# Management of Dialysis Access

**Steven P. Woratyla, MD**
*Surgical Specialists of Lancaster*

## ABSTRACT

*The management of end-stage renal disease accounts for a significant portion of healthcare expenditures in the United States. The creation and maintenance of access for both hemodialysis and peritoneal dialysis is a large aspect of this endeavor. Of the two current options for dialysis access, the most common is hemodialysis and the alternative is peritoneal dialysis. The primary component of hemodialysis requires, ideally, the creation of an autologous arterial-venous fistula in the upper extremity. When this is not feasible or reasonable, an arterial-venous shunt is created with a prosthetic graft. An autologous arterial-venous fistula is preferred as it has a superior patency rate, as well as a lower infectious complication rate. Peritoneal dialysis requires the insertion of a catheter into the abdominal cavity and is less popular as it requires more patient involvement in delivering dialysis. Either form of dialysis may be acceptable; however there are circumstances when a patient may choose one form over another. The patient's nephrologist will often guide the decision regarding the most reasonable and logical form of dialysis access while at other times anatomic, economic, or lifestyle considerations will guide the decision. Once the decision is made, the patient will consult with a surgeon in order to undergo a through evaluation regarding candidacy for creation of an arterial-venous fistula, or insertion of a catheter for peritoneal dialysis. This article will discuss various aspects of creation and maintenance of dialysis access in the twenty-first century.*

## INTRODUCTION

The creation and maintenance of dialysis access is the cornerstone of ongoing care of the patient with end-stage renal disease. The ultimate goal for these patients may be renal transplantation, but many patients will not find this possible or feasible, and dialysis can allow them to maintain an active and productive life. The intent of this article is to give the reader a better overall foundation and understanding of dialysis access for the two common forms of dialysis: hemodialysis, and peritoneal dialysis. We will discuss each of these in detail with a focus on creation and maintenance of access for each modality.

## HISTORICAL BACKGROUND

The modern era of hemodialysis access began in the 1960's with the creation of the autologous radial artery to cephalic vein arterial-venous fistula by Drs. Breshcia and Cimino. This allowed, for the first time, a reliable and long-term dialysis access site with relatively few complications. Prior to this innovation hemodialysis access consisted of externally created shunts, such as the Scribner Shunt, or one-time needle access into arteries and veins. These methods were not reliable, they had high complication rates, and they were destructive to the patients' anatomy. The success of the radial to cephalic arterial-venous fistula took hold, and soon other arterial to venous combinations were introduced.

At the same time that hemodialysis was being developed in the 1960's and 1970's, the concept of peritoneal dialysis through a permanent catheter was also taking shape. This method provided an alternative to hemodialysis for patients wishing more control over their own treatment and increased freedom and mobility.

## HEMODIALYSIS ACCESS

Modern hemodialysis access consists of a well created autologous arterial-venous fistula. The underlying strategy is to use the best artery and vein available, so most often the fistula is created in the upper extremity. The cephalic vein and the basilic vein are the primary venous options, while the radial artery and brachial artery are the primary arterial options. Ideally, the first sites chosen for the fistula are in the distal arm, which preserves more proximal sites for future access if and when the primary access site fails. The various combinations of arterial-venous fistulas include: radial-cephalic, radial-basilic, brachial-cephalic, and brachial-basilic. The cephalic vein is located anatomically in an anterior lateral location, which allows easier needle access during dialysis. The basilic vein is located more medially in the arm and often will require translocation in order to accomplish a usable arterial venous fistula. Translocation of a basilic vein is a more complex and time consuming procedure, but when done

correctly will provide the patient with a very useful and very reliable arterial-venous fistula.[1]

Ideally, an autologous arterial-venous fistula requires six to eight weeks to mature. This process may take longer depending on the quality of the patient's inflow artery and outflow vein. Other patient factors may play a role such as the patient's body habitus and blood pressure. The maturation process of an arterial-venous fistula is crucial to its success by allowing time for the fistula to dilate; the increase in diameter provides easier access. It also allows the fistula to thicken and maintain durability over time from repeated access sticks.

Traditionally, approximately 80-85% of autologous fistulas mature enough to support hemodialysis, but this figure can be improved with an aggressive follow up program that utilizes adjuvant techniques to assist in fistula maturation. Often a fistula will require superficialization in the arm if it lies too deep under the skin; or a side branch may need to be occluded to direct primary flow through the main outflow vein. When an autologous fistula is not feasible a prosthetic arterial-venous graft can be placed. Though not as good as a well constructed arterial-venous fistula, a prosthesis can and will support hemodialysis for extended periods. Materials such as Polytetrafluoroethylene or PTFE, also known as Gore-Tex, and the Vectra graft are two of the more common prosthetic graft materials used today. These materials are more prone to infection and have a lower patentcy rate than autologous fistulas, but in some instances they are all that is available to create access for hemodialysis. Bioprostheses are a third option for hemodialysis access, usually in the form of Bovine tissue. Studies have shown that Bovine grafts have similar patency rates to prosthetic grafts with fewer infectious complications.[2]

Overall, the best initial approach to hemodialysis is an autologous arterial-venous fistula; this will give the patient the best chance of long-term maintenance free hemodialysis. This plan does require some forethought as arterial-venous fistulas require approximately 6-8 weeks on average to mature prior to use. When a patient requires more immediate hemodialysis a tunneled catheter may be required. These catheters are less than ideal as they have a high rate of infectious complications as well as leading to significant long-term problems with central vein occlusion. These problems impact the creation and maintenance of upper extremity arterial-venous fistulas. If these catheters are intended to be temporary, they are placed directly into the blood vessels through a skin puncture; if permanent, they are tunneled under the skin and away from the primary insertion site. The latter are intended for use over a few months while waiting for a fistula to mature. The temporary catheter is designed for use over a few days as an inpatient when immediate dialysis is required in a critically ill patient. Ideally it is best to avoid any catheter placement in the central or peripheral veins in a patient requiring dialysis as all of the catheters lead to venous injury such as intimal hyperplasia, scarring and subsequent occlusion of the vein. These veins are then rendered unusable as an outflow vein or for an arterial-venous fistula.

The National Kidney Foundation has put out The Kidney Disease Outcome Quality Initiative in 1997, and updated it in 2006.[3] This initiative is a comprehensive guide to the management of patients with end-stage renal disease.[4] In particular, it addresses the many aspects of vascular access in patients undergoing hemodialysis. One purpose of this initiative was to increase creation of autologous arterial-venous fistulas as the primary access means when suitable for hemodialysis patients. Thus the "Fistula First" initiative was born. The current recommendation is that two thirds or more of hemodialysis patients should have autologous arterial-venous fistulas. The morbidity, mortality, and cost associated with the creation and maintenance of an arterial venous fistula has been shown to be much less than with arterial-venous grafts or central venous catheters. Timely referral of patients with chronic renal insufficiency to a nephrologist will allow appropriate and expedious surgical evaluation for native arterial-venous fistula creation. This will avoid costly and morbid dependency on central venous catheters.

## PERITONEAL DIALYSIS

Because Peritoneal Dialysis (PD) is often done by the patient at home, it can give patients more freedom by not making them committed to centers for dialysis. PD can thus enhance lifestyle in some ways, and may be chosen over hemodialysis. Though an effective method of dialysis, PD does require significant involvement and effort by the patient or a family member. The recent development of home hemodialysis provides an increasingly attractive alternative to home PD.[5]

PD requires a tunneled catheter inserted into the peritoneal cavity as a portal of entry and exit for the dialysate fluid. Catheters are usually inserted laparoscopically during an outpatient surgical procedure and require approximately two weeks of healing prior to use. Peritoneal catheters can become infected and

may have to be removed. Certain conditions, such as multiple prior abdominal operations, poor hygiene, or morbid obesity may obviate the chances of success with peritoneal dialysis.

## MAINTENANCE OF DIALYSIS ACCESS

Maintenance of a hemodialysis fistula plays a very important role in its longevity. Ideally most fistulas should last an indefinite length of time, but many factors may converge to create problems with the fistula. Function of the access is monitored and assessed during each dialysis session. Poor or delayed maturation, difficult sticks, increased venous pressure, or increased recirculation may necessitate evaluation of the fistula.

Physical examination is the initial technique utilized for evaluation. A fistula should be easily visible and easy to cannulate, should have an audible bruit with a stethoscope, and a strong thrill should be palpable. A second step is evaluation by ultrasound, which is noninvasive and provides valuable information regarding the fistula's function. Ultrasound can assess flow rates, depth of the fistula from the skin surface, diameter of the fistula, and velocity of blood flow to assess the presence of a stenosis, which may also be visualized directly with ultrasound. Once a problem is uncovered a fistulagram may be performed. This study is done as an outpatient procedure under local anesthesia, is minimally invasive, and uses intravenous contrast material and fluoroscopy. The fistula is accessed directly and any underlying stenoses can usually be treated with percutaneous balloon angioplasty and/or stenting.

Occasionally, a fistula may be resistant to angioplasty or not amenable to percutaneous techniques and surgical revision may be required. Surgical revision may take the form of a patch over an area of stenosis or a bypass graft around a stenosis or occlusion. Many fistulas can be kept patent for prolonged periods of time with these techniques. The process of maintaining a fistula is challenging and requires a team effort from the patient, dialysis nurse, nephrologist, interventionist, and surgeon. When a fistula does thrombose an attempt can still be made to salvage it by catheter-based minimally invasive means or by surgical revision, but the results of such salvage are marginal. An active maintenance program is much more effective in the long term.

## CONCLUSION

Dialysis access may take many forms. Ideally, patients and physicians plan ahead appropriately and a peritoneal dialysis catheter or an autologous arterial-venous fistula is in place and ready to use by the time a patient requires dialysis. This approach will minimize the need for central venous catheters. Ongoing maintenance of arterial-venous fistulas is crucial to long term success and requires good communication between the patient, nurse, and physician. The ultimate goal is to provide the patient with a functioning access which will support dialysis.

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Steven P. Woratyla, M.D., FACS
Surgical Specialists of Lancaster
2101 Embassy Drive
Lancaster, PA 17603
717-735-7410
SPWoraty@lghealth.org