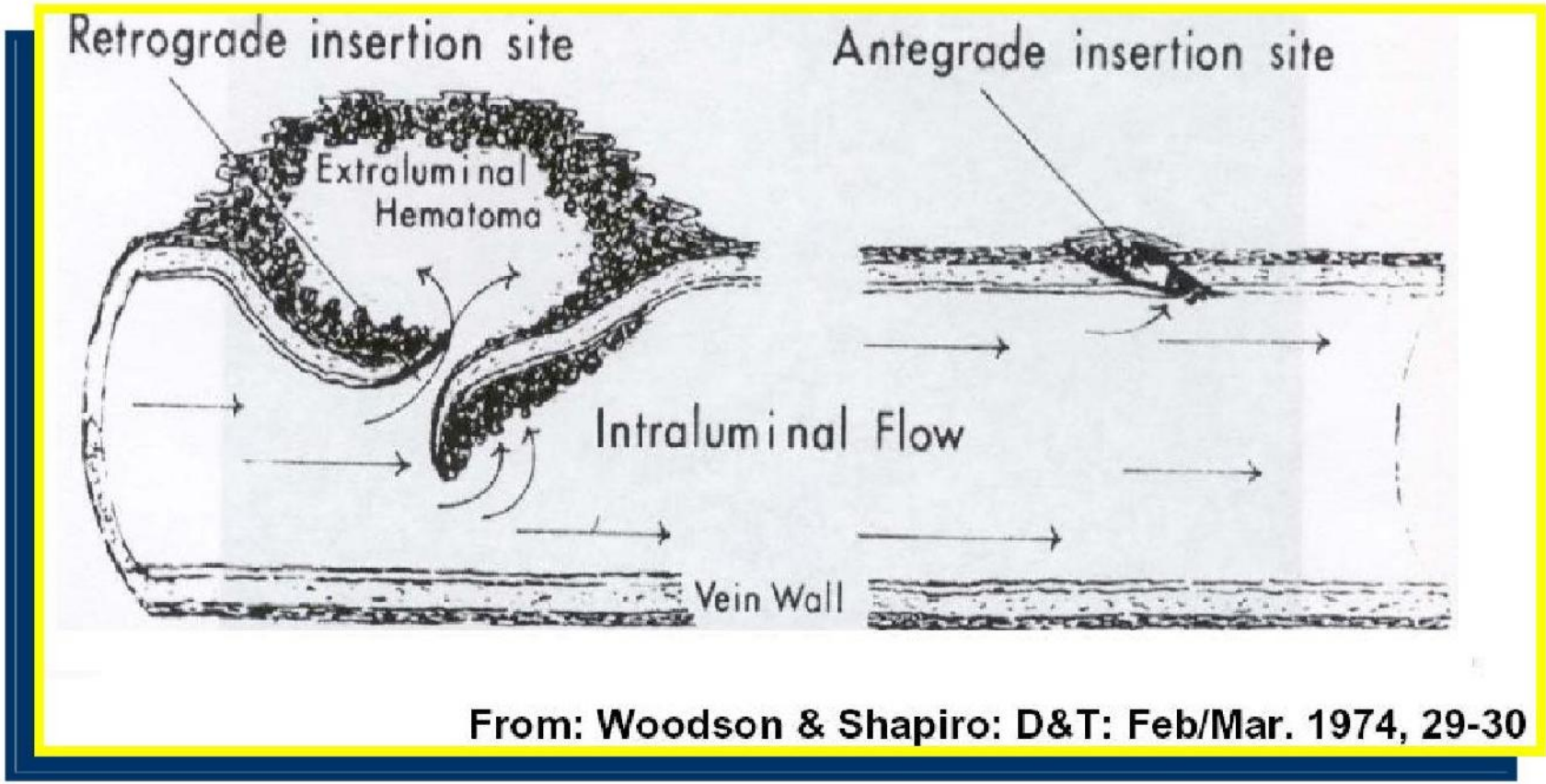
# Arterial needle antegrade: Effect of bevel up direction



# Arterial needle antegrade: Effect of bevel down direction



# Antegrade puncturing may be fistula protective




From: Woodson & Shapiro: D&T: Feb/Mar. 1974, 29-30

- Increased risk of haematoma formation from retrograde filling
- Tract closure through flow force by antegrade puncture

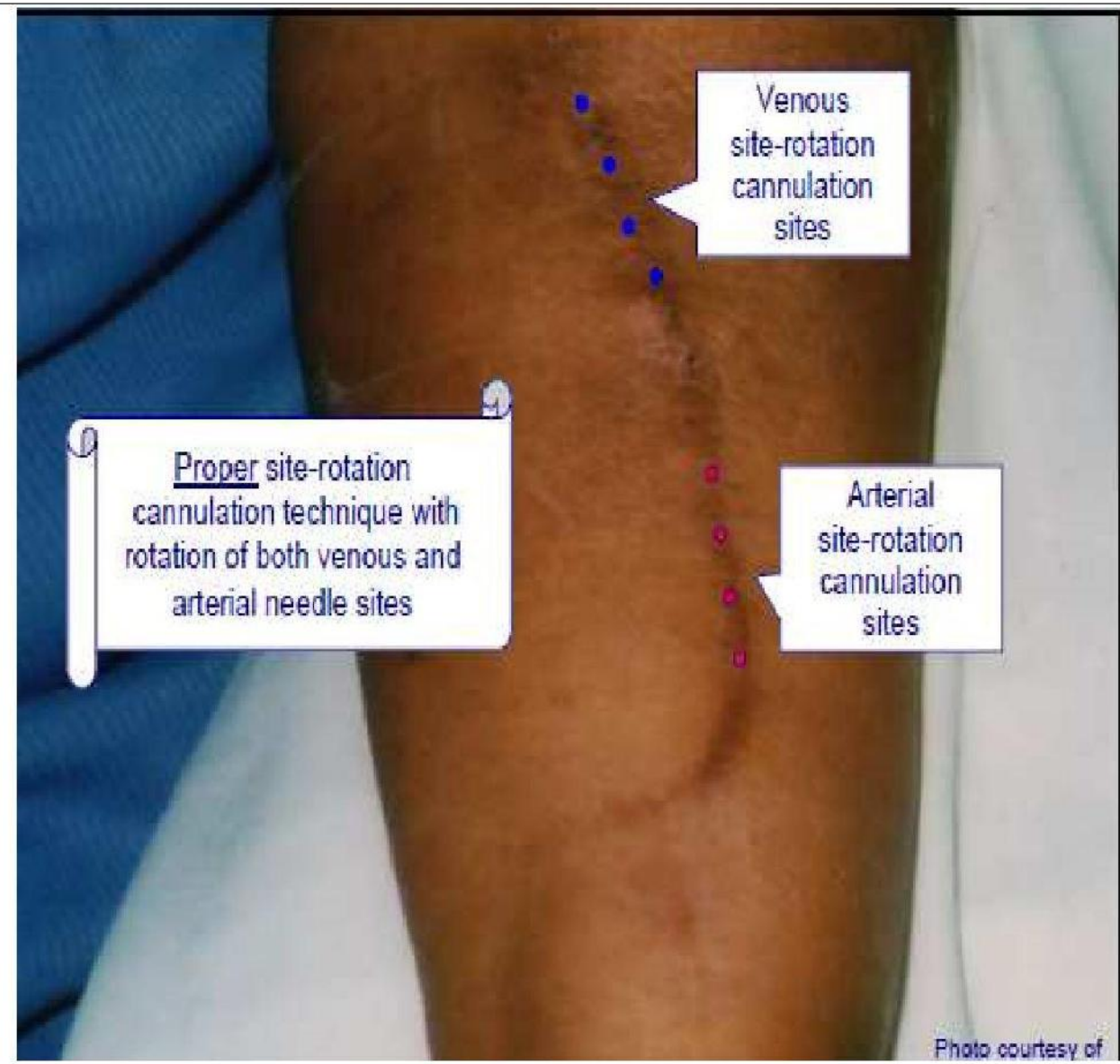
# Cannulation technique vs VA survival: Summary (1/2)

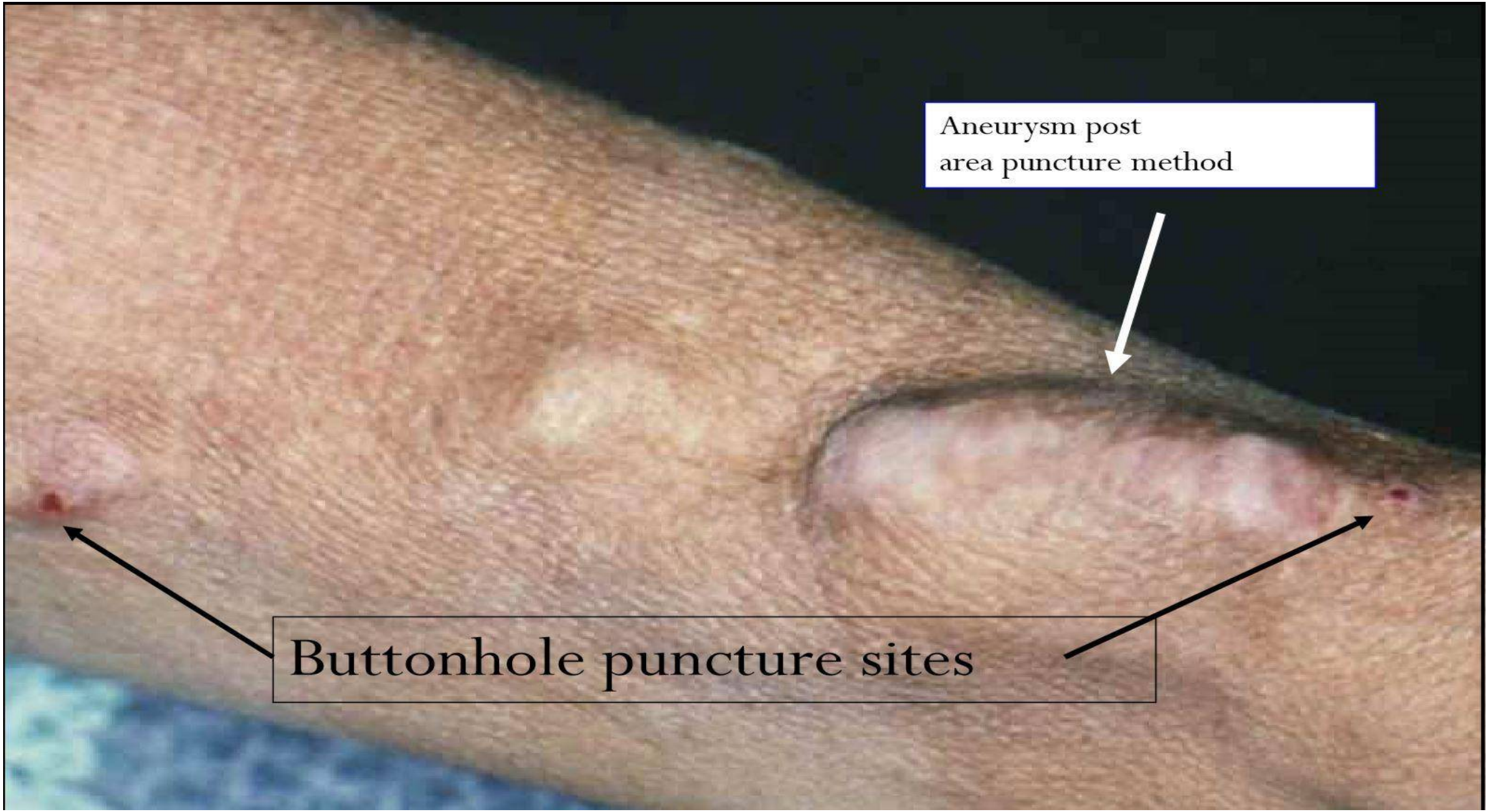
- In summary, the study revealed that **area cannulation technique, despite being the most commonly used, was inferior to both rope-ladder and buttonhole** for the maintenance of Vascular Access functionality.

- With regard to the effect of needle and bevel direction, the combination of **antegrade position of arterial needle with bevel up or down was significantly associated with better access survival than retrograde positioning with bevel down.**

## 3.6.1 The rope ladder Technique

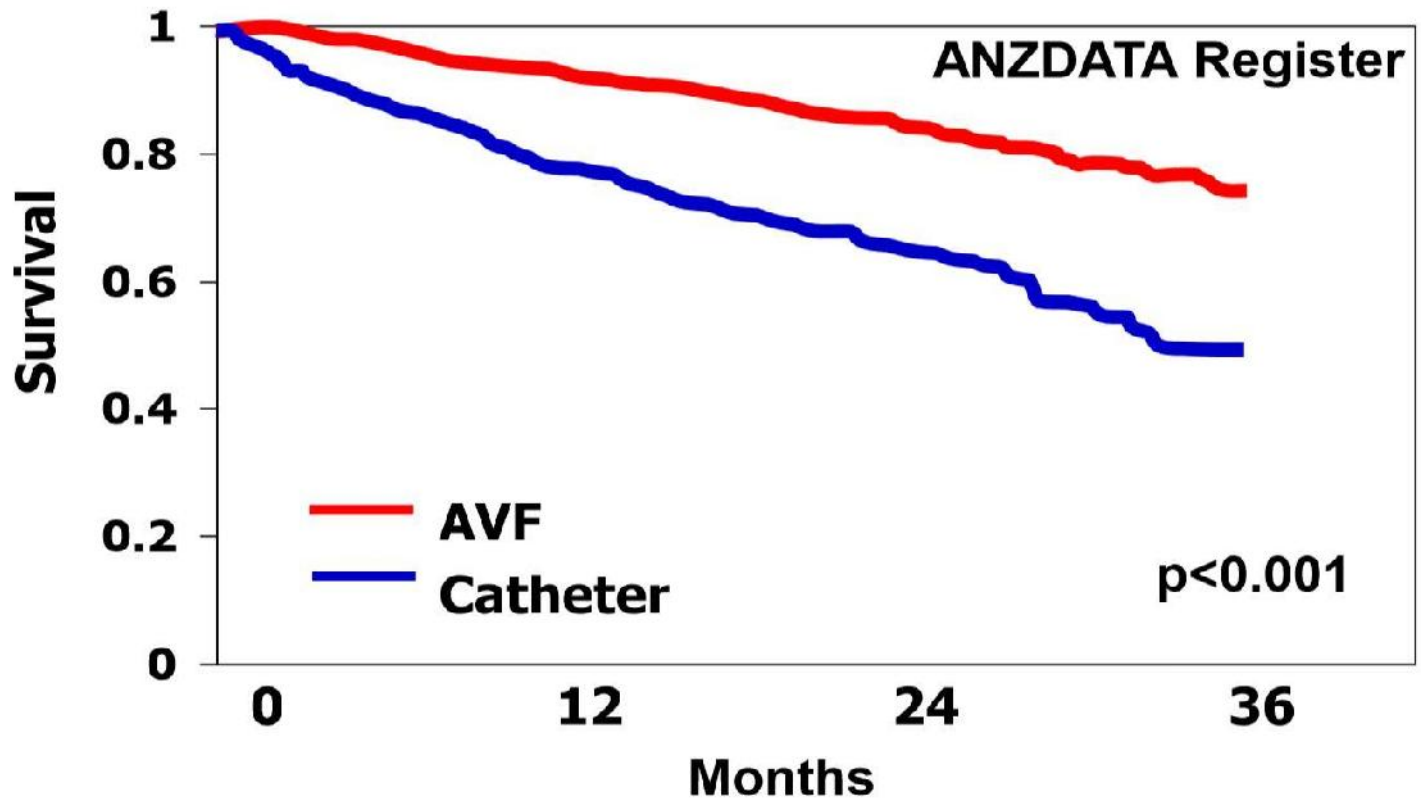
- Cannulation sites are rotated up and down the AVF to use its entire length
- Classic technique used in most dialysis centers
- Look for straight areas of at least 1″ for each cannulation site
- Avoid aneurysms and flat or thinned-out areas




Aneurysm post
area puncture method
Buttonhole puncture sites

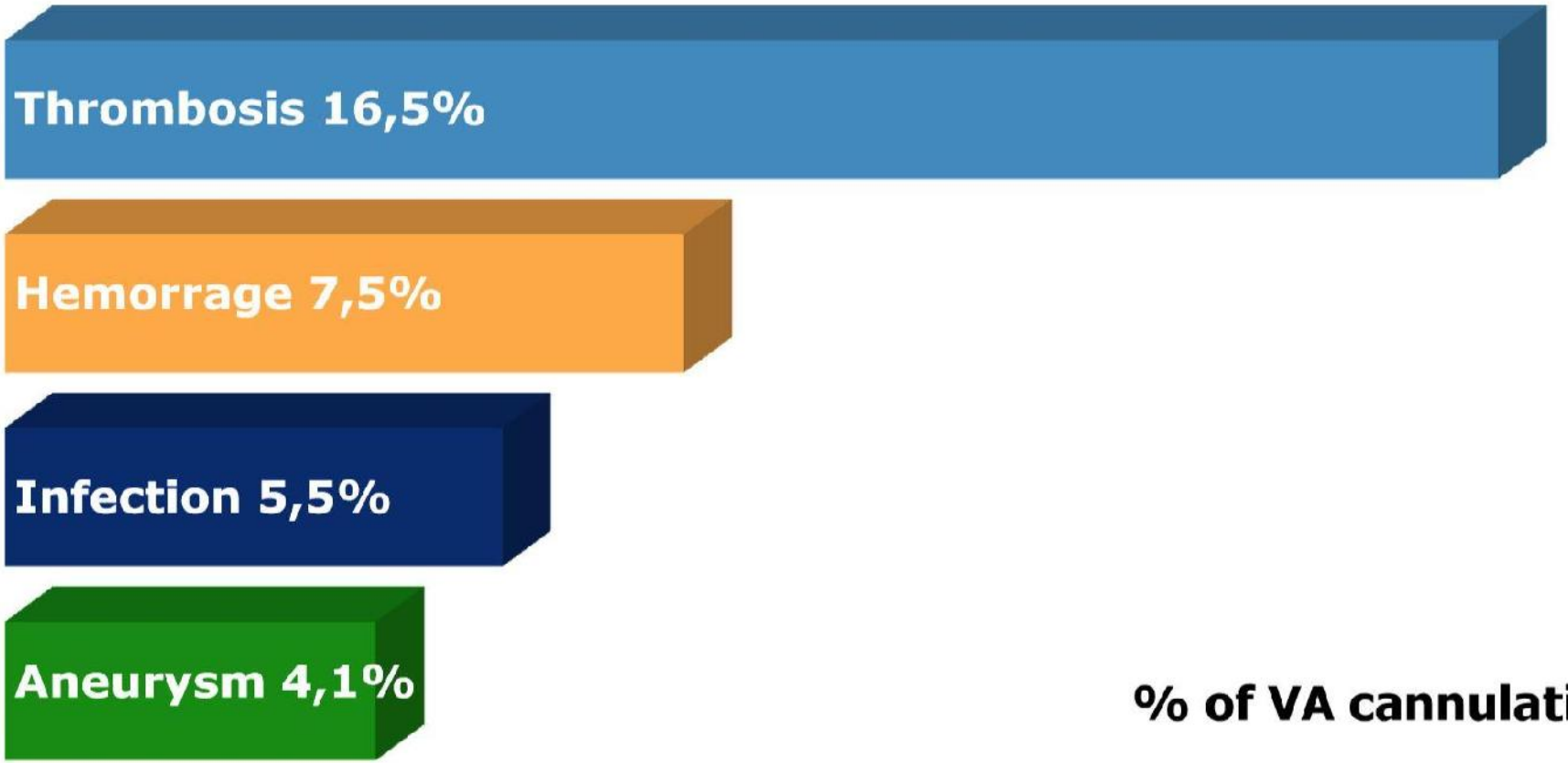
# The Good, The Bad, & The Ugly

# Preserving the AVF as the patient lifeline: reduced mortality with the AVF compare to Catheter




*Polkinghorne et al. J Am Soc Nephrol 15: 477-486, 2004*

# Complications Associated to VA Cannulation




*Yürügen and Erdogan, J Vasc Access 2001; 2: 119-124 (Data from Master Thesis at Istanbul University)*

# Forearm Fistula Exercises

## Ball Squeeze

As soon as the pain from surgery has subsided, start arm exercises by squeezing a rolled-up washcloth or a "stress" ball. Squeeze, and release rapidly for 10 minutes, 6 times a day. Additionally, you may use your other hand to squeeze the bicep of your fistula arm. This hinders blood return and causes the fistula to dilate because of increased pressure and blood in the vein.

## Clothes Pin Grasp

Using a clothespin, squeeze open and allow to close repeatedly for 5 minutes, 6 times daily.

## Finger Touches

Lastly, another good exercise to help strengthen and develop your fistula are finger tip touches. Touch each finger to the tip of your thumb, opening up your hand after each touch. Touch tips to thumb repeatedly for 5 minutes, 6 times a day.

# Skin Preparation

- If possible, the patient should wash the access with antibacterial soap before coming to the chair
- Staph is the leading cause of infection in dialysis patients

# Proper Cleansing Technique

Proper needle-site preparation reduces infection rates

- Start where you are going to place the needle (the black dot) and cleanse in a circular, outward motion
- Do not touch skin after cleansing area