The Ins and the Outs of Vascular Access for Hemodialysis: Venous Catheters

Hemodialysis catheters. Have you seen one of these lately? Whether you work in the inpatient or outpatient setting, chances are that you encounter these venous access devices in your patients. Approximately 14 percent of the US population is affected by chronic kidney disease (CKD), with an estimated 468,000 individuals with kidney failure requiring dialysis.¹ When hemodialysis is utilized to remove waste from the bloodstream because the human kidneys have failed from disease or injury, there must be a means of connecting to a patient's bloodstream in order to cleanse the blood and then return it to the patient. The high flow that typically occurs through normal health kidneys must be mimicked with the dialysis machine, and therefore the type of vascular access that is used should allow as much blood as possible to be filtered during each treatment.

CKD is classified into stages I through V based on glomerular filtration rate (GFR).

**Stage IV:** function is severely decreased with the GFR at 15-29 ml/min/1.73m² (*normal GFR*).

Patients should be educated about forms of renal replacement including hemodialysis, peritoneal dialysis, and kidney transplantation.

**Stage V:** kidney failure is defined with the GFR <15 ml/min/1.73m²

*Dialysis is started once the patients reach stage V or have signs of uremia.*

Short-term vascular access is obtained and long-term access is planned.

There are a few options when it comes to vascular access for hemodialysis. Prior to any access placement, a thorough examination and work-up should be performed to include duplex ultrasound of the upper-extremity arteries and veins and central vein evaluation if patients have had a pacemaker or prior catheter.² Our normal veins would not be able to tolerate regular hemodialysis and may be damaged or collapse under the strong suction that is required.

The various forms of access are designed for short and long-term use. Long-term solutions for vascular access include the arteriovenous (AV) fistula and the AV graft. AV fistulae are created at least 3-4 months before their anticipated use, and patients will sometimes require temporary hemodialysis access while the fistula matures. The AV
fistula lasts longer and is less likely to get infected, but take 2-3 months to mature prior to use. AV grafts can be used 2-3 weeks after surgery, but are more likely to clot and have infection.

Large bore double-lumen central venous catheters are most often used when hemodialysis is needed and the patient does not yet have a long-term means of vascular access such as a fistula. Peripherally inserted central catheters (PICC) are not routinely used for dialysis because of the potential loss of upper-extremity veins.² The remainder of this article will focus on central venous catheters used for hemodialysis.

Venous Catheters

There are no recommendations on specific catheter devices, but they may be chosen according to purpose and duration of use. There are many brands and types of catheters available, and each catheter has unique specifications and features per manufacturer research. Most catheters also have uses in addition to hemodialysis, and have additional indications for apheresis, medication administration, and intravenous infusion.

Venous catheters used for hemodialysis typically have have one shaft that splits into two ports, one with one to carry blood to the dialyzer and one to carry blood from the dialyzer back to the patient. It is preferable to have a flow ability of greater than 350 mL/min.² The catheters typically come in diameter sizes ranging from 8-13.5 French (Fr) and varying lengths (9-50 cm).⁸ The length of the catheter should be determined based on the access site, with the longer lengths used for femoral vein access.

Variations in catheter anatomy also exist such as pre-curved designs for jugular insertions. Some catheters have two separate channels in the device, that allow directional blood flow. The tips of hemodialysis catheters are most often dual lumen, but may have the arterial and venous tips staggered.² Others have a split-tip end that helps to minimize recirculation during hemodialysis. Various shapes of catheter lumens also exist, such as round, oval, and D-shaped.

Another way that venous catheters are typically classified is the following:
• tunneled and non-tunneled
• triple-lumen and double lumen

Tunneled vs. Non-tunneled
As mentioned above, tunneled catheters are for use longer than 3 weeks. They also typically have a larger diameter size of 15.5-16 Fr, which also allows for greater blood flow rates.⁸

Triple-lumen vs. Double-lumen
The double-lumen ports are typically blue and red colored to identify “venous” and arterial” flow.⁸ Triple lumen catheters are beneficial when blood access, fluid, or
medication delivery is desired. Having the third lumen available helps to limit the need for additional venous access for these purposes.

Examples of various central venous catheters are provided in the table below.
## Examples of Central Venous Catheters Used for Hemodialysis

<table>
<thead>
<tr>
<th>Catheter</th>
<th>Size/Design</th>
<th>Unique Features</th>
<th>Lumens</th>
<th>Flow-Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-Term Catheters</strong></td>
<td></td>
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</tr>
<tr>
<td>Power-Trialysis Slim-Cath Short-Term Dialysis Catheter</td>
<td>• 12 Fr • 12.5 cm - 30 cm lengths • Straight</td>
<td>• Has third 17 Ga. lumen for IV therapy • Oval catheter lumen</td>
<td>Triple</td>
<td>Allows for flow of 400 mL/min</td>
</tr>
<tr>
<td>Duoglide Short-Term Dialysis Catheter</td>
<td>• 13 Fr • 12.5 cm - 30 cm lengths • Straight</td>
<td>• Symmetrical tip</td>
<td>Double</td>
<td>Allows for flow of 400 mL/min</td>
</tr>
<tr>
<td>Covidien Mahurkar Elite and Acute Dialysis Catheters</td>
<td>• 8 - 12.5 Fr • 13 cm - 30 cm</td>
<td>• Large “Double-D” lumen design</td>
<td>Double and triple</td>
<td>Allows for flow of 400 - 450 mL/min (depending on size)</td>
</tr>
<tr>
<td><strong>Long-Term Catheters</strong></td>
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</tr>
<tr>
<td>EQUISTREAM Long-Term Hemodialysis Catheters</td>
<td>• 14.5 - 16 Fr • 15 cm - 42 cm lengths • Straight • Pre-Curved • Cuffed</td>
<td>• Split-tip design • Blood intake through two arterial inlets • Catheter shaft has two separate lumens</td>
<td>Double</td>
<td>Allows for flow rates as high as 500 mL/min</td>
</tr>
<tr>
<td>HICKMAN Chronic Dialysis Catheters</td>
<td>• 13.5 Fr (double) • 10.8 and 14.4 (single lumen) • 28 cm - 45 cm lengths • Cuffed</td>
<td>• Pre-staggered tip and side holes</td>
<td>Single and Double</td>
<td>Specific flow rates not available</td>
</tr>
<tr>
<td>Covidien Mahurkar Chronic Catheters</td>
<td>• 8 - 13.5 Fr • Straight, Pre-curved, Curved • Cuffed</td>
<td>• Carbothane and silicone options</td>
<td>Double and triple</td>
<td>Allows for flow rates around 350 mL/min</td>
</tr>
<tr>
<td>MeritMedical ProGuide Chronic Dialysis Catheter</td>
<td>• 14.5 Fr • 19 cm - 50 cm lengths • Cuffed</td>
<td>• Peel away sheath introducer • Thin-walled “Double-D” lumen design</td>
<td>Double</td>
<td>Allows for flow rates as high as 500 mL/min</td>
</tr>
</tbody>
</table>
Access Sites for Venous Catheters

The most common access sites are the internal jugular vein in the neck, the subclavian vein under the collarbone, and the femoral vein in the groin. Each site has pros and cons for use and clinical judgment is used to determine the appropriate access for each patient. Because the preservation of veins is important, several principles should be kept in mind:

- Venous catheters are not a long term solution, but may be used for several weeks or months while awaiting permanent dialysis access. For use longer than 3 weeks, placement of a tunneled catheter is recommended.
- Subclavian vein catheterization is typically avoided if possible to prevent central vein stenosis that would affect the placement of potential upper extremity fistulae.\(^2\)
- If possible, venous catheters should be placed on the opposite side of a maturing AV access.\(^2\)
- The right internal jugular vein is preferable due to the anatomical path straight to the superior vena cava (SVC).
- Long-term catheters that are tunneled should typically have tips within the right atrium, while short-term catheter tips should be in the superior vena cava (SVC).\(^8\)

Placement

Each manufacturer has different nuances for insertion of their products that is beyond the scope of this article. While the exact insertion procedure is not outlined here, most venous catheters are placed using the modified Seldinger guide-wire technique. This can be performed percutaneously (with local anesthesia) by insertion of the catheter directly through the skin into the desired vein. Tunneled catheters can be placed under local, sedation, or general anesthesia. Some catheters have peel away sheaths that allow for easy tunneling.

After insertion, it is important to keep in mind that temporary catheters need to be flushed regularly to prevent clotting and locked with an anticoagulant solution. Heparin may be used for locking the catheter as well as other agents such as citrate, tissue plasminogen activator (tPA), and hypertonic saline.\(^6\) Each catheter will be labeled with the volume needed for each catheter lumen as determined by the manufacturer. Finally, fluoroscopy should always be used to confirm the placement, catheter tip position, and for identification of any other immediate complications.

Patient Education

Education with individuals that have central venous catheters for dialysis is important. Follow up is especially critical with long-term catheter placement and education should be provided about complications such as infection and clotting. The following points should be emphasized:

- Change the catheter dressing frequently and keep the insertion site clean
- Avoid tampering with the caps at the end of the catheter to avoid air entry
• Avoid showering or swimming (submerging the catheter in water) until cleared by your clinical provider
• Contact your clinical provider immediately for any fever, or redness, tenderness, and drainage from the catheter insertion site
• Utilize good hand hygiene whenever working with catheter

Conclusion

Venous catheters for hemodialysis can play a critical role in the management of chronic kidney disease. With the information in this article, you have a basic knowledge and understanding of some of the options available. With additional research you can be an expert and know all of the “ins and outs” of hemodialysis catheters!

References:


8. Bander SJ, Schwab SJ, Woo K. Central catheters for acute and chronic hemodialysis access. In: UpToDate, Collins KA (Ed), UpToDate, Waltham, MA.


