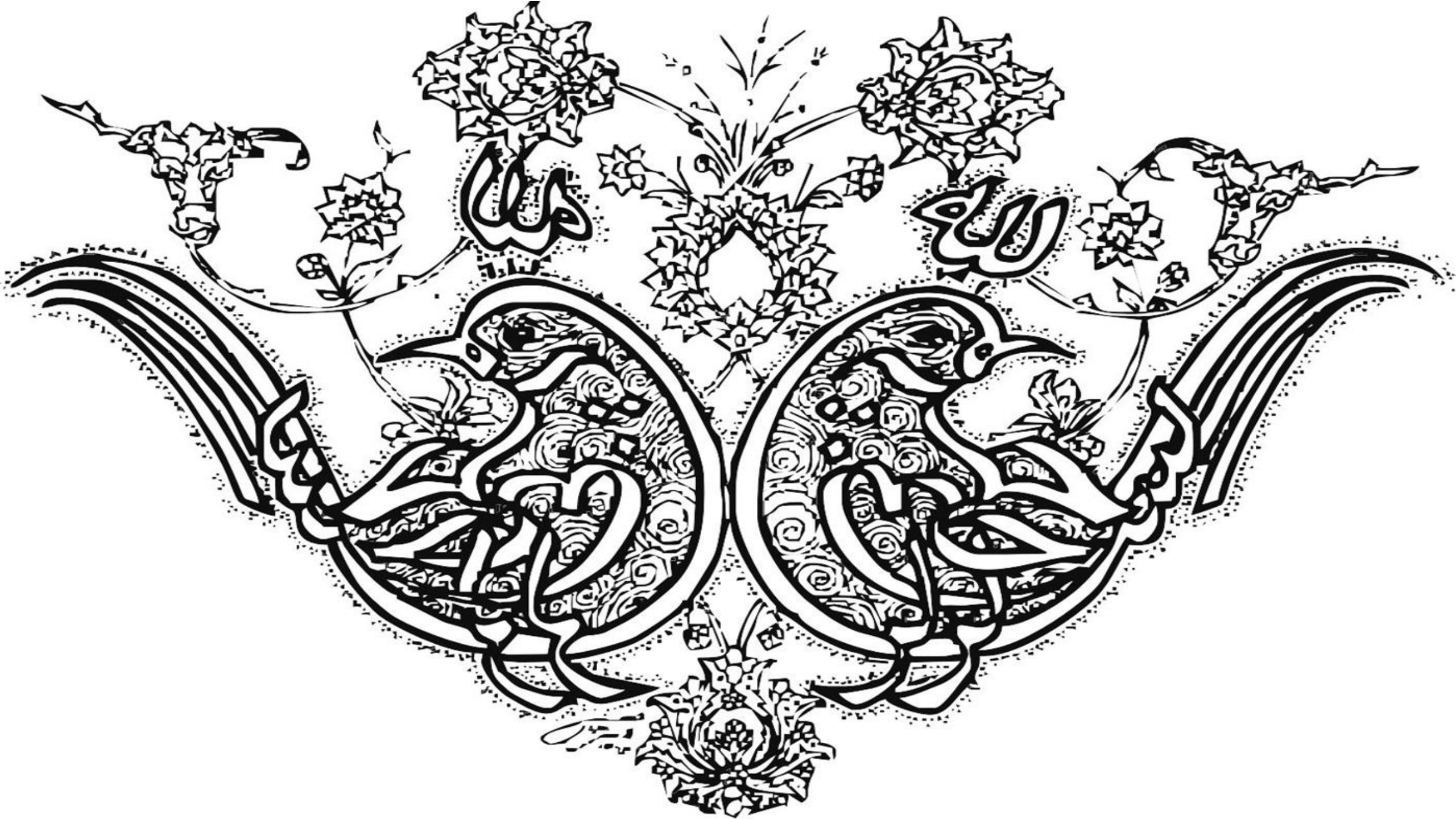

(*an introduction to*) Common Challenges in Vascular Access (catheters)

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ESVS (European Society for Vascular Surgery):

- Definition of vascular access. Patients with acute renal failure or end stage renal disease require renal replacement therapy, which includes peritoneal dialysis (PD), haemodialysis (HD) or kidney transplantation.
- A VA is essential for patients on HD and can be accomplished with central venous catheters (CVC), but also with arterialization of a vein or by interposition of a graft between an artery and a vein for the insertion of HD needles.
- The blood flow available for HD should reach at least 300 ml/min and preferably 500 ml/min depending on the VA modality to allow a sufficient HD.

Schmidli J, et al., Vascular Access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS), Eur J Vasc Endovasc Surg. 2018 Jun;55(6):757-818

RUTHERFORD:

- Central venous catheters play an important role in the treatment of patients with end-stage renal disease.
- Despite initiatives to improve fistula creation, more than 80% of patients initiated hemodialysis with a catheter, a number that has changed little over the past decade.
- Both acute and chronic hemodialysis catheters can be placed percutaneously, chronic catheters have a subcutaneous cuff at the skin exit site, whereas acute catheters do not. As a result, acute catheters are at higher risk for infectious complications and can easily become dislodged.

Rutherford's Vascular Surgery and Endovascular therapy. 10th edition. Philadelphia, PA : Elsevier, 2023

- **Thus acute catheters should be placed only in hospitalized patients and used for a short duration, usually less than 2 weeks.**

- **This time frame is in stark contrast to chronic catheters, which can be used in the outpatient setting indefinitely.**

- The most common indication for placement of a tunneled hemodialysis catheter is for urgent hemodialysis while
  - patient is waiting for an autogenous arteriovenous fistula (AVF) to be created or to mature.
  - patients in whom an AVF or prosthetic arteriovenous graft (AVG) is not anatomically feasible
  - who are not operative candidates because of advanced comorbidities.
- Temporary hemoaccess is also indicated
  - after revision of a permanent hemodialysis access for management of a complication (e.g., access revision for pseudoaneurysm formation or infection),
  - after placement of a peritoneal dialysis catheter, and for a chronic ambulatory peritoneal dialysis patient requiring abdominal or inguinal surgery.

- The benefits of tunneled hemodialysis catheters over AVF and AVG vascular access include:
    - immediate use for hemodialysis, uncomplicated and needle-free connection to the dialysis circuit
    - elimination of cannulation site complications
    - simple insertion technique that can be performed by many different interventional specialists

Catheter design:

- aim to achieve one main goal: adequate dialysis clearance at a relatively high flow rate of 300 to 350 mL/min.

- the phenomenon of recirculation must be minimized to ensure adequate clearance.
- The “arterial lumen” of the catheter is the outflow to the dialysis machine from the patient; the “venous lumen” is defined as the inflow from the machine back to the patient.

- Access recirculation is the reentry of dialyzed blood from the venous lumen directly into the arterial lumen, thus bypassing the systemic circulation and leading to inefficient dialysis.

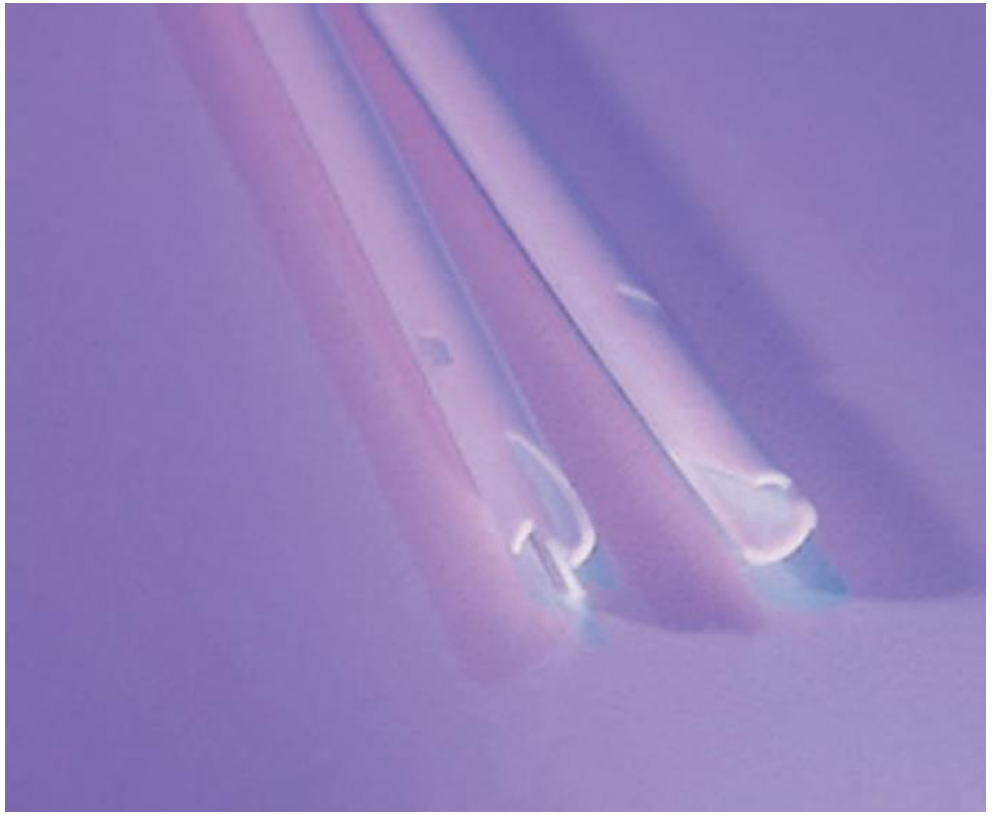
Design categories

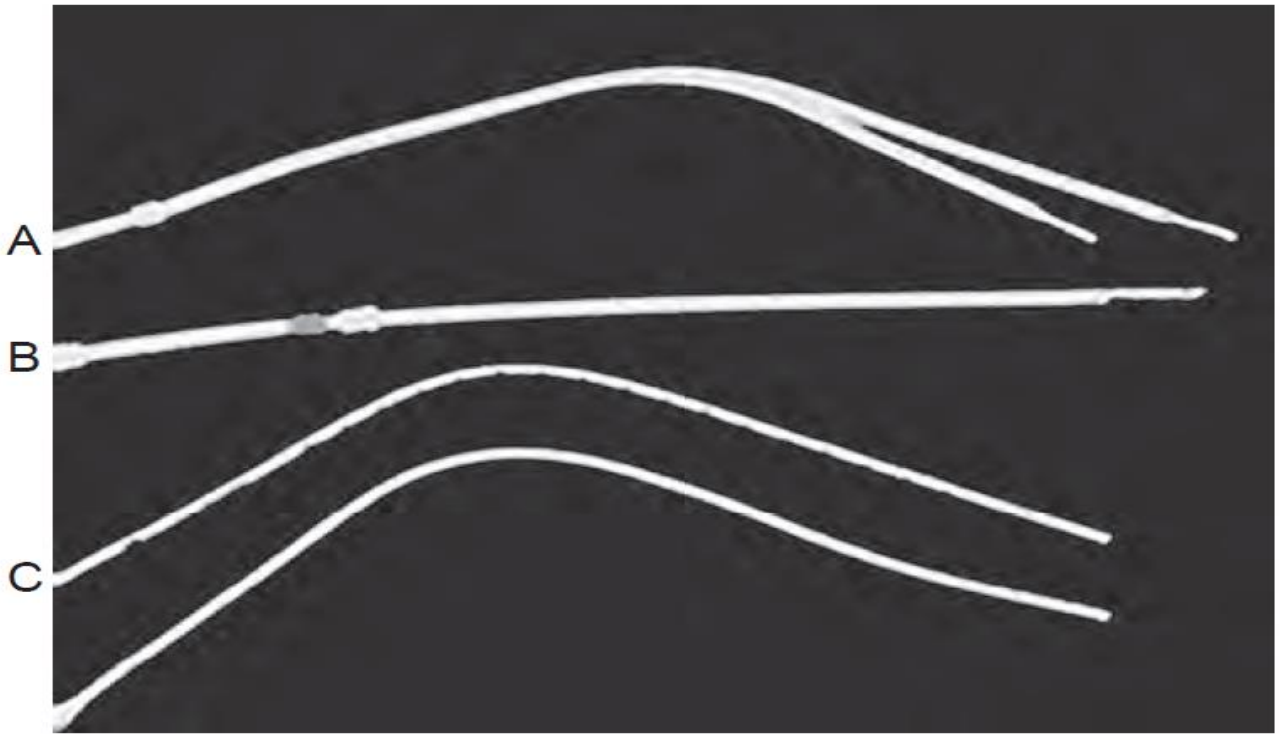
- Numerous manufacturer modifications exist in an effort to satisfy the requirements of high flow rates and minimal recirculation.

- The modifications fall into four general categories:
- Split Tip catheters have a double-lumen, single-body configuration in the midbody but separate into two distinct distal tips, each with side holes in all directions
- Step Tip staggered-tip or step-tip catheter is a double-lumen, singlebody catheter with the venous limb extending at least 2.5 cm beyond the inflow tip.

- Dual Catheter The dual catheter design consists of two completely separate catheters that can be inserted in two different locations

- Symmetric Tip The Tal Palindrome is the only catheter that has a symmetric tip design with equal length of arterial and venous limbs and biased spiral ports.





- Numerous reviews directly compare performance of individual tunneled hemodialysis catheters with specific outcome variables of flow rate, recirculation time, and patency.

- Unfortunately, despite isolated beneficial characteristics of a particular catheter, no universal significant benefit has been demonstrated by one catheter over the competitors.

- Prior guidelines and initiatives have emphasized a “fistula first” approach to vascular access choice due to the AV fistula’s associations with superior patency and lower complications compared with other vascular access types.
- More recent data have challenged these associations because of the high complication rates of AVF maturation failure requiring interventions and, therefore, have prompted a re-evaluation of this Fistula First approach.
- A patient-centered approach to hemodialysis vascular access that considers multiple aspects of a patient’s needs and dialysis access eligibility has been emphasized.

Lok CE, et al., National Kidney Foundation. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020 Apr;75(4 Suppl 2):S1-S164

- Thus, the focus moves away from the prior Fistula First approach and urges providers to think not only about what access is first, but “what’s next” during the planning of the first access. , KDOQI has refocused on a P-L-A-N for each patient: Patient Life-Plan first, followed by his or her corresponding Access Needs
- KDOQI suggests an AV access (AVF or AVG) in preference to a CVC in most incident and prevalent HD patients due to the lower infection risk associated with AV access use. (Conditional Recommendation, Low Quality of Evidence)

Case	Description	ESKD Life-Plan Modality Choice	Dialysis Access	Comments
14 yo girl 	Congenital cause of kidney damage, CKD nondialysis (eGFR 22 mL/min) has living donor for transplant, active – wants to be a teacher, right handed	1. Living donor transplant 2. PD 3. Home NHD	1. Transplant - NA 2. PD catheter 3. RC-AVF (left)	• Follow closely, long life anticipated • Flexibility required - Life-Plan may change • Life-Plan must consider multiple modalities and optimize dialysis access
26 yo woman 	GN, on HD; failed PD with temporary CVC, has potential living donors, actively working during day, R hand dominant	1. Home NHD 2. Transplant	1. RC-AVF (left) 2. BC-AVF (left)	Anticipating patient will get transplant – reassess annually for change in Life-Plan and AV access needs
48 yo man 	DM, HTN, AFib, obese. Copes poorly and non-adherent to medical management and presented needing to urgently start HD, works in outdoor maintenance, L handed	1. IC-HD 2. Transplant wait list 3. PD may be possible later	1. Early cannulation forearm loop graft (right) 2. BC-AVF 3. PD catheter	IC-HD most appropriate; poor self care makes patient poor home PD or HD candidate – may change over time – reassessment necessary

64 yo man 	HTN, PCKD; ESKD on HD x7 years; R handed; Jehovah witness; sudden loss of RC-AVF (left)	1. IC-HD 2. PD may be possible	1. CVC (left, IJ) 2. BC-AVF (R) 3. PD catheter	Transplant not an option due to personal reasons; continue to preserve site for future HD access; patient reluctant to consider PD due to poor home situation
77 yo woman 	Frail, DM, CAD, PVD, urgently started dialysis, with CVC, lives alone, R handed	1. IC-HD 2. PD may be possible	1. BC-AVF (left) 2. Upper arm graft (left) 3. PD catheter	Patient likely has limited life expectancy; focus on AV access and limiting CVC dependency vs preserving sites for future access
88 yo man 	Palliative patient and very frail but still enjoys time with family	1. IC-HD	1. CVC (right IJ)	Patient preference for CVC vs graft for palliative patients

- There is inadequate evidence for KDOQI to make a recommendation for incident HD patients using a CVC on converting to an AV access (AVF or AVG) within the first year of dialysis initiation, solely to reduce their risk of mortality.

- KDOQI considers it reasonable to use tunneled CVC in preference to non tunneled CVC due to the lower infection risk with tunneled CVC. (Expert Opinion)

Central Venous Catheters (CVC): Indications for Use

- KDOQI considers it reasonable in valid clinical circumstances to use tunneled CVCs for short-term or long-term durations for incident patients, as follows (Expert Opinion):

Short-term duration:

- AVF or AVG created but not ready for use and dialysis is required
- Acute transplant rejection or other complications requiring dialysis
- PD patient with complications that require time-limited peritoneal rest or resolution of complication.
- Patient has a living donor transplant confirmed with an operation date in the near future (eg, < 90 days) but requires dialysis

- AVF or AVG complication such as major infiltration injury or cellulitis that results in temporary nonuse until problem is resolved

Long-term or indefinite duration:

- Multiple prior failed AV accesses with no available options
- Valid patient preference whereby use of an AV access would severely limit QOL or achievement of life goals and after the patient has been properly informed of patient-specific risks and benefits of other potential and reasonable access options for that patient (if available)

Long-term or indefinite duration: (continue)

- Limited life expectancy
- Absence of AV access creation options due to a combination of inflow artery and outflow vein problems (severe arterial occlusive disease, non correctable central venous outflow occlusion) or in infants/children with prohibitively diminutive vessels

CVC Locations

KDOQI considers it reasonable to choose the site of the CVC after careful consideration of the patient's ESKD Life- Plan as follows (Expert Opinion):

- Upper extremity before lower extremity, only if choices are equivalent
- There are valid reasons for CVC use and its duration of use is expected to be limited (eg, <3 months):
  - AV access is likely to be ready for use in near future—consider preferential use of tunneled cuffed CVC in opposite extremity to anticipated AV access
  - Transplant is anticipated in near future (preserve iliac vessels)—consider preferential use of tunneled cuffed right IJ Catheter

- Some experts support that in urgent dialysis start situations, under limited use circumstances (<1 month) and transplant is not an option, use of a tunneled, cuffed femoral CVC is acceptable (unless contraindicated) until the AV access or PD catheter can be quickly created and used.
- Use of the femoral vein preserves the upper extremity vessels for future AV access creation.
- Note: Contraindications to femoral vein CVC include femoral or iliac vessel pathology or prior surgery/reconstruction; hygienic reasons(chronic unresolved diarrhea), morbid obesity (BMI > 35 kg/m2), or other difficult vein access.

- When there are valid reasons for CVC use and duration of use is expected to be prolonged (>3 months) without anticipated use of AV access, CVC may be placed in the following locations in order of preference:
- _ Internal jugular
- _ External jugular
- _ Femoral
- _ Subclavian
- _ Lumbar
- Note: In the absence of contraindications, prior pathology (central stenosis) or intervention (pacemaker) CVC insertion on the right side is preferable to the left side due to more direct anatomy.
- If one side has pathology that limits AV access creation but allows for CVC insertion, this side should be used for the CVC to preserve the other side for AV access creation

CVC Configuration and Materials

- KDOQI suggests that the choice of tunneled HD CVC type and design be based on the clinician's discretion and best clinical judgment. (Conditional Recommendation, Low Quality of Evidence)

1. The catheter tube material is made from premium silicone, which hav excellent biocompatibility.
2. The dacron cuff helps keep the catheter from slipping out and reduce the chance of CRBI(catheter related bloodstream infections.)
3. The silicone material makes catheter more floppy,hence it can minimize the trauma to the vein and reduce the icident of clot.
4.Radiopacity facilitates confirmationof catheter placement

- **There is inadequate evidence for KDOQI to make a recommendation on the use of a multidisciplinary team to reduce the rate of CVC use or increase the use of AVF.**

Timing of CVC Removal

Noncuffed, Nontunneled Catheters (NT-CVC)

- KDOQI considers it reasonable to limit the use of temporary, noncuffed, nontunneled dialysis catheters to a maximum of 2 weeks due to increased risk of infection, and this should be considered only in patients in need of emergent access. (Expert Opinion)

Cuffed, Tunneled CVC

- KDOQI considers it reasonable that in HD patients for whom a cuffed, tunneled CVC is the most appropriate permanent dialysis access, there is no maximum time limit to CVC use, but regular evaluation is required to determine if the CVC remains the most appropriate dialysis access.

Thanks for your attention

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