Prevention and Treatment of Dialysis Catheter Malfunction and Infections

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Catheter Malfunction & Infection

- Fibrin Sheath
- Thrombus
- Biofilm

Catheter Malfunction

Catheter Infection
Simplified Pathogenesis

Similar classifications for etiologies of malfunction and infection

Intraluminal

Extraluminal
Malfunction

Definition and Implications

Catheter that delivers blood flow <300ml/min
(at pre-pump arterial pressure more negative than -250 mmHg)
K-DOQI

Intraluminal Thrombi

Poorer flows → Poor dialysis adequacy =
Longer dialysis time
Catheter Malfunction

Early: Positional/ Tip malposition

Late: Occlusions

• Intrinsic
  • Intraluminal thrombus

• Extrinsic
  • Fibrin sheath
  • Mural thrombus
  • Right atrial thrombus

K/DOQI Recommended Catheter Position

• Internal jugular vein
• Tip at mid right atrium
• Fluoroscopic guidance is mandatory for accurate tip placement
Early Malfunction: Catheter Kinks

Sometimes due to fibrous band at venotomy site
Late Catheter Malfunction

Remember: Late complications can occur early and early complications can occur late

Intrinsic occlusions
• Intraluminal/tip thrombus

Extrinsic occlusions
• Fibrin sheath
• Mural thrombus
• Atrial thrombus
Late Malfunction: Intrinsic Thrombus

Etiology

• Occurs intraluminally or at tip
• Inadequate anticoagulant fill
• Loss of anticoagulant from catheter
• Failure to clear blood from catheter post dialysis

Prevention

• Forceful flush post use
• Use adequate anticoagulation
• Adequate intradialytic locking heparin or citrate concentration
• Overfill catheter by 0.1 or 0.2 cc of locking solution
• Clamp port securely with syringe attached
Late Malfunction: Fibrin Sheath

Comprised of:
organized thrombus,
collagen,
endothelial and inflammatory cells
Treatment: Fibrin Sheath

Disruption by balloon angioplasty, gooseneck snare stripping, embolectomy balloons, disruptions via catheter exchange (CXG), thrombolytic infusions

Fibrin sheath disruption/stripping
• Initial success ≈ 75-98%; Primary patency ≈ 30-90 days

Concerns & Complications
• Invasive (approach via femoral vein)
• Fem v. puncture thrombosis /groin hematoma, inominate v. thrombosis
• Safety of embolization of sheath/thrombus? Pulmonary emboli?
• Unproven efficacy via RCTs and $$
  • Gray et. al (2000) – FSS=UK
  • Merport et. al (2000) – CXG >FSS
  • Oliver et al (2007) – AP disruption>XCG ; (Qb & PRU)
Extrinsic Occlusions

Mural thrombosis

• Attached to the wall of vessel at point of contact
• Likely related to mechanical trauma
• Catheter tip often incorporated

• Asymptomatic, problem related to malfunction
• Recognized only when catheter malfunctions (venogram)
• Management: remove catheter and anticoagulate
Extrinsic Occlusions

Right Atrial thrombus
- Rare but serious

Etiologies:
- Elongation of intraluminal thrombus
- RA endothelial damage from CVC tip

Presentation:
- Mostly asymptomatic
- CVC malfunction
- Pulmonary systemic emboli
- Incidental mass within RA (2D echo)

Management
Consider:
- Symptomatic or not
- Other problem? Sepsis?
- Candidate for anticoagulation/fibrinolysis?
- Does patient have functional permanent access?

Treatment Options:
- Remove CVC
- Anticoagulate x 6 mos
- TPA infusion e.g. 1mg/hr x 12-24 hrs
- Surgical thrombectomy
Importance of Infection in Hemodialysis

• Most common cause of morbidity
• 2nd most common cause of death
• Majority of infectious deaths due to bacteremia
• Vascular access is a main source of bacteremia
• Catheters are the vascular access type associated with the highest risk
• Catheter related bacteremia rate reported: 0.5-6.5/1000 catheter days
• Avg. cost $22 000 USD /bacteremia

• Infection can be prevented
Catheter Related Bacteremia: Key Risk Factors

- Catheter site: Femoral > IJ > subclavian
- Catheter characteristic: Non-cuffed vs. cuffed, Non-tunneled vs. tunneled
- Prolonged duration of catheter use
- Thrombosis of the catheter
- Patient “stressed state”
  - Recent surgery
  - Diabetes
  - Immunocompromised
- Poor hygiene
- Previous bacteremia
Early Infection
(via Extraluminal route of bacteria entry)

Bacteria from exit site track down the catheter into the catheter tip

Early Infection is often due to SKIN CONTAMINATION
Later Infection
(via Intraluminal route of bacteria entry)

- Caused by touch/hub contamination
- Frequent problem with hemodialysis catheters

Other (time independent)
- Hematogenous seeding (uncommon)
- Infected infusate (rare)

I am tough to eradicate because of biofilm!
Biofilm on a Catheter

• A biofilm is derived sessile community, characterized by cells that are irreversibly attached to a substratum or to each other, embedded in a matrix of exopolysaccharide that they have produced

• Ultimate result is the creation of a layer of exopolysaccharide that coats the biofilm and can protect it from inhospitable environments

• Pathogenesis of biofilm development to fibrin sheath formation is not well understood
Extraluminal Prophylaxis at Exit Site

RCT Evidence

• Prevention of hemodialysis subclavian vein catheter infections by topical poviodine-iodine (Levin, A. et. al. KI 1991)

• Prophylaxis with mupirocin at exit site (Sesso R. et. al., JASN 1998; Johnson DW et. al, Nephrol Dial Transplant 2002)

• Prophylaxis with Honey (Medihoney) (Johnson D.W., JASN 2005)

• Prophylaxis with Polyantibiotic Ointment at exit site (Lok, C.E. et. al., JASN 2003)

• Long term outcomes with Polyantibiotic Ointment (Battistella, M. et. al., AJKD 2011)
Intraluminal Prophylaxis with Antibiotic Lock (ABL) solutions

At least 4 meta-analysis & 2 systematic reviews on prophylaxis with ABL/AML: ↓ CRB ↓ ESI ↓ CVC loss

Allon, M. AJKD 51(2); 2008
PRECLOT Study: Prevent thrombosis to improve malfunction & infection

Hemmelgarn B et al, NEJM;364; 303-311, 2011

Multi-centre double blinded RCT

Received

- Heparin 5000U/ml
  N=115

- TPA 1 mg/lumen
  N=110

Primary outcome: Catheter malfunction
Secondary outcome: Catheter related bacteremia
PRECLOT Study: Prevent thrombosis to improve malfunction & infection

- 225 patients randomly assigned undergoing long-term hemodialysis in whom a central venous catheter had been newly inserted to a catheter-locking regimen of heparin (5000 U per milliliter) three times per week or recombinant tissue plasminogen activator (rt-PA) (1 mg in each lumen) substituted for heparin at the midweek session (with heparin used in the other two sessions).

- The primary outcome occurred in 62 patients — 22 (20.0%) in the rt-PA group and 40 (34.8%) in the heparin group (hazard ratio with heparin vs. rt-PA, 1.91; 95% confidence interval [CI], 1.13 to 3.22; P = 0.02).

- The secondary outcome, catheter-related bacteremia, occurred in 5 patients (4.5%) assigned to receive rt-PA and 15 patients (13.0%) assigned to receive heparin alone (hazard ratio with heparin, 3.30; 95% CI, 1.18 to 9.22; P = 0.02).

Hemmelgarn B et al, NEJM;364; 303-311, 2011
Summary

- Catheter malfunction and infection a major cause of morbidity and mortality in dialysis patients
- Thrombus and fibrin sheaths play major roles in catheter malfunction
- Biofilm formation plays a major role in catheter infection
- Prophylaxis at exit and intraluminally within the catheter has shown effective to reduce catheter-related bacteremia