# Guidelines for Venous Access in Patients with Chronic Kidney Disease

## A Position Statement from the American Society of Diagnostic and Interventional Nephrology[1] Clinical Practice Committee and the Association for Vascular Access[2]

Jeffrey Hoggard,* Theodore Saad,† Don Schon,‡ Thomas M. Vesely,§ and Tim Royer¶

*Eastern Nephrology Associates, P.L.L.C., Greenville, North Carolina, †Nephrology Associates, P.A., Department of Medicine, Nephrology Christiana Care Health System, Newark, Delaware, ‡Arizona Kidney Disease and Hypertension Surgery Center, Phoenix, Arizona, §Vascular Access Center, Frontenac, Missouri, and ¶VA Puget Sound Health Care System, Seattle, Washington

**ABSTRACT**

At the time of hemodialysis vascular access evaluation, many chronic kidney disease patients already have iatrogenic injury to their veins which impedes the surgical construction of an arteriovenous fistula (AVF). Achieving the important goal of a greater prevalence of arteriovenous fistulae in the US hemodialysis population will require identification of those patients prior to reaching end-stage renal disease and an educational and procedural system for preserving their veins.

The use of venous access devices is ubiquitous in modern medicine. Establishing and maintaining intravenous access for patients with chronic kidney disease (CKD) necessitate special considerations unique to this patient population. In patients with CKD preservation of the integrity of peripheral and central veins is of vital importance for future hemodialysis access. Cannulation of veins and insertion of venous access devices have potential to injure the veins and thereby incite phlebitis, sclerosis, stenosis or thrombosis. The creation of a high quality arteriovenous fistula (AVF) may become difficult or impossible in the presence of prior venous injury.

The purpose of these guidelines is twofold. First, they provide criteria for early identification of CKD patients who are likely to need a hemodialysis graft or fistula in the future. Secondly, these guidelines provide an algorithm for delivery of optimal venous access in these high-risk patients. Ultimately, this requires an integrated team approach involving the physician requesting venous access, the nurses caring for the patient, the vascular access nurses responsible for placement of peripheral venous access, vascular access experts responsible for image-directed placement of venous access (interventional radiologists, nephrologists, or surgeons), the clinical nephrologist managing the patient's CKD, and the vascular surgeon responsible for creating arteriovenous hemodialysis accesses. Optimal venous access practice and management for the CKD patient is likely best achieved by establishing consensus Policy and Procedure at each institution.

## Background

### Vascular Access for Hemodialysis

The autogenous AVF is the preferred form of vascular access for hemodialysis, delivering superior patency with lower morbidity, hospitalization, and costs relative to prosthetic grafts or hemodialysis catheters (1–6). For these reasons, the nephrology community has implemented a nationwide agenda to increase the creation of autogenous fistulae in hemodialysis patients. The National Kidney Foundation – Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) publishes

[1]ASDIN Clinical Practice Committee members: Steve Ash, M.D., Chair, Gerald Beathard, M.D., Jeffrey Hoggard, M.D., Terry Litchfield, M.P.A., Dr.PH., George Nassar, M.D., Tony Samaha, M.D., Don Schon, M.D., Vijay Sreenarasimhaiah, M.D., Tom Vesely, M.D., Monnie Wasse, M.D.

[2]AVA members: Denise Macklin, RNBC, Kathy McHugh, RN, BSN, Tim Royer, BSN, CRNI, Kelli Rosenthal, MS, RN, BC, CRNI, ANP, APRN, BC

Address correspondence to: Jeffrey Hoggard, MD, 1776 Blue Banks Farm Rd, Greenville, NC 27834, or email: jhoggard@suddenlink.net.

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specific guidelines relative to creation and management of hemodialysis vascular accesses (7). More recently, the Centers for Medicare and Medicaid Services (CMS) along with the regional End-Stage Renal Disease (ESRD) Networks and the clinical nephrology community have developed and promoted the National Vascular Access Improvement Initiative (NVAII) called "Fistula First Breakthrough," with the specific goal of promoting more autogenous fistulae in hemodialysis patients. By 2009, the goal is to achieve a 67% prevalence rate of autogenous fistulae in hemodialysis patients (8). Ultimately, this strategy to create more functional fistulae is critically dependent on the availability and condition of the patient's central and peripheral veins. Frequent venipuncture and the indiscriminate use of peripheral intravenous lines, peripherally inserted central catheters (PICCs) or central venous catheters can damage veins, impair venous circulation and jeopardize future fistula construction or function. Therefore, to preserve peripheral and central veins for future hemodialysis vascular access it is of paramount importance that CKD patients achieve early protection of their critical venous real estate. This important concept has been emphasized in editorials by Trerotola (9), Saad and Vesely (10), and more recently by McLennan (11).

## Venous Injury

The injurious effects of phlebotomy and peripheral and central venous catheters include phlebitis, venous sclerosis, stenosis, and thrombosis. Vascular damage may occur early, at the time of catheter insertion, or the injury may be progressive if the catheter remains in the vein for an extended period of time (12). Forauer and colleagues reported their findings from an autopsy study; these investigators described pathological changes of endothelial denudation associated with short-term central catheter use. With long-term catheter use, there was vein wall thickening, increased number of smooth muscle cells, and focal catheter attachments to the vein wall with thrombus and collagen (13). Ducatman et al performed an autopsy study of 141 patients with central venous catheters and reported that 32% had pericatheter thrombus in the brachiocephalic veins or superior vena cava within 2 weeks after catheter insertion (14). In the majority of previously published studies, including the classic study of PICCs by Grove and Pevec, follow-up imaging studies were only performed in symptomatic patients (15). A more accurate assessment of venous injury would require thorough venographic imaging both before and after placement of the venous catheters in all patients. Allen et al. used contrast venography at the time of initial PICC placement, and then again when a subsequent PICC was placed in the same patients (16). These investigators reported that 23.3% of patients developed venous thrombosis after initial PICC placement. When all subsequent PICC placements were included for patients who underwent multiple PICC insertion procedures, the rate of thrombosis increased to 38%. In this study, the rate of thrombosis in the cephalic vein was particularly high with 57% of patients developing thrombosis after PICC placement. In a similar study, Gonsalves et al. reviewed venographic studies that were performed both before and after insertion of PICCs in 150 patients to determine the incidence of central venous stenosis or occlusion (17). These investigators reported that 7.5% of patients with previously normal central venograms developed subsequent venographic abnormalities after PICC placement; 4.8% developed central venous stenosis and 2.7% had central venous occlusion. Abdullah et al performed venography at the time of PICC removal in a small prospective study and documented venous occlusion in 38.5% of 26 patients (18). Central venous catheters inserted into the subclavian vein can cause stenosis and thrombosis. Hernandez et al. used serial venographic studies to evaluate the long-term effects of subclavian vein catheters in 42 patients (19). At the time of catheter removal, 45% of patients had stenoses and 7% had total thrombosis of the subclavian vein. In a retrospective study of 279 central venous catheters in 238 patients, Trerotola et al. reported that catheter-related venous thrombosis occurred in 13% of patients with subclavian vein catheters, compared with 3% of patients with internal jugular vein catheters (20). The mean time to thrombosis was 36 days for subclavian catheters and 142 days for internal jugular vein catheters. Similarly, Bambauer reported an incidence of thrombosis or stenosis in 8% of patients receiving subclavian vein catheters and only 0.3% of patients with internal jugular vein catheters (21). The NKF-KDOQI Guidelines recommend the use of internal jugular vein and avoidance of the subclavian vein and PICCs for venous access based on this data.

## Guidelines for Venous Access in Patients with Chronic Kidney Disease

**A. Identify CKD patients who may need hemodialysis treatment in the future.**

1. **Patients with CKD Stages-3, 4 or 5. This includes stage 5 CKD patients currently receiving hemodialysis or peritoneal dialysis.**
2. **Patients with a functional kidney transplant.**

**B. Venous Access for stage 3–5 CKD patients.**

1. **The dorsal veins of the hand are the preferred location for phlebotomy and peripheral venous access.**
2. **The internal jugular veins are the preferred location for central venous access.**
3. **The external jugular veins are an acceptable alternative for venous access.**
4. **The subclavian veins should not be used for central venous access.**
5. **Placement of a PICC should be avoided.**

**C. Implementation of Policy and Procedure for Venous Access in CKD patients.**

Policy and Procedure should be established to allow members of the vascular access team to assess and provide recommendations for vascular access issues for stage 3–5 CKD patients.

## Discussion

**A. Identify CKD patients who may need hemodialysis treatment in the future.**

1. **Patients with CKD Stages-3, 4 or 5. This includes stage 5 CKD patients currently receiving hemodialysis or peritoneal dialysis.**
2. **Patients with a functional kidney transplant.**

### Rationale

Identifying those patients at risk for future hemodialysis is the first step of a care path designed to protect venous anatomy. An isolated serum creatinine is a notoriously inaccurate measure of kidney function. The NKF recommends calculating an estimated glomerular filtration rate (eGFR) in all CKD patients to assess and stage their renal insufficiency (7) (see Table 1). Using the modified Levey formula of the Modification of Diet in Renal Disease (MDRD) equation one can easily calculate an eGFR standardized for body surface area with the following four variables: serum creatinine, age, sex, and race (22) (see Table 2). The NKF and National Kidney Disease Education Program recommend that all clinical laboratories provide an eGFR value when a serum creatinine is ordered (23). The Cockcroft-Gault formula, a method of estimating creatinine clearance standardized for weight, is an alternative method of evaluating renal function (see Table 2). Personal digital assistants and websites routinely provide easy calculator tools for both these formulas. The value of these equations in estimating renal function as well as the limitations have been published (24). Lastly, in the absence of an eGFR or creatinine clearance an elevated serum creatinine of greater than 2.0 mg/dl would be a conservative indication to restrict venous access. This recommendation to evaluate renal function with an eGFR is not limited to the assessment of CKD patients needing venous access. Pharmacy, radiology, and cardiology organizations are routinely adopting similar guidelines for optimum care of CKD patients (25).

**TABLE 1. Classification of Chronic Kidney Disease**

| Stage | Description | eGFR (ml/min/1.73 $m^2$) |
|---|---|---|
| I | "Normal" renal function | > 90 |
| II | "Mild" renal dysfunction | 60–89 |
| III | "Moderate" renal dysfunction | 30–59 |
| IV | "Severe" renal dysfunction | 15–29 |
| V | "End-Stage" renal disease | < 15 |

**TABLE 2. Estimating Renal Function**

Cockcroft-Gault formula

Creatinine Clearance (ml/min) $= \frac{(140-\text{age})\times\text{weight (kg)}\times{}^{*}0.85\text{ if female}}{72\times\text{serum creatinine (mg/dl)}}$

MDRD equation (modified Levey formula)

eGFR (ml/min/1.73 $m^2$) = 186 × (serum creatinine) − 1.154 × (age) − 0.203 × (0.742 if female) × (1.210 if African-American)

A normalized creatinine clearance or eGFR of < 60 mL/min/1.73 $m^2$ (Stage 3 CKD) is associated with a cascade of systemic changes in the body related to decreased renal function. This diminished degree of function typically predicts further deterioration of renal function and progression of renal disease regardless of the underlying cause albeit at different rates of decline (26). The American Society of Diagnostic and Interventional Nephrology Clinical Practice Committee (ASDIN CPC) and the Association for Vascular Access (AVA) believe that a care path for preservation of veins should begin when risk for progression to ESRD is ascertained. Therefore, we recommend that CKD patients with stage 3 or worse be considered for a venous preservation care path. The NKF-KDOQI Clinical Practice Guidelines for Vascular Access currently recommends restricting venous access for patients with CKD stage 4 or worse. Clinical Practice Guideline 1.2 states that in patients with CKD stage 4 or 5, forearm and upper-arm veins suitable for placement of vascular access should not be used for venipuncture or for the placement of intravenous catheters, subclavian catheters, or PICCs (7). Waiting until stage 4 CKD to initiate this protective strategy is potentially too late in our opinion. The NVAII recommends timely referral of CKD patients to a nephrologist prior to stage 4 so that education of vein protection can begin (8). We support the NVAII approach in which education and vein protection begins in Stage 3 CKD and planning for dialysis access takes place in Stage 4 CKD. In the absence of prior nephrology evaluation and determination of risk of kidney disease progression, the vascular access nurse or team will play a critical "gate-keeper" role in this risk identification and education process. Just as a vascular access nurse will pause to assess the relative contraindication of placing venous access in the ipsilateral arm of a mastectomy patient, similar restraint is applicable to the CKD patient.

The critical issue of vein preservation is not resolved once hemodialysis patients have a functional vascular access. Any hemodialysis vascular access is at risk for failure and therefore protecting veins for future fistula creation remains an important part of the dialysis patient's health care (27). The same applies to CKD patients with alternative forms of renal replacement therapy, including peritoneal dialysis or renal transplantation. Peritoneal dialysis patients, who do not require immediate vascular access, have a substantial risk of modality failure (28). Failure of peritoneal dialysis requiring conversion to hemodialysis can occur at rates of 20–30% per year (29). Although transplant survival has been improving over the past two decades, there remains a significant rate of long-term allograft failure necessitating return to hemodialysis (30). Some medical centers rank transplant failure as one of the most common reasons for initiation of dialysis (31). Therefore, vein preservation continues to be an important issue for all patients with ESRD regardless of the type of renal replacement therapy or existing vascular accesses.

**B. Venous Access for stage 3–5 CKD patients.**

1. **The dorsal veins of the hand are the preferred location for phlebotomy and peripheral venous access.**
2. **The internal jugular veins are the preferred location for central venous access.**
3. **The external jugular veins are an acceptable alternative for venous access.**
4. **The subclavian veins should not be used for central venous access.**
5. **Placement of a PICC should be avoided.**

## Rationale

Every patient starts with only four superficial upper extremity veins with potential to become an autogenous AVF, the cephalic and the basilic vein in each arm. Frequently, one or more of these veins are already damaged or unsuitable by the time hemodialysis is required. Therefore, the loss of any of these veins from iatrogenic injury represents a significant morbidity that should be strenuously avoided. No peripheral vein should ever be considered "expendable" in the high-risk CKD population. Once these patients are identified they should be educated about venous access and phlebotomy restrictions. Medical bracelets which identify the patient as having CKD and the need for vein protection should be considered. The NVAII supports the recommendation for such bracelets.

For peripheral venous access the vascular access nurse should utilize the dorsal hand veins, preferably in the dominant arm. NKF-KDOQI guidelines similarly recommend the dorsal hand vein sites (7). The hand veins in the non-dominant arm would be a second choice. Hand warming has been shown to assist and improve successful cannulation of the hand veins. Lastly, the external jugular vein could be used for peripheral intravenous access. The forearm cephalic vein, the antecubital veins, and upper arm veins should not be used for peripheral intravenous access.

For central venous access a small-bore, tunneled catheter inserted into the internal jugular vein is recommended. These devices may include:

- 4, 5, 6, or 7 Fr single, double, or triple lumen catheters: centrally inserted central venous catheters (CICVC)
- 6–10 Fr single, double, or triple lumen cuffed tunnel catheters
- 6–9 Fr implanted catheters (ports)

The option of power-injectable catheters for computed tomography studies may be chosen by the operator or ordering physician. The external jugular vein is a second choice for central catheters. With the use of appropriate image guidance, the placement of jugular venous catheters is extremely low risk. Serious complications including pneumothorax, hemothorax, arterial puncture, or significant bleeding should approach zero. The catheter tip position for non-dialysis catheters should be near the junction of the superior vena cava and right atrium (CA junction). The smallest diameter catheter for the therapy required should be selected. This recommended tip position and smaller caliber of catheter are both associated with a lower risk of thrombus formation and stenosis in the central vessels (15, 32, 33,). Tunneling a jugular venous catheter along the anterior chest wall may reduce infection rates and improve patient acceptance of this route (34). In their paper addressing alternative venous access for patients with CKD, Sasadeusz et al. reported successful placement of 43 small bore catheters, with short subcutaneous tunnels, into the internal or external jugular veins (35). These investigators reported one catheter-related infection (0.17 per 100 catheter days) and one catheter-related thrombosis.

Non-tunneled jugular vein catheters appear to be associated with a higher incidence of infection when compared with subclavian vein catheters (36, 37, 38). For this reason, the Centers for Disease Control recommends avoidance of jugular vein catheters (39). However, in stage 3–5 CKD patients the subclavian veins should not be used for central venous access notwithstanding the Centers for Disease Control recommendation for the general population. This recommendation is based on the substantial data that subclavian venous catheters are associated with a high risk of stenosis and thrombosis to the central venous anatomy which can preclude the use of any future arteriovenous dialysis access in the ipsilateral arm (40, 41). Again, it should be emphasized that this recommendation to avoid use of the subclavian veins is a relative one. For example, in patients who have no other potential for an arm arteriovenous access, a subclavian catheter could be inserted on the ipsilateral side.

In general, a PICC line should not be placed in patients at risk for future hemodialysis vascular access. PICCs are commonly placed to facilitate earlier hospital discharge in patients requiring ongoing intravenous therapy, but the decision to place a PICC in the high risk CKD patient should be guided by medical necessity rather than convenience. A request for a PICC in a stage 3–5 CKD patient should be halted, and an order for a tunneled internal jugular catheter should be substituted. A PICC may be an appropriate venous access device for a subgroup of CKD patients. These include patients with terminal disease or very short life expectancy, patients with previous failures of arteriovenous access or severe peripheral arterial disease for whom there is no possibility of future fistula construction in that limb, and patients with a high-quality functional AVF and limited life-expectancy such that no future arteriovenous access is likely to be required.

**C. Implementation of Policy and Procedure for Venous Access in CKD patients.**

Policy and Procedure should be established to allow members of the vascular access team to assess and provide recommendations for all vascular access-related issues for CKD patients.

## Rationale

It must be recognized that a request for placement of venous access may originate from a variety of different health care providers and may or may not be based upon a carefully considered assessment of the individual patient's likelihood of requiring hemodialysis. Implementation of a Policy and Procedure for "Venous Access in CKD patients" can help standardize the approach and ensure favorable outcomes. An important factor in developing a hospital-wide policy for management of venous access is collaboration between interested parties. Primary physicians, nephrologists, nurses, interventionalists, and hospital administrators should be encouraged to work together to develop consensus policies to address this issue.

As with all medical decisions, there is no protocol that can entirely substitute for good medical judgment; individualized decisions need to be made according to the patient's circumstances. For example, a CKD patient with no further arteriovenous access options in a limb may appropriately have a venous catheter placed in that limb without affecting future dialysis access. Our proposals for venous access in CKD patients are relative guidelines and not absolute recommendations. As such, Policy and Procedure development should allow flexibility in vascular access planning for each individual patient.

Medical bracelets not only help with identification and education of high risk CKD patients but can also empower these patients in the protection of their venous real estate in various health care settings. Electronic medical records have the potential to automatically identify stage 3–5 CKD patients on hospital admission and facilitate individual bed, door or room signs to help prevent indiscriminate phlebotomy or intravenous access placement. The vascular access nurse/team will play a critical role in this implementation and educational process. A Policy and Procedure for "Venous Access in CKD patients" would allow the dedicated vascular access nurse to perform an assessment of the venous access order, a determination of the patient's CKD stage, the venous anatomy, the type of intravenous therapy required including frequency, duration, and potential toxicity to peripheral veins. Policy and Procedure would then allow the vascular access nurse to place the preferred venous access or arrange for the preferred access by an interventionalist.

In some instances, the goal of preserving veins in stage 3–5 CKD patients is simply achieved by determining that venous access is not necessary because alternative routes of therapy can be utilized. In patients with renal failure, the delayed elimination of certain antibiotics can be advantageous. In particular, vancomycin, aminoglycosides, and most cephalosporins can be dosed to maintain effective levels when administered three times per week at each hemodialysis treatment (42, 43). Most quinolones can achieve systemic levels with oral administration just as well as with an intravenous route. The selection of one of these antibiotics, when medically appropriate, can obviate the need for a separate venous access.

The administrative policies in many hospitals forbid the use of an existing hemodialysis catheter for any application other than hemodialysis treatment. These policies are based on the premise that frequent use of a hemodialysis catheter by non-dialysis staff may lead to an increased incidence of infection, although there is no published evidence to support this conclusion. This potential risk must be weighed against the potential long-term consequences associated with the insertion of a separate venous access. In some instances, particularly for patients with limited venous access, it may be prudent to use the existing hemodialysis catheter for other needs. Establishment of intravenous fluids at a slow rate to these chronic dialysis catheters can then allow other intravenous medications via a piggyback system. Routine blood samples can be obtained when the catheter is accessed for hemodialysis rather than subjecting the patient to phlebotomy. Meticulous dialysis catheter care combined with a concerted effort to minimize use of the catheter can make this a viable option.

Lastly, a Policy and Procedure for "Venous Access in CKD patients" can allow timelier placement of the appropriate access. For many CKD patients with poor peripheral veins a catheter inserted into the internal jugular vein is easier, faster, and potentially less traumatic than multiple attempts to insert a catheter into a deep, diminutive, peripheral vein. Additionally, once the appropriate access is established blood draws can be obtained without need for further phlebotomy.

## Summary

A well-functioning, long-term vascular access is a critical factor affecting the morbidity and mortality of hemodialysis patients. An autogenous fistula is the overwhelmingly preferred hemodialysis access as it provides the best patient outcomes as measured by mortality, hospitalization rates, infections, and requirement for repeated access interventions. Importantly, there is attendant significant cost savings to the health care system and a concerted effort nationwide is underway to increase the use of AVFs. The ability to establish an autogenous AVF is critically dependent on having a patent peripheral vein, of sufficient size and elasticity to allow for dilation and maturation after surgical construction. Furthermore, the function of AVFs as well as prosthetic grafts is critically dependent on a healthy venous circuit back to the heart. Many patients at the time of initial nephrology referral already have significant disease in their veins from vascular disease, aging, and prior venous injury from phlebotomy and intravenous lines. Avoiding unnecessary iatrogenic trauma to the arm veins is critical in our national efforts to optimize AVF use for hemodialysis access. Identifying CKD patients at risk and adoption of a vein preservation care path will enhance our ability to achieve a higher percentage of native AVFs. A Policy and Procedure for "Venous Access in CKD patients" can maximize this potential in the hospital setting.

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