The PICC Conundrum:

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catheters. Careful attention to venous access decisions should be effective in reducing venous catheter–associated complications and in preserving the veins of patients at risk for needing dialysis in the future so that successful arteriovenous fistulae can be constructed.

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The Scourges of the **Hemodialysis Catheter**

By Anatole Besarab

Hemodialysis (HD) sustains life for those with ESRD. Currently, nearly 400,000 individuals in the United States receive HD as management of ESRD (1). Sustainable vascular access that provides high-volume blood flow rates (Qb) above 300 mL/min is essential, whether through arteriovenous autologous fistulas, synthetic grafts, or tunneled dialysis catheters (TDCs) (2). Unfortunately, the overwhelming majority of incident patients begin HD treatments with a TDC: 82 percent, according to the most recent data from the U.S. Renal Data System (1). More than 20 percent of prevalent patients become or remain dependent on long-term TDC use, spanning months to years (3–5). Other nations, such as Brazil and some in Europe and the Far East, appear to be able to reduce their use of TDCs more quickly and to reduce dependence on long-term TDC use to less than 5–10 percent.

Because of the widespread use of TDCs, research efforts are focused on identifying strategies to prevent and minimize the risk of the most common catheter-related complications—thrombotic occlusion, infection, and central vein occlusion—the three catheter scourges. Proper catheter management to preserve patency and maintain high blood flow rates, reduce the risk of infection, and avoid stenosis is vital in improving patient outcomes.

The first scourge: maintaining patency

The standard procedure for maintaining patency between dialysis treatments, the instillation of heparin into the lumens in a volume sufficient to fill to the lumen tip (the lock) is being replaced by the substitution of a trisodium citrate (TSC) 4 percent lock at many centers. One large Canadian study (6) showed a lower rate of TDC exchange and tissue plasminogen activator (tPA) use without a change in hospitalization for TSC 4 percent versus heparin. On the basis of available evidence, the American Society of Diagnostic and Interventional Nephrology Clinical Practice Committee (7) recommends using a locking solution of heparin 1000 U/mL or TSC 4 percent to maintain TDC patency.

Although a larger-bore catheter design allows an initial rate of blood flow above 400 mL/min to be achieved, virtually all catheters show eventual flow dysfunction manifested as progressive blood flow reductions at prepump pressures considered safe: 200–250 mm Hg.

Prospective monitoring for blood flow dysfunction through systematic monitoring of blood flow and prepump negative arterial pressure (Pa) during HD should be a routine part of the management of patients using TDCs (8) but in many centers it is not. Most large-gauge catheters have a conductance (Qb/Pa) of 2 mL/min/mm Hg. When prescribed blood flow rate (e.g., 350–400 mL/min) is examined serially over time, an increasing negative prepump pressure over time to achieve the prescribed flow reflects alterations in inlet orifice and suggests impending access dysfunction, which may warrant intervention.

Dysfunction manifests as thrombus formation within or at the tip of an HD catheter or by its entrapment within a fibrin sleeve. Systemic anticoagulants and antiplatelet agents have proved to be ineffective in preventing such dysfunction while adding a risk of bleeding. Noninvasive pharmacotherapy with thrombolytic agents has proved to be effective in restoring catheter patency over the short term. All too often, however, adequate flow function can be restored only by catheter replacement with balloon disruption of the fibrin sheath (9), an invasive and costly procedure.

Various protocols for thrombolytic dwells are used by dialysis centers to restore TDC blood flow, usually when the situation is urgent. I favor the slow advancement of the thrombolytic by the injection of saline solution 0.2 mL/lumen behind it every 10–15 minutes to advance the lytic to the catheter tip during a 1-hour dwell, because this strategy decreases the need for repeat lytic dwells by 81 percent (10). Two alternative strategies attempt to improve flow before the development of an "emergency" TDC flow problem: so-called preemptive postdialysis thrombolytic lock or intradialysis lytic infusions. I favor the use of a thrombolytic agent as a prolonged lock of 44–68 hours, both to restore flow and to prevent flow dysfunction. Regular once-weekly use of a tPA agent as a catheter lock solution may be the most effective technique to reduce the risk of vessel occlusion between HD sessions, avoid bleeding risk, and may incur the additional benefit of lower catheter-related bloodstream infection (CRBSI) (11). However, there have been no comparative efficacy or cost studies of the various strategies.

The second scourge: CBRSI

TDCs are responsible for almost half of all infections in HD patients. The infection rates of TDC are 15- and 25-fold higher than those for grafts and native fistulas, respectively. Infection is the leading cause of catheter removal, and CRBSI is a major reason for the loss of anatomic sites for vascular access. CRBSI is associated with substantial morbidity, including metastatic infection. One can estimate from the U.S. Renal Data System and Medicare reimbursement data that there are approximately 100,000 episodes of CRBSI per year in the United States at an average cost of $22,000 per episode (1). CRBSI usually requires catheter removal and 3 weeks of appropriate antibiotics. In some circumstances, catheter removal may be avoided by adding an antibiotic lock to the systemic antibiotic therapy.

Several approaches have been used to decrease the incidence of CRBSI: the use of intravenous antibiotics around the time of catheter implantation; the use of exit-site antimicrobial agents such as honey, mupirocin, and povidone-iodine combined with nasal mupirocin; and the use of antimicrobial-impregnated catheters and antimicrobial locks (AMLs) instilled into the catheter lumen.

Of these, only AMLs and exit-site antimicrobial agents significantly reduce the risk and rate of catheter-related infection and the risk of catheter loss from any complication (12). In a metaanalysis, the use of AMLs resulted in a 75 percent reduction in the risk of CRBSI (12) and only one published study showed the emergence of resistant organisms. Despite the demonstrated effectiveness of AMLs in reducing CRBSI, there is obvious reluctance to their use because of the potential for the development of bacterial drug resistance. Given that the U.S. Food and Drug Administration is unlikely to approve an antibiotic lock, current research focuses on the use of antimicrobial agents, usually combinations of several agents that prevent biofilm formation (13).

The third scourge: central vein stenosis and occlusion

The insertion of a large-bore catheter into a central vein is all too frequently associated with the development of stenosis within that vein. Central vein stenosis is catastrophic when it develops on the side of an established or maturing permanent access, graft, or native fistula, and it all too often precludes the placement of permanent access in the ipsilateral upper extremity. When such catheters are placed in the inferior vena cava, stenosis of the iliac vein can compromise the placement of a kidney graft. Strategies considered to reduce such stenosis include self-centering catheters and catheters configured to support themselves at opposite points of the superior vena cava. Inasmuch as longer catheter dwell times increase the development of central vein abnormalities, and catheter-related infection appears to promote stenosis, it is imperative to keep a TDC as short as possible and prevent infection.

Although catheters offer several advantages in the acute setting, acting as a bridge to more permanent vascular access, continued improvement in the design and performance of catheters is needed. Future studies should focus on better defining the prophylactic use of thrombolytic agents as locking solutions and the appropriate use of AMLs. Clearly, we need improvements in the process of care to reduce the fraction of patients in whom HD is begun with a TDC.

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Peritoneal Dialysis and the Interventional Nephrologist

By Anil Agarwal

The incidence of ESRD is increasing, with a current prevalence of over half a million patients in the United States. Most ESRD patients are treated with hemodialysis (HD) and the number of patients receiving peritoneal dialysis (PD) has steadily declined over the past several decades. According to the U.S. Renal Data System 2011 annual report, approximately 7 percent of patients were being treated with PD at the end of 2009, reflecting gross underuse of this form of therapy (1). Of the incident patients, dialysis was initiated using PD in only 6.1 percent.

The growth in the number of interventional nephrologists during the past decade has established a new paradigm of approach to vascular access and to PD catheter placement. The safety of these procedures and the growth of the PD patient population in the interventional nephrology programs that perform PD catheter placement have been well documented. Interventional nephrologists are uniquely poised to improve the use of PD by highlighting and capitalizing on the following attributes.

Biological benefits of PD

PD offers several advantages over HD including better autonomy, improved patient satisfaction, superior volume control, and better initial survival. The mortality and morbidity in incident HD patients is much higher than in incident PD patients. Inasmuch as HD is started with a catheter in nearly 80 percent of patients, almost all of this early mortality has been attributed to catheters (2). Improving processes to achieve nephrology care early to avoid catheter use will be needed to decrease this early disparity in the future. Meanwhile, the ready placement of PD catheters by interventional nephrologists to initiate dialysis using PD or as a bridge access will remain an easy approach to curtail high incident mortality.

Financial benefits

The recent enactment of a prospective payment system (popularly known as the "bundle") offers even greater incentive to providers if PD is used instead of HD. Furthermore, PD catheter placement is now reimbursed at a much more favorable rate, especially if imaging is used. Given that interventional nephrologists use a peritoneoscopic or fluoroscopic approach, the financial gain should provide impetus to improve PD use.

Counteracting challenges to offering PD

Late referral, poor modality education or offering to patients, lack of new physician training in PD, and delay in PD catheter placement often result in missed opportunities. By offering PD and expeditiously placing the PD catheter without delays in scheduling, interventional nephrologists have the ability to increase PD use. Indeed, PD catheter placement by interventional nephrologists has been reported to improve PD use. Gadallah et al. reported a significant increase in the fraction of incident patients choosing PD from 19 percent to 76 percent with placement of the PD catheter by interventional nephrologists, almost tripling the prevalent PD population (3). The results were confirmed by a multicenter study that showed not only an increase in the PD population at centers providing PD catheter placement by interventional nephrologists but also a decline in the PD population when interventional nephrologists discontinued placing PD catheters (4). Perhaps the fact that the PD population increased is also a testament to the dedication of the providers of this modality.

Improving awareness and training

PD catheter placement by interventional nephrologists is also likely to result in increased awareness and interest by the provider and in better education of trainees. Because the nephrologist is likely to provide significant continuity of care to the patient, better outcomes are likely.

Technical aspects

Interventional nephrologists can place PD catheters with ease using peritoneoscopy or fluoroscopy. As opposed to open surgical dissection or laparoscopic placement, peritoneoscopic placement uses a much smaller scope (2.2 mm in diameter), a small puncture size, one peritoneal puncture site, local rather than general anesthesia, and freedom from scheduling delays, making outpatient same-day placement a possibility. As mentioned earlier, the reimbursement policy for PD catheter placement is now more favorable.

Safety of PD catheter placement by interventional nephrologists

Published data on PD catheter placement by interventional nephrologists does not indicate a higher incidence of complications than with those placed by surgeons. A randomized trial compared the peritoneoscopic and surgical techniques and found that early peritonitis episodes (occurring within 2 weeks of catheter placement) and exit-site leaks were higher in the surgical group than in the peritoneoscopic group (5). PD catheter survival with peritoneoscopic placement was significantly better at 12, 24, and 36 months, and the overall catheter failure rate was higher in the surgical group. Similar results were shown in a separate randomized study (6). The avoidance of various complications by peritoneoscopic placement may relate to the decreased tissue dissection required with this technique.

Interventional nephrologists can also manage most of the complications. Bowel perforation can be a serious complication of the peritoneoscopic technique. However, a study of 750 PD catheter insertions performed by nephrologists using this technique found a low incidence (0.8 percent) of bowel perforations. All of these events were diagnosed and managed by the nephrologists (7). When a Veress needle (blunt, self-retracting end, smaller gauge) was used instead of a trocar, a study of 82 consecutive PD catheter insertions showed no bowel perforation (8). This technical modification deserves consideration.

A PD catheter that has migrated to the upper part of the abdomen can often be repositioned with use of a Foley catheter, or a new catheter can be reinserted during the same procedure, avoiding transfer to HD, placement of a hemodialysis catheter, and interruption of PD. Catheter insertion has also been shown to be successful in patients with a history of abdominal surgery and intraperitoneal adhesions. Thus, patients with previous abdominal surgery should not be summarily denied this procedure. The peritoneoscopic technique is able to identify intraperitoneal adhesions and determine a patient's suitability for catheter placement.

In conclusion, interventional nephrologists can safely perform PD catheter insertion using imaging. This paradigm of care has great potential to improve the use of PD.

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