

Acute Dialysis Catheters

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ABSTRACT

Acute dialysis catheters are non-cuffed, non-tunneled catheters used for immediate vascular access. They are primarily used for acute renal failure in bed-bound patients and for short-term use in patients with malfunction of permanent access. Long-term use of acute catheters is not recommended, but does occur with acceptable infection rates in dialysis centers where tunneled, cuffed catheters are not available. Most acute catheters are made of polyurethane, but silicone catheters are now available with larger lumen sizes capable of delivering blood flow rates over 300 ml/min. Acute catheters

should be inserted in the internal jugular or femoral vein under ultrasound guidance to minimize complications. Subclavian catheters cause stenosis, thrombosis, and perforation of vessels. Intermittent catheter malfunction still occurs, particularly for left-sided internal jugular catheters and catheters placed in women. Blood flow may improve with lumen reversal, intraluminal t-PA, or guidewire exchange. Limiting duration of use and dressing catheter exit sites with dry gauze and antiseptic ointments can prevent catheter-related infections.

Acute dialysis catheters are vital for achieving immediate vascular access. While their role has lessened with the widespread availability of tunneled dialysis catheters, they are still used primarily in three settings. Acute femoral catheters are used in bed-bound critically ill patients with acute renal failure and for "in and out" use in patients with temporary loss of permanent access. Acute internal jugular catheters are used in ambulatory patients at centers not using tunneled dialysis catheters.

Use of acute catheters is greater for incident compared to prevalent hemodialysis patients and generally greater in the United States than in Europe. Preliminary data from the Dialysis Outcomes and Practice Patterns Study (DOPPS) study show 14% of patients in Europe and 34% of patients in the United States begin dialysis with an acute catheter (1). The prevalence of acute catheters in chronic hemodialysis patients is 4% and 15% for Europe and the United States, respectively. Patients referred late for dialysis are more likely to require an acute dialysis catheter (2).

Acute Catheter Design and Insertion

Most acute catheters are non-cuffed, non-tunneled, dual-lumen catheters composed of polyurethane

which is strong, permitting larger internal lumens for a given outer diameter of the catheter. Polyurethane is stiff at room temperature to facilitate insertion, but softens at body temperature. It has replaced Teflon and polyvinyl because it is less thrombogenic. New acute catheters composed of silicone or silicone elastomer are available, but may require an inner stylet for insertion.

Various catheter lengths accommodate proper positioning of the distal tip. The tip of catheters placed in the neck and groin should reside in the superior vena cava and inferior vena cava, respectively. In general, 15 cm catheters are inserted in the right internal jugular, 20 cm catheters in the left internal jugular, and 20 cm or 24 cm catheters in the femoral vein. The outer diameter of catheters ranges from 11 to 14 French. Curved extensions increase comfort for patients when acute catheters are placed in the internal jugular vein.

Placement of acute catheters is usually performed at the bedside using standard sterile techniques. If available, bedside ultrasound (e.g., Site-Rite) should be utilized to view vein anatomy prior to insertion or permit real-time insertion. High-quality studies conducted in the intensive care unit have demonstrated that ultrasound guidance reduces the number of needle passes, failed placements, and insertion-related complications. Inexperienced operators increase their success rate to 95% with the use of ultrasound guidance (3). Ultrasound imaging is a valuable tool in caring for dialysis patients because 28–35% have significant vein abnormalities, such as total occlusion, non-occlusive thrombus, stenosis, and anatomic variation (4, 5).

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Insertion-Related Complications from Acute Dialysis Catheters

Nephrologists inserting acute catheters should be aware of the immediate and late complications. The risk of insertion-related complications varies according to the skill of the operator, site of insertion, and use of imaging equipment such as ultrasound and fluoroscopy. The average risks of the most commonly reported insertion-related complications available in the literature are summarized in Table 1. In addition to those complications listed, brachial and laryngeal nerve palsy may also occur, although rarely (6, 7).

Late Complications from Acute Dialysis Catheters

Late complications from acute dialysis catheters include central vein stenosis/thrombosis, vessel perforation, cardiac tamponade, and hemomediastinum. Central vein stenosis and thrombosis are more common with subclavian catheters. In prospective studies, stenosis/thrombosis complicates up to 28% of subclavian dialysis catheters, and infection further increases the risk (8). For this reason subclavian catheters should be avoided if possible. They are contraindicated if the patient is expected to require future permanent access on the same side as the catheter. Acute catheters in the internal jugular vein caused thrombosis/stenosis in only 2% of cases surveyed with ultrasound in one study (9). Because acute catheters are relatively stiff, they have been associated with perforation of vessels and of the right atrium. Perforation causing hemomediastinum or cardiac tamponade complicates up to 0.5% of subclavian catheters (7,10). Tricuspid regurgitation, pseudotumor cerebri, pseudoaneurysms, carotid jugular fistulas, and lymphorrhea has also been reported (11-14).

Acute Dialysis Catheter Malfunction

Catheter malfunction occurs when a catheter is unable to provide sufficient blood flow for adequate dialysis. The actual corresponding blood flow rate will depend on the situation. Only 100-150 cc/min of blood flow is required for continuous renal replacement, so catheter malfunction is rare in this setting. The metabolic complications

of acute renal failure can usually be corrected with intermittent dialysis at blood flow rates of 200-300 ml/min. Ambulatory patients usually require blood flow rates in excess of 300 ml/min with minimal recirculation to achieve a Kt/V of 1.2 or urea reduction ratio of 65%.

Previous prospective studies of acute dialysis catheters report mean blood flow rates of 254-298 cc/min with recirculation ranging 3-10% (15,16). Recirculation increases to 18% in short femoral catheters (15 cm) at blood flow rates of 250-ml/min (17). Recirculation also increases if the lumens of well-functioning catheters are inadvertently reversed (18).

We recently performed a randomized comparison of acute dialysis catheters to determine if a newly designed catheter offered advantages over our standard catheter (19). Blood flow was maximized by protocol to highlight any potential differences, and blood flow over the entire use of the catheter was compared. All catheters were placed in either the interval jugular or femoral vein. The results showed that both the Two-Lumen catheter (Arrow Int'l Inc., Reading, PA, U.S.A) and the newly available Niagara catheter (Bard Access Systems, Salt Lake City, UT, U.S.A.) were capable of delivering blood flow rates well over 300 ml/min with acceptable recirculation (Table 2). The newer catheter design was associated with modest improvement in blood flow. Independent of catheter design, acute dialysis catheters in the left internal jugular vein provided blood flow rates of 103 ml/min, less than catheters in the right internal jugular vein. These results further support the placement of dialysis catheters in the right internal jugular vein whenever possible. Blood flow rates were also significantly lower in catheters placed in female patients (-36 ml/min) compared with male patients. Reversal of catheter lumens to improve blood flow was required in 27-57% of dialysis treatments and 19-22% of catheters required guidewire exchange for low blood flow.

Another study has shown guidewire exchange for malfunction does not increase the risk of infection (20). Intraluminal t-PA (2 mg) can be used but it has primarily been tested in tunneled dialysis catheters (21).

Infection from acute dialysis catheters

The risk of infection from dialysis catheters depends on the catheter design, location, duration of use, and practices to prevent infection. Since acute dialysis

TABLE 1 Incidence of complications during acute catheter insertion

Complication	Incidence (Range)
Arterial puncture	4.4% (0-12%)
Local bleeding	4.0% (0-16%)
Pneumo/Hemothorax ^a	2.0% (1-3%)
Air embolism	0.6% (1-1.3%)
Retroperitoneal bleeding ^b	0.6%

^a Primarily reported for acute catheters inserted in subclavian vein. The incidence in studies including internal jugular catheters is ~0.6%.

^b Acute dialysis catheters inserted in femoral vein.

TABLE 2 Catheter performance by acute dialysis catheter type

	Arrow Two-Lumen	Bard Niagara
N	36.0	40.0
Mean blood flow, ml/min	320.0	349.0 ^a
Lumen reversal, %	27.0	57.0 ^b
Recirculation, %		
Normal lumen polarity	5.1	2.4
Reversed lumen polarity	7.7	9.1
Catheter replacement for poor blood flow, No. (%)	7.0 (19)	9.0 (22)

^a $p < 0.05$, compared with the standard catheter.

^b $p < 0.01$, compared with the standard catheter.

TABLE 3. Infection from acute dialysis catheters compared with tunneled dialysis catheters

Type of infection	Acute no. per 1000 CDs (%)	Tunneled no. per 1000 CDs (%)
Bacteremia	6.2 (10.0)	1.8 (39)
Exit site infection	3.6 (9.0)	1.4 (22)
Tunnel infection	NA	0.02 (0.2)
Distant infection*	1.1 (1.6)	0.4 (5.3)

* A distant infection includes endocarditis, spinal abscess, osteomyelitis, septic arthritis, and septic death.

CD, catheter days; NA, not available.

catheters are not cuffed or tunneled, they generally have higher rates of infection than tunneled dialysis catheters (Table 3). It should be noted that while the rate of infection is higher (infections per 1000 catheter days) for acute catheters, the risk of infection (incidence) is lower compared with tunneled catheters because of the shorter duration of use.

The exact relationship between duration of use and risk of bacteremia was highlighted in our prospective study of 211 patients with acute catheters (20). We found the risk of catheter-related bacteremia from acute catheters increased over time in an exponential fashion at both the femoral and internal jugular site. While the risk of infection at the femoral site was always greater than at the internal jugular site, the instantaneous risk (hazard) of bacteremia at the femoral site increased after 1 week compared with 3 weeks at the internal jugular site (Figure 1). In addition, if an exit site infection occurred and the catheter was left in place, the risk of bacteremia rose from 2% at 24 hours from onset of exit site infection to 13% at 48 hours.

These findings support the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) guidelines to limit acute dialysis catheter use in the femoral vein and internal jugular vein to 1 and 3 weeks, respectively, and to remove catheters immediately if an exit site infection occurs (22). Catheter-related bacteremia from acute catheters should be treated with immediate catheter removal and appropriate antibiotics.

Despite these recommendations, some centers manage patients for months to years with "acute" dialysis

catheters. One study reports a bacteremia rate of only 1.2 per 1000 catheter-days with long-term use (23). Of note, this center uses dry gauze and providone to dress catheter exit sites. Both providone and mupirocin ointments with dry gauze dressings have been shown to significantly reduce the risk of bacteremia from acute dialysis catheters in randomized controlled trials (24, 25).

Recommendations

Acute dialysis catheters are essential for providing immediate vascular access. Some centers use acute dialysis catheters only in the femoral vein for bed-bound patients or for "in and out" insertions for urgent dialysis. Other centers use acute catheters in the ambulatory dialysis patient to provide access over longer periods of time. All acute catheters should be placed in the femoral or internal jugular veins if possible. The subclavian vein site should be avoided to reduce overall catheter-related complications, particularly subclavian stenosis. Right internal jugular catheters provide superior blood flow and are less likely to require exchange for malfunction. The catheter should be positioned so the tip is in the superior vena cava rather than the right atrium. To prevent excessive recirculation, femoral catheters should be of sufficient length (20–24 cm) so that the tip is in the inferior vena cava. Ultrasound should be used to survey anatomy prior to insertion and/or it should be used in real time to reduce complications and increase the success rate of insertion.

Dressing the exit site with antiseptic ointments and dry gauze dressings reduces the risk of infection. If an exit site infection occurs, the catheter should be removed immediately if possible. Catheter-related bacteremia should be treated with immediate catheter removal and appropriate antibiotics.

Newly designed catheters are softer and provide moderately increased blood flow rates, but the clinical significance of these differences is unknown. Poor blood flow can be safely treated with lumen reversal, t-PA, or guidewire exchange.

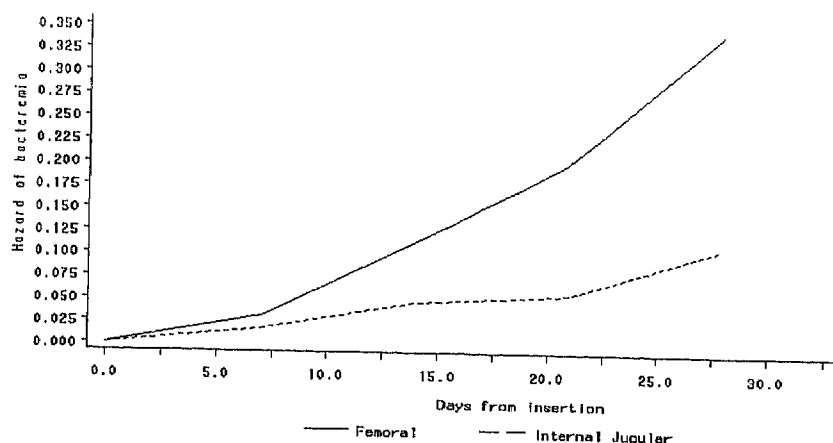


Fig. 1. Risk of bacteremia from acute dialysis catheters placed in the femoral and internal jugular vein. The slope of the line estimates the instantaneous risk (hazard) of infection. The risk of infection for femoral lines is always greater than for internal jugular catheters. The risk of infection for femoral catheters and internal jugular catheters increases at 1 week and 3 weeks, respectively. Reprinted with permission from Oliver MJ et al. (20).

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