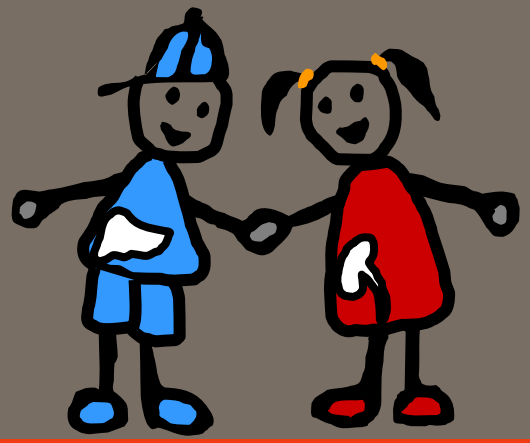
Vascular access for acute & chronic HD

Dieter Haffner, M.D.
Professor and Chairman
Department of Pediatric Kidney, Liver and Metabolic Diseases
Center for Rare Kidney Diseases



MHH
Medizinische Hochschule
Hannover

IPNA Teaching Course
13.-14. September 2018, Cairo, Egypt

References

Textbooks:

- Handbook of dialysis therapy, editors: Nissenson & Fine, 5th edition 2017
- Pediatric dialysis, editors: Warady & Schafer, 2nd edition 2012

Guidelines:

- Clinical practice guideline for vascular access in children requiring maintenance hemodialysis; ESPN Dialysis WG (R. Shroff et al; will be published soon)
- KDOQI Clinical practice guidelines for vascular access, AJKD 2006

Vascular access for acute HD

- Central venous catheter (CVC) are best suited for acute HD since they offer benefit of immediate and painless access.
- When used long-term CVCs have a high risk of infection, malfunction, and central venous stenosis.
- CVC should allow for adequate blood flow, i.e. > 3 – 5 ml/kg/min (>100 ml/m^2/min)
- CVC should not be so large that it obstructs the vein.
- The catheter tip should end in the right atrium or at the junction of the superior vena cava and right atrium.
- Cave: inadequate blod flow, if the tip of the catheter does not reach down far enough and stays in the superior vena cava (entry & exit sites press up against the vessel wall).

Vascular access for acute HD

Type of catheter:

- Uncuffed, nontunelled CVC
- Dual lumen catheters (silicone, polyurethane)
- Alternative: split catheters or two seperate catheters

Location:

- Femoral vein is prefered in infants & small children
  - Short period (<2weeks), high risk of infection (diapered children)
- Older children: right or left internal jugular vein
- Subclavian catheters should be avoided (high risk of stenosis)
- CVC should not be placed on the same side as a constructed and maturing AVF

Vascular access for acute HD

Placement:

- Ultrasound guided placement (Seldinger technique) performed by either ICU physicians, interventional radiologists or surgeons
- X-ray and/or ECG is used to confirm the position of the catheter tip

Patient Weight	CVC
Newborn	7-Fr dual lumen
5–20 kg	8-Fr dual lumen
20–40 kg	7-Fr Tesio (20–25 kg)
	10-Fr dual lumen
	10-Fr split catheter
	10-Fr Tesio catheter
	11.5-Fr dual lumen (>30 kg)
>40 kg	10-Fr Tesio
	11.5-Fr dual lumen
	12.5-Fr dual lumen

Care of HD central venous catheter

1. Catheters should be accessed only by experienced dialysis personnel.
2. Clean exit site with CHG/alcohol-based solution.
3. When using heparin to lock CVC, 1000 units/mL concentration is preferred.
4. Measure aPTT before any procedure.
5. Avoid flushing catheter in the perioperative period.
6. Avoid using catheter for IV fluids, medications, or blood draws.

aPTT, activated partial thromboplastin time; CHG, chlorhexidine gluconate; CVC, central venous catheter; IV, intravenous.

Vascular access for acute HD

Acute complications:

- Inadvertent arterial puncture
- Air embolism
- Pneumothorax
- Hemothorax
- Bleeding

Long-term complications:

- Malfunction
- Bacteremia (up-to 9 infection episodes/1000 catheter days)
  - antibiotic lock solutions may be helpful
- Vascular thrombosis, central venous stenosis, fibrin sheath formation
- Accidental extraction

THINK BEFORE YOU STICK!!!

(Does this patient have renal disease????)

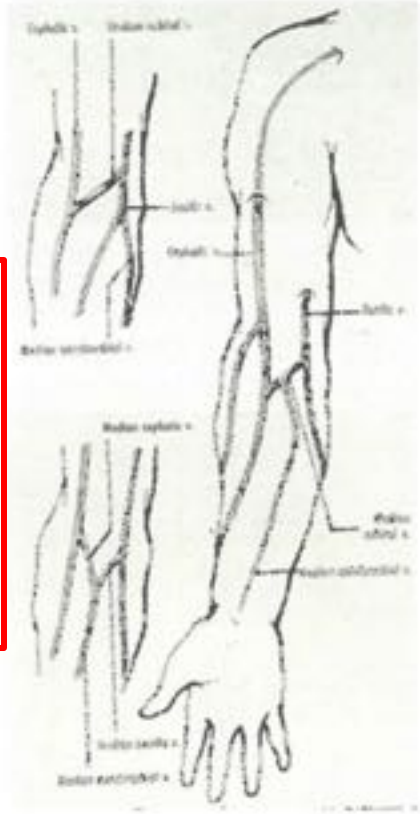
Post signs if you have to...

This IV is in the cephalic vein, which is used to create arteriovenous fistulae for dialysis. A single stick or IV in this vein can occlude it permanently, and compromise the access the patient may have in the future!!

Likewise, andy IV or needle stick in the antecubital fossa of the NONDOMINANT hand can result in future failure of the patient's dialysis access.

IF THE PATIENT HAS RENAL DISEASE:

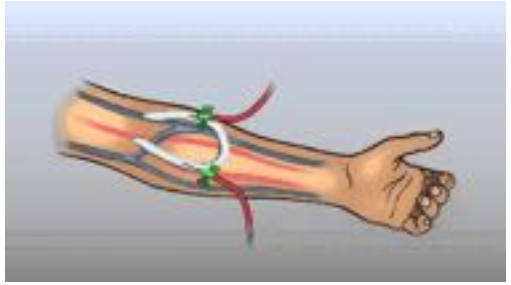
1. Avoid the non-dominant arm all together
2. Avoid the cphalic vein on both arms, but never use the cephalic vein in the non-dominant arm
3. If you don't know, please ask!!



Vascular access types for chronic HD

Arteriovenous fistula
(AVF)

Central venous catheter
(CVC)



Arteriovenous graft
(AVG)

Vascular access type according to age

Survey of the European Society of Paediatric Nephrology (n=111; 13 units)

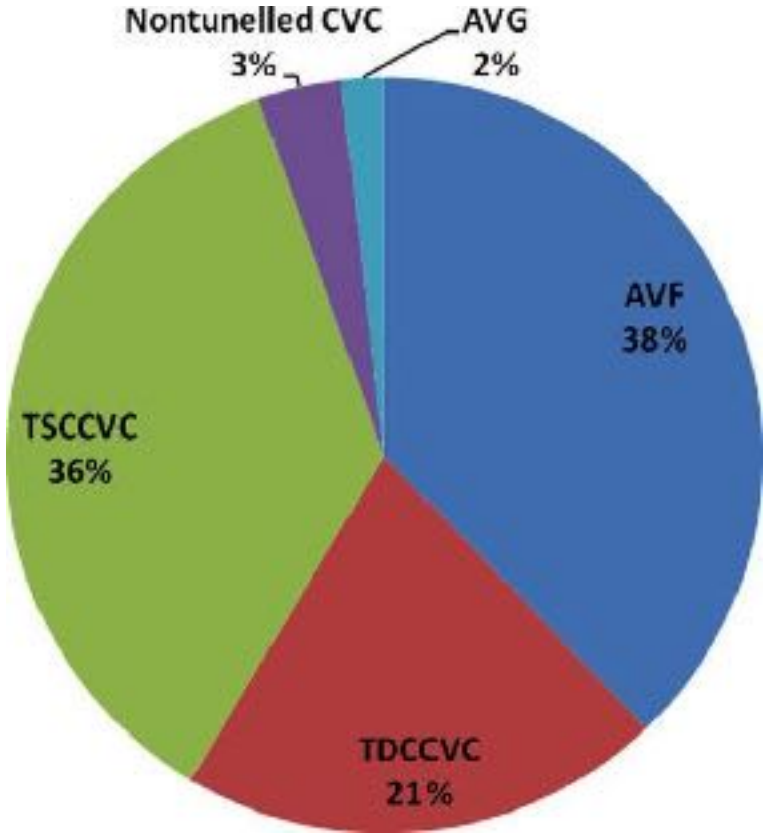


Fig. 3 Choice of vascular access. *AVF* arteriovenous fistula, *AVG* arteriovenous graft, *CVC* central venous catheter, *TSC CVC* tunneled single-cuff CVC, *TDC CVC* tunnelled double-cuff CVC

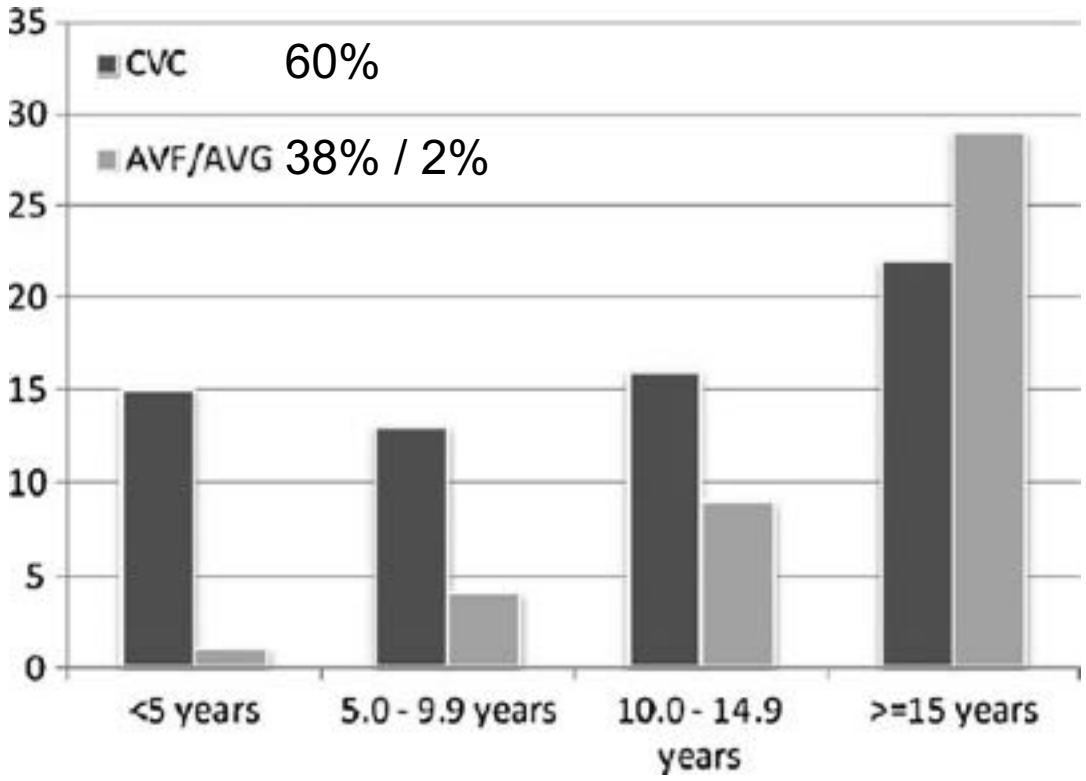
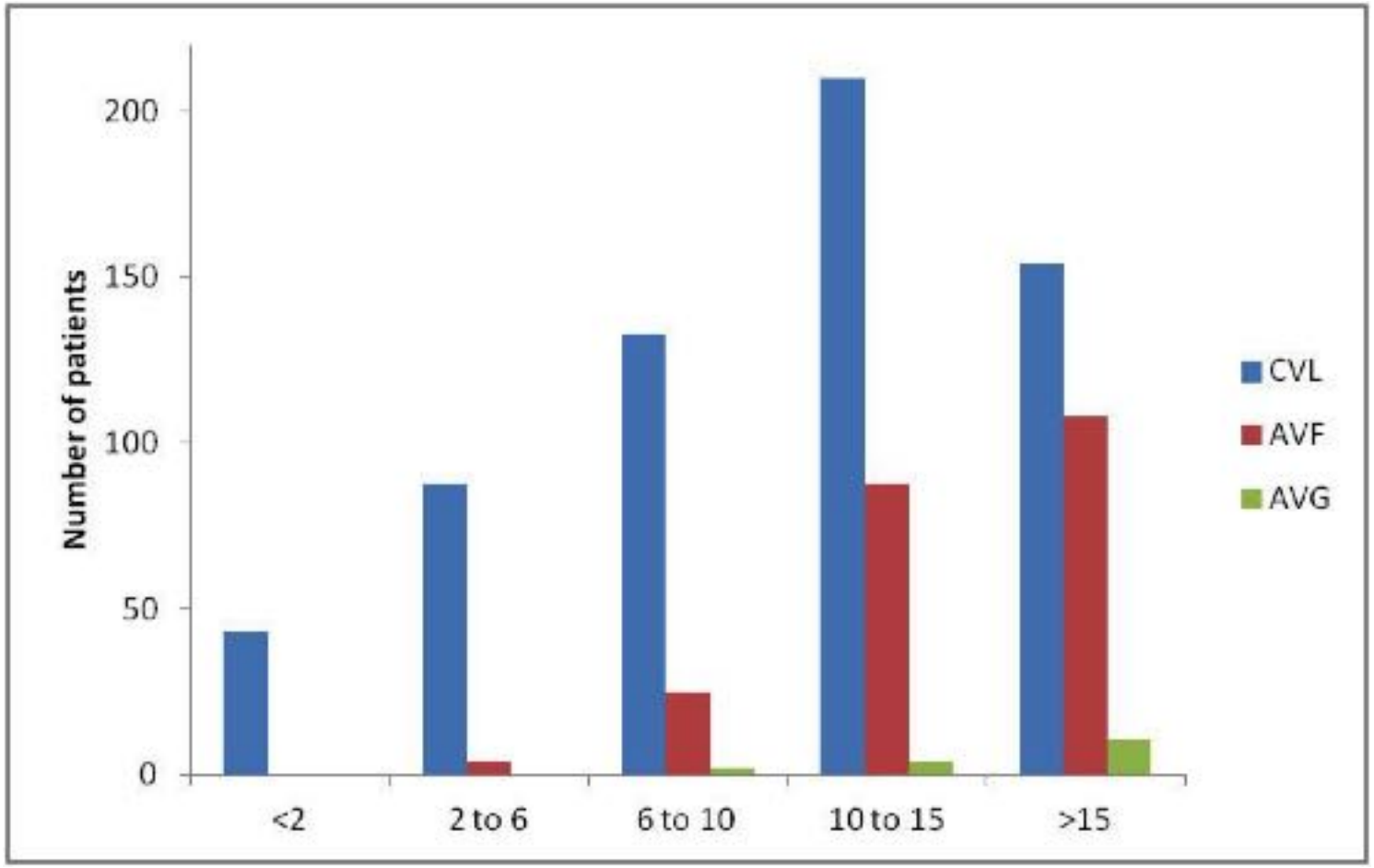


Fig. 4 Vascular access choice vs patient age; *CVC* central venous catheter, *AVF* arteriovenous fisrtula, *AVG* arteriovenous graft

Hayes WN et al, Ped Nephrol 2012;27:999-1004

Vascular access type according to age

International Pediatric Hemodialysis Network (n=870)



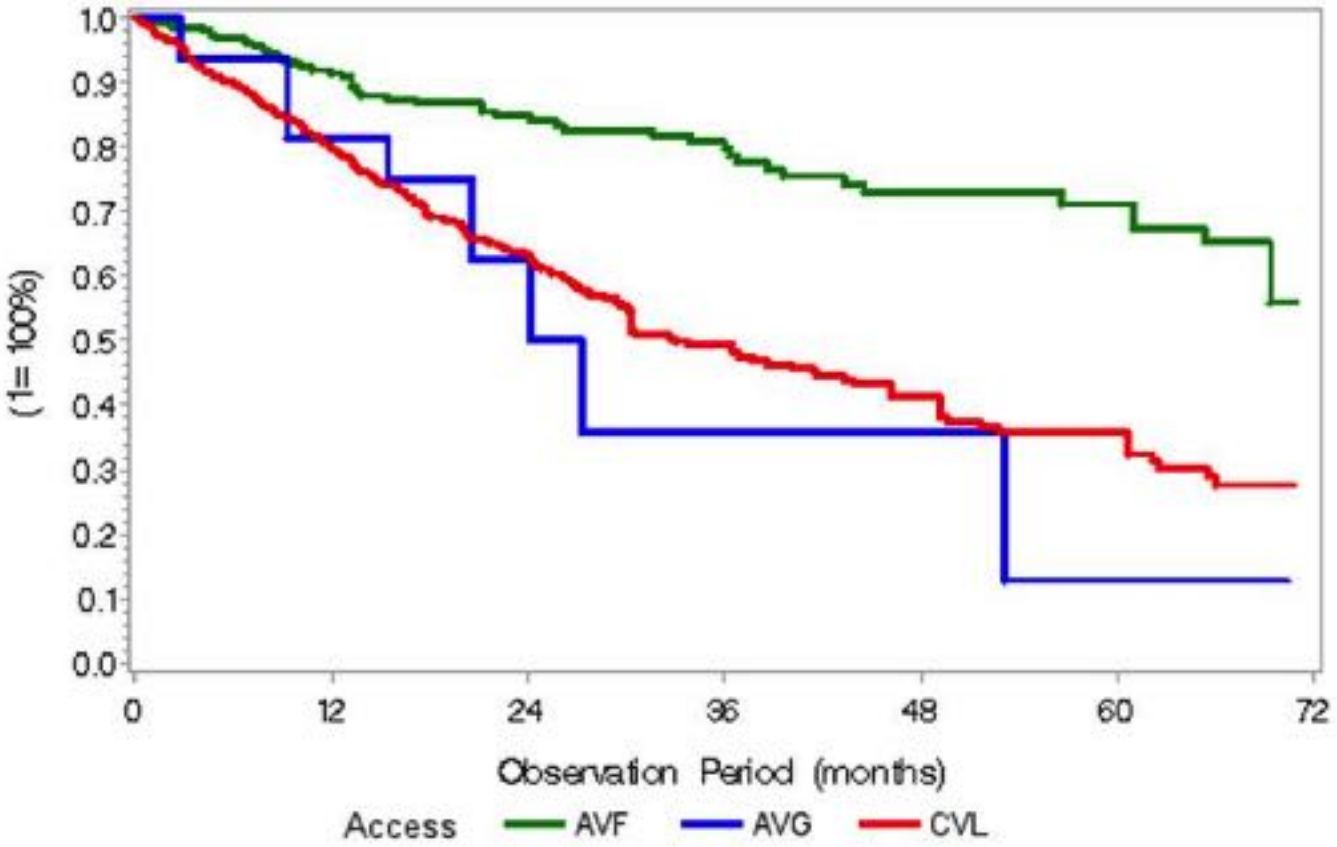
73%
26%
1%

Borzych-Duazalka D et al, A J Kidney Dis (in revision)

Primary access patency rates

International Pediatric Hemodialysis Network (n=870)

Event free survival probability until first intervention or surgival revision



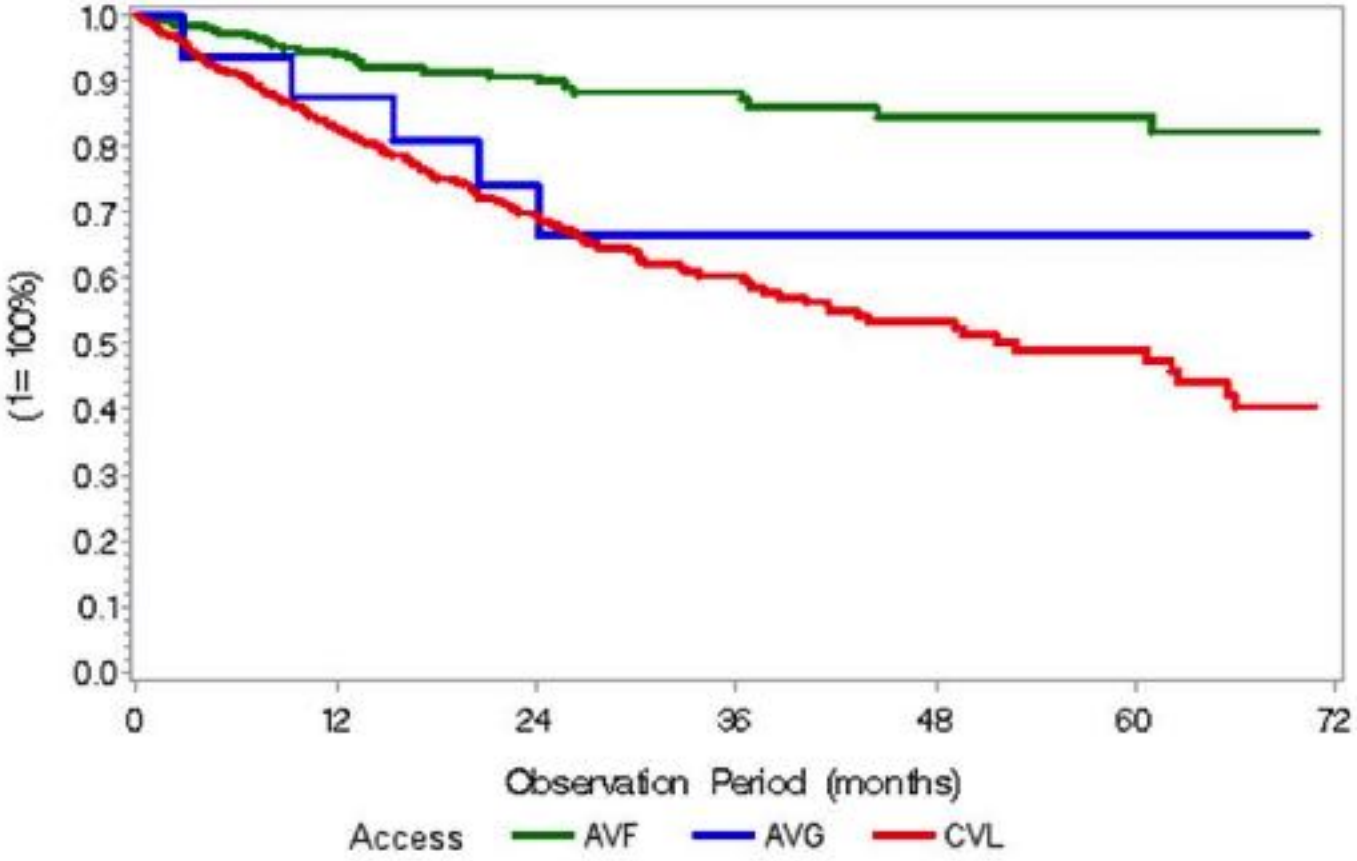
P<0.001 AVF vs. others

Borzych-Duazalka D et al, A J Kidney Dis (in revision)

Secondary access patency rates

International Pediatric Hemodialysis Network (n=870)

Event free survival probability until access excahnge of CVC, AVF, and AVG

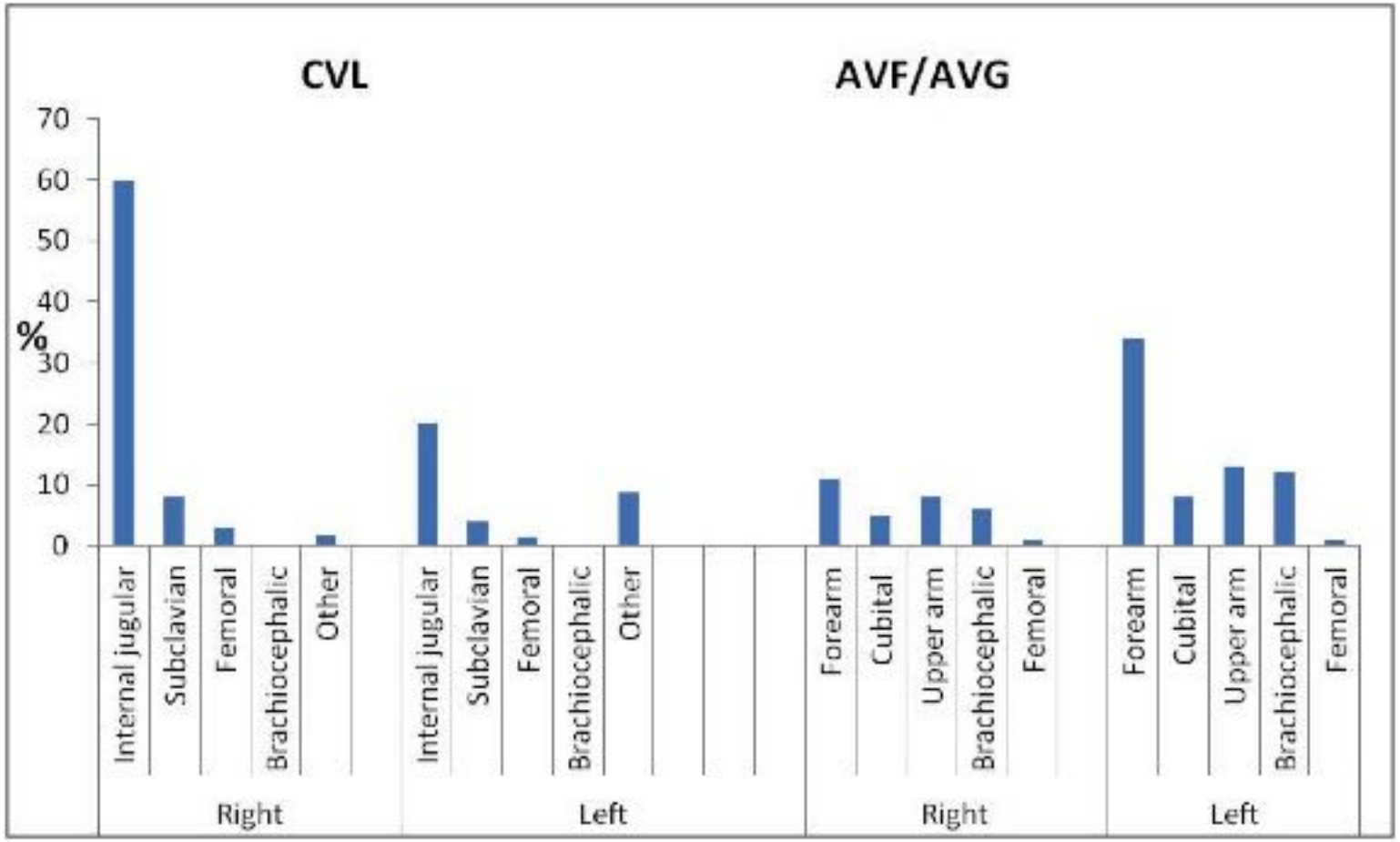


P<0.001 AVF vs. others

Borzych-Duazalka D et al, A J Kidney Dis (in revision)

Access placement sites by access type

International Pediatric Hemodialysis Network (n=870)



Borzych-Duazalka D et al, A J Kidney Dis (in revision)

Pros and cons for vascular access types for chronic HD

Pros AVF

- Allows for high blood flow rates

  => efficient and effective dialysis delivery
- Best long-term survival
- Lowest complication and hospitalization rates
- Higher blood albumin levels
- Higher mean hemoglobin levels
- Require lower doses of erythropoietin
- Patients can bathe and swim without restrictions
- Primary failure less then 30% (microsurgery 10%)

Cons AVF

- Needs time to mature
- Needling pain
- Physical changes in the appearance of the arm (cosmetic features)

Pros and cons for vascular access types for chronic HD

Pros CVC

- Immediate access
- Needle-free dialysis

Cons CVC

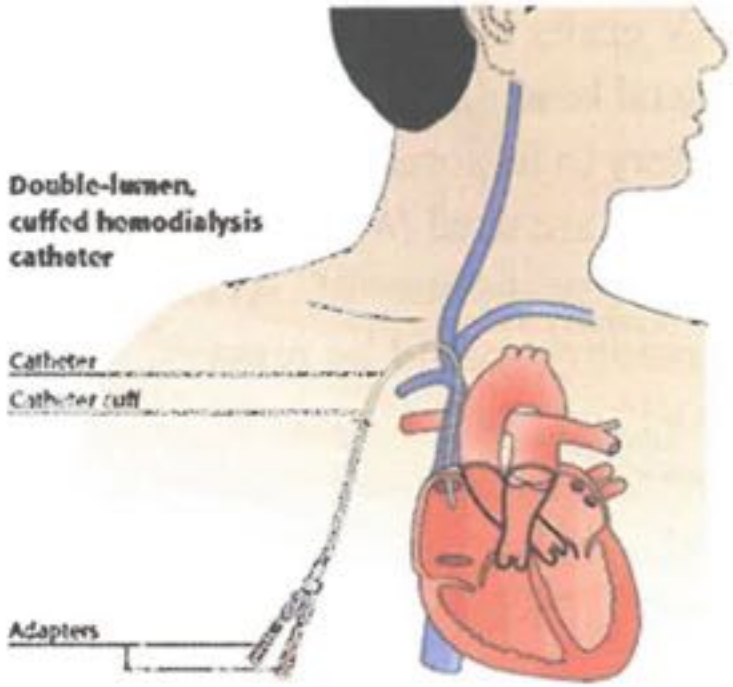
- High infection rate
- Inadequate blood flow (malposition, fibrin sheath formation)
- Restriction of the child activities (swimming)
- Associated with high markers of inflammation (despite absence of infection)
- **Central venous thrombosis or stenosis**
  - **May prohibit successful future placement of AVF !**

⇒ AVF: ideal vascular access

Patients should be educated with the emphasis of the many advantages of their AVF

Fistulae are the goal… but catheters are still necessary

- Small children
- Poor anatomy for fistula
- Anticipated rapid transplant



Planning vascular access

european society for paediatric nephrology

Recommendations

1. 1 Educate children with CKD and their carers about venous preservation, irrespective of the choice of future dialysis modality, and starting from their early contact with the nephrology services. (Ungraded)

1.2 Educate children with CKD stage 4 (estimated GFR < 30 mL/min/1.73 m^2; Schwartz formula), those with rapidly declining renal function, or those who need to start maintenance dialysis imminently, about kidney failure and options for its treatment, including kidney transplantation, peritoneal dialysis (PD), hemodialysis in the home or in-center, and conservative treatment, where appropriate. (Ungraded)

Planning vascular access

european society for paediatric nephrology

Recommendations

1.3 Refer children with CKD 4 who are planning for future hemodialysis to a dedicated vascular access team. (2D)

Optimal vascular access in children

european society for paediatric nephrology

Recommendations:

2.1 We suggest that children requiring chronic hemodialysis start with a functioning AVF where appropriate. (2B)

2.2 We suggest that cuffed CVLs are reserved for very small children depending on vessel size and surgical expertise, those requiring urgent or unplanned hemodialysis, patient preference and where a short period on hemodialysis is anticipated before transplantation. (Ungraded)

2.3 There is insufficient evidence to provide recommendations on AVGs in children. (Ungraded)

Pre-operative evaluation for AVF formation

european society for paediatric nephrology

Recommendations:

3.1 We suggest that a structured history, physical examination and duplex ultrasound of upper limb arteries and veins is performed to plan AVF formation. (2C)

3.2 We suggest that in children in whom central venous stenosis is suspected, such as those with previous CVLs, appropriate imaging of central veins is performed (venography, MRI, ultrasound) (2D)

Comments:

- Check: swelling, discomfort of the extremity or face, presence of collateral veins, scars from previous catheters, presence and quality of arterial pulses
- Minimum vessel diameter: 2.5 mm for veins; 1.5 mm for arteries

Site of AVF placement

european society for paediatric nephrology

Recommendation:

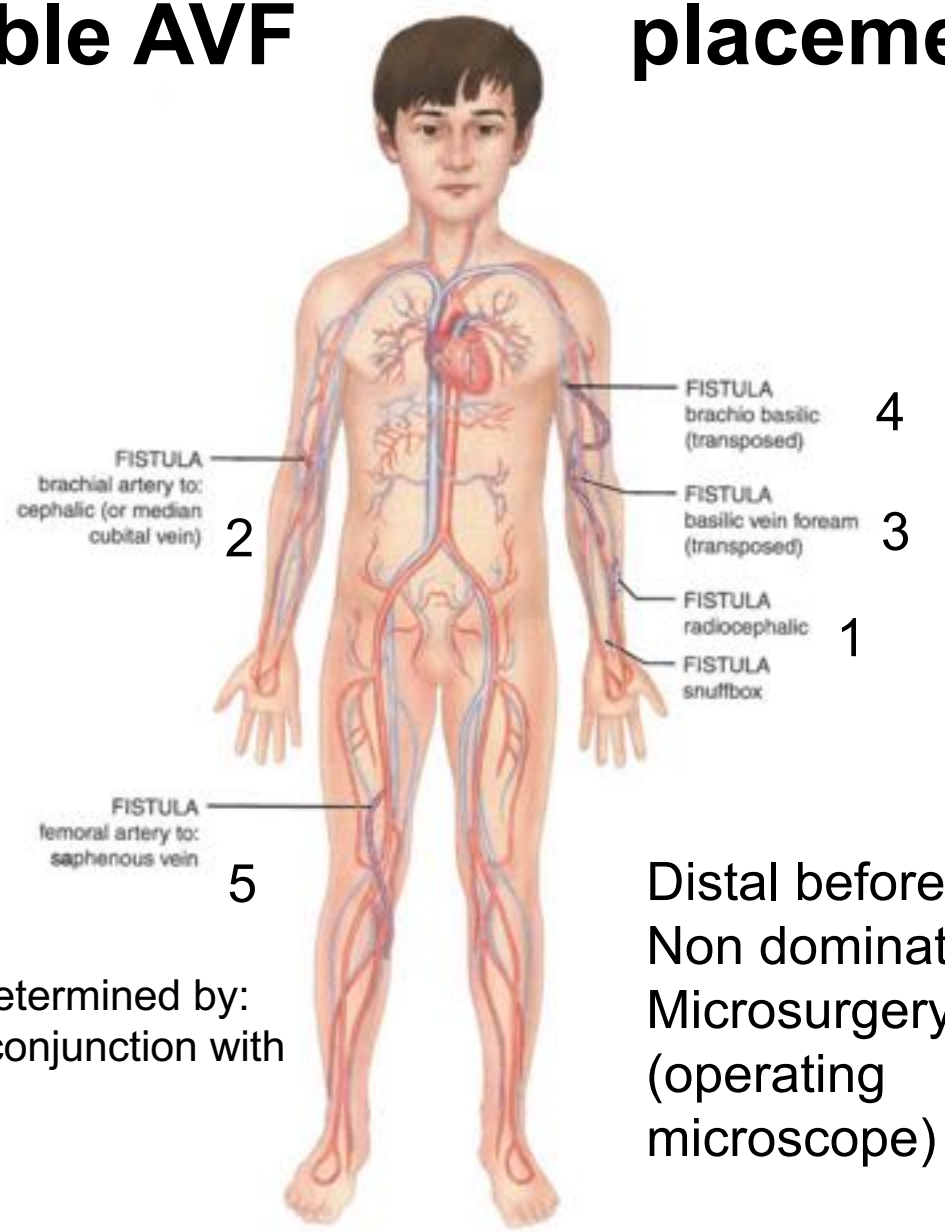
4.1 We recommend that an AVF is placed in the non-dominant arm. (Ungraded)

4.2 We suggest that an AVF is placed distally in the arm. (2D)

Comments:

- Local or regional anaesthesia in cooperative patients
- Otherwise: sedation or general anesthesia
- Microsurgery allows fistula creation even in pts. < 15 kg

Possible AVF placement sites



Cave: steal syndrome
Extremity pain, paresthesia, coolness, absence of distal pulses, paralysis

Distal before proximal
Non dominating arm
Microsurgery
(operating
microscope)

Potential AVF flow volume is determined by:
inflow artery diameter in conjunction with heart rate & BP

Timing of creation of vascular access

european society for paediatric nephrology

Recommendation:

We suggest that AVF placement is performed at least 3 months before its anticipated use. (2D)

european society for paediatric nephrology

Assessment of AVF maturation

Recommendations:

We suggest that clinical examination and duplex ultrasound should be performed 4 to 6 weeks after access formation in order to assess for AVF maturation. (2D)

Comments:

- Post-op: Hand exercise, aspirin, keep up blood pressure (90th pct.), adequate hydration
- Maturation time: 4 weeks – 6 months

AVF cannulation

european society for paediatric nephrology

Recommendations:

7.1 We recommend that AVF cannulation is performed only when adequate maturation has occurred. (2D)

7.2 We recommend that an aseptic technique is used for AVF cannulation. (ungraded)

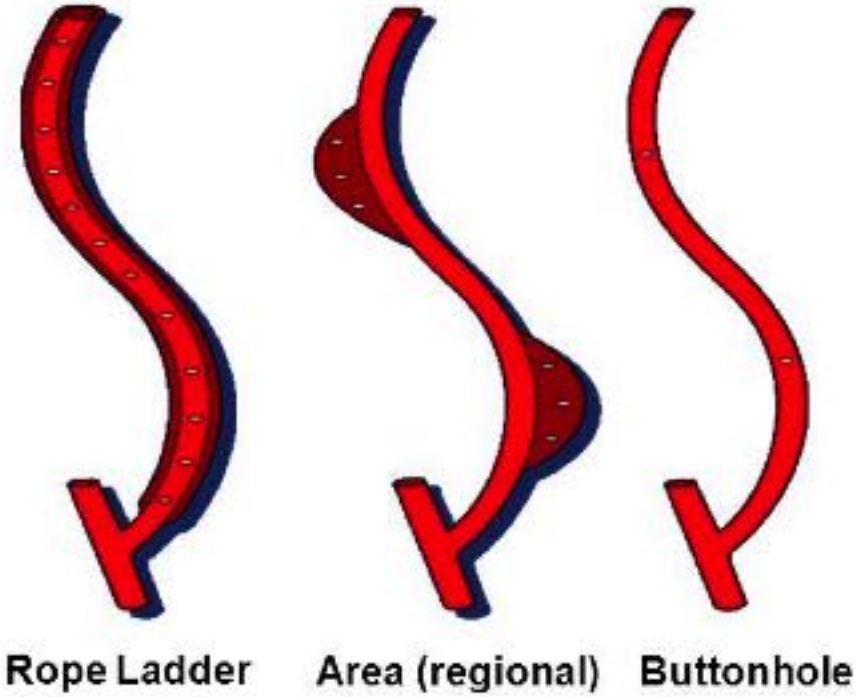
7.3 We suggest that either rope-ladder or button-hole techniques may be used for AVF cannulation (2C)

Comments:

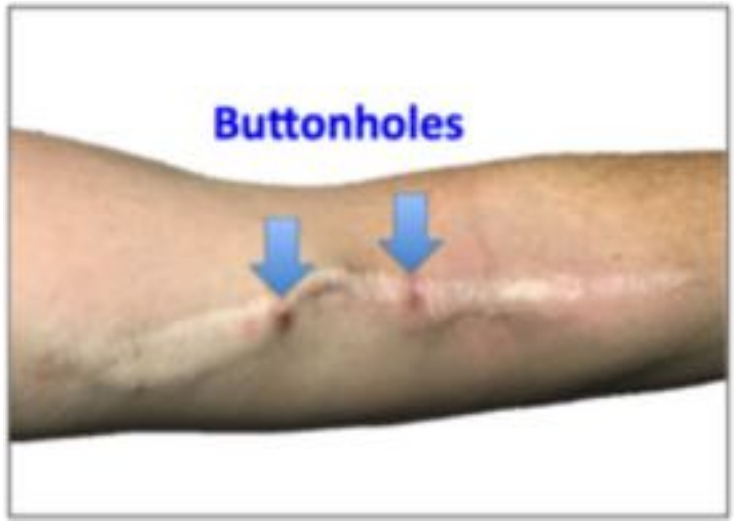
- First use: 17-gauge needle (single needle)

Puncture Techniques

NephroCare



Rope ladder puncture



A common misconception among care providers:

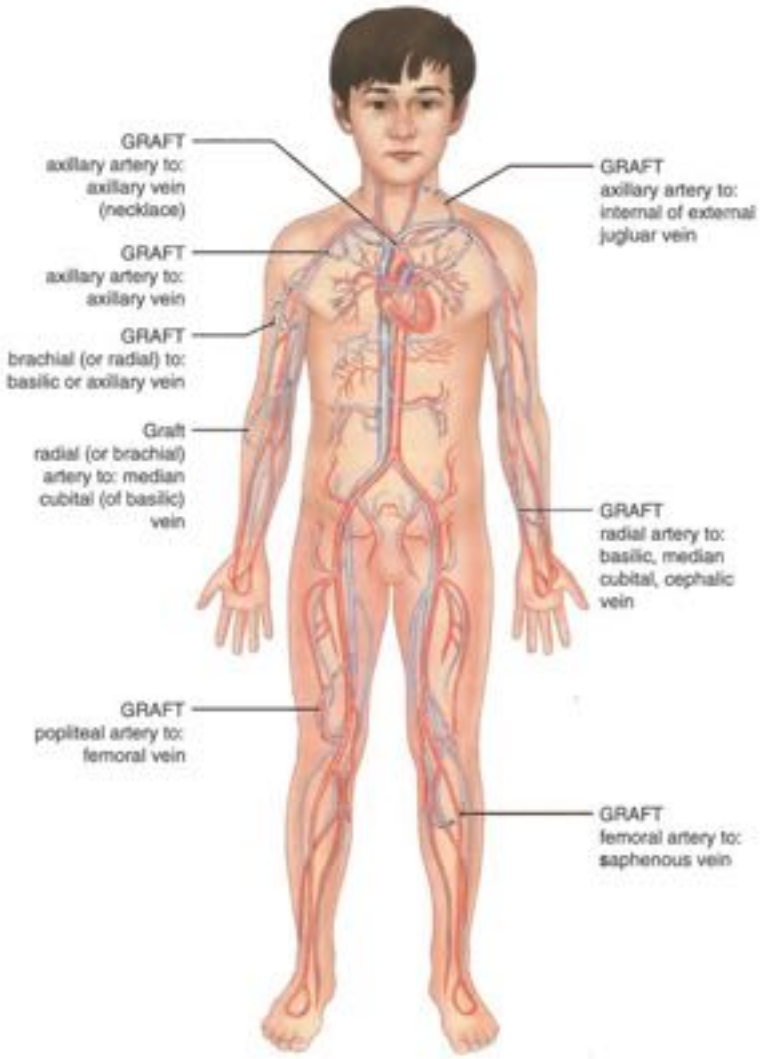
- Children avoid AVF due to cannulation discomfort

Evidence:

Brittinger et al (Ped Nephrol 1997; n=75)

- 39% no discomfort
- 39% tolerable discomfort
- 22% great discomfort
- Only 7% would return to CVC (cosmetic reasons)
- No patient was converted to CVC due to pain

AVG: Possible placement sites & considerations

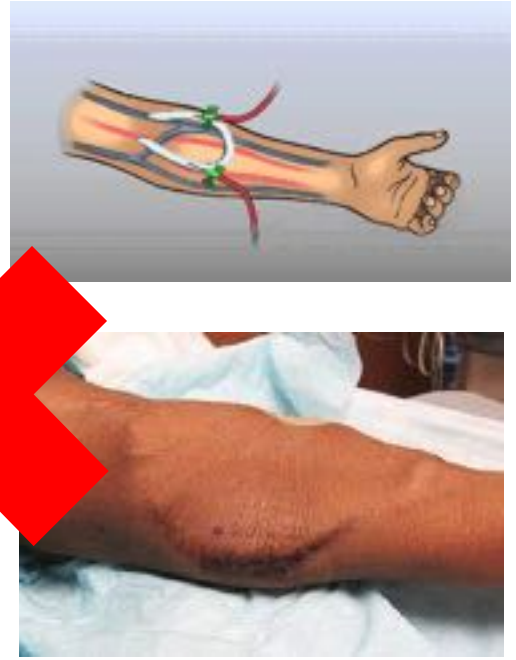


- Autogenous before prosthetic
- AVG more prone to thrombosis
- Higher infection rates
- Can be used much sooner

Go for a AVF if rapid transplantation can not be anticipated!

Arteriovenous fistula (AVF)

Central venous catheter (CVC)



Arteriovenous graft (AVG)

Thank you for your attention

Vascular access for acute & chronic HD: Question 1

Which statement is not true?

Central venous catheter for **acute HD**....

a. Should be preferably placed in the subclavien vein
b. Should allow for an blood flow of at least 3 ml/kg/min
c. Should not be placed on the same side as the constructed AVF
d. Should be checked for correct placement by ECG or X-ray

Vascular access for acute & chronic HD: Question 2

Which statement to vascular access for **chronic HD** is not true?

a. AVF are associated with best long-term survival

b. CVC are associated with high infection rates

c. CVC are associated with high markers of inflammation

d. AVF are associated with venous thrombosis and stenosis

Vascular access for acute & chronic HD: Question 3

Which statement to vascular access for **chronic HD** is not true?

a. Maturation of AVF needs usually less then 10 weeks

b. Hand exercise is associated with faster maturation of AVF

c. AVF should be placed at the non-dominating arm

d. AVF is associated with great cannulation discomfort in approx. 20% of pediatric patients