

# **Prevention and Treatment of Dialysis Catheter Malfunction and Infections**

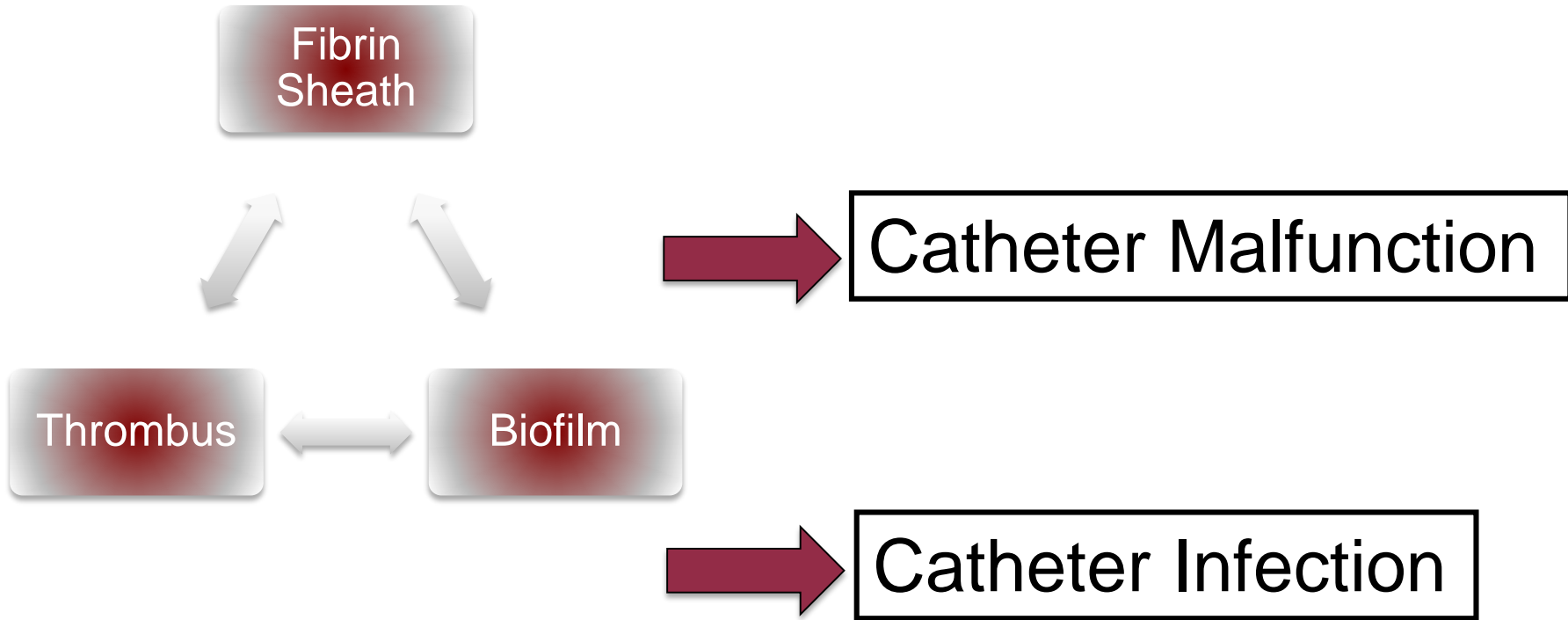
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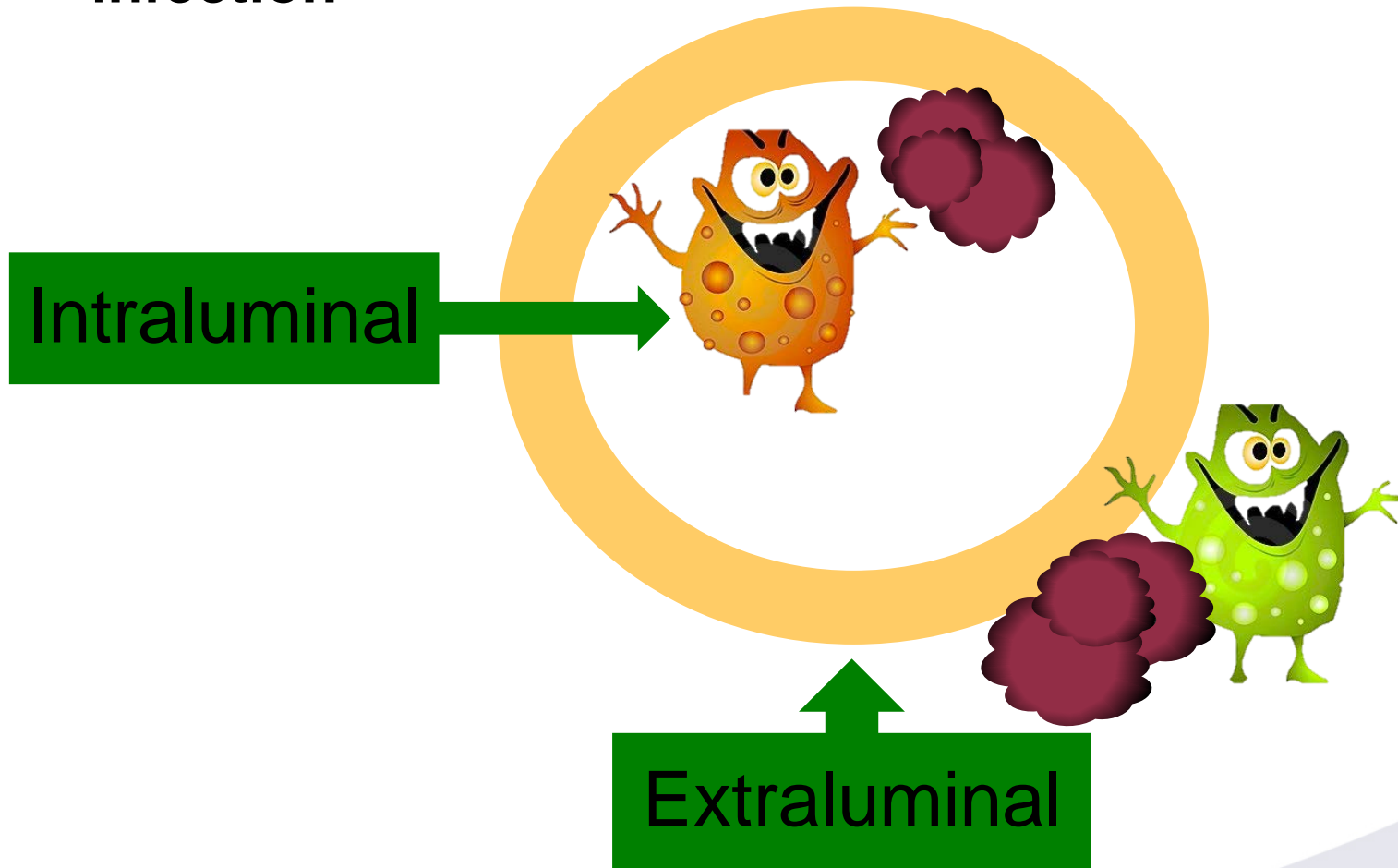
**Toronto, On. Canada**

# Catheter Malfunction & Infection



# Simplified Pathogenesis

Similar classifications for etiologies of malfunction and infection



# Malfunction

## Definition and Implications

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



Poorer flows  $\rightarrow$  Poor dialysis adequacy =  
Longer dialysis time

# Catheter Malfunction

## Early: Positional/ Tip malposition

## Late: Occlusions

- **Intrinsic**

- Intraluminal thrombus

- **Extrinsic**

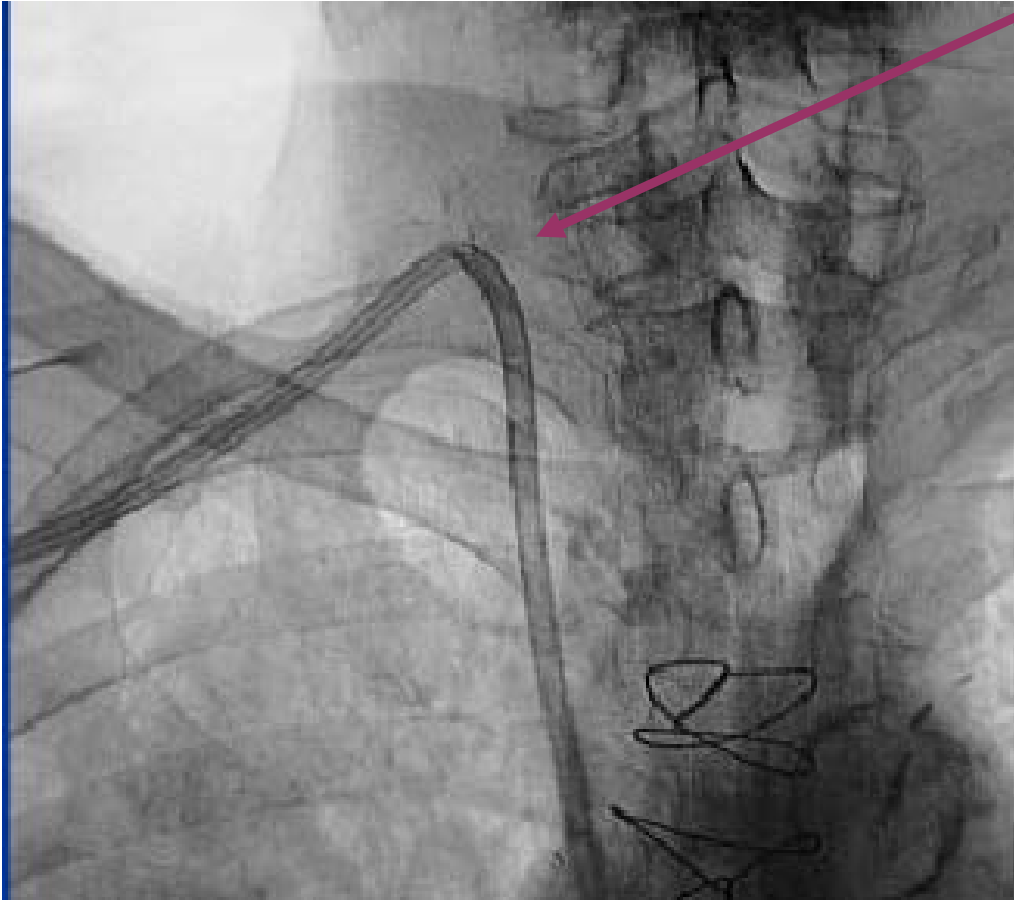
- Fibrin sheath
- Mural thrombus
- Right atrial thrombus

## 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

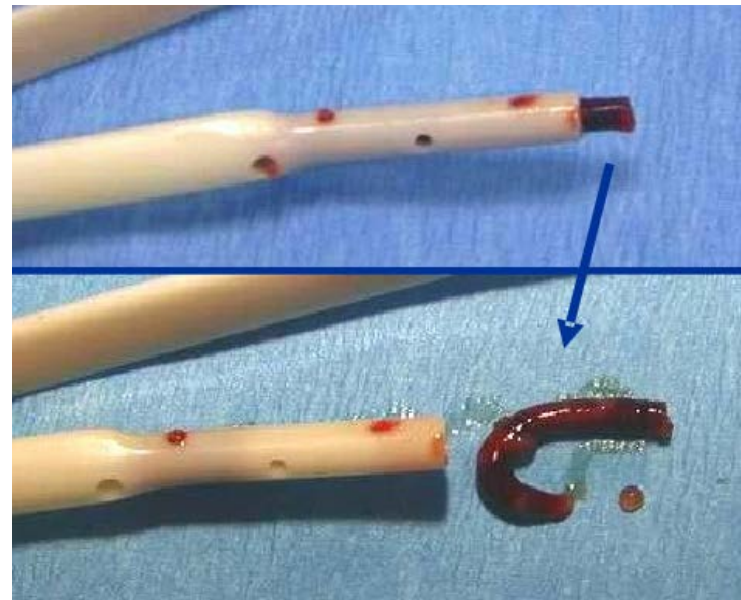
*Remember: Late complications can occur early  
and early complications can occur late*

## 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  $\approx$  75-98%; Primary patency  $\approx$  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

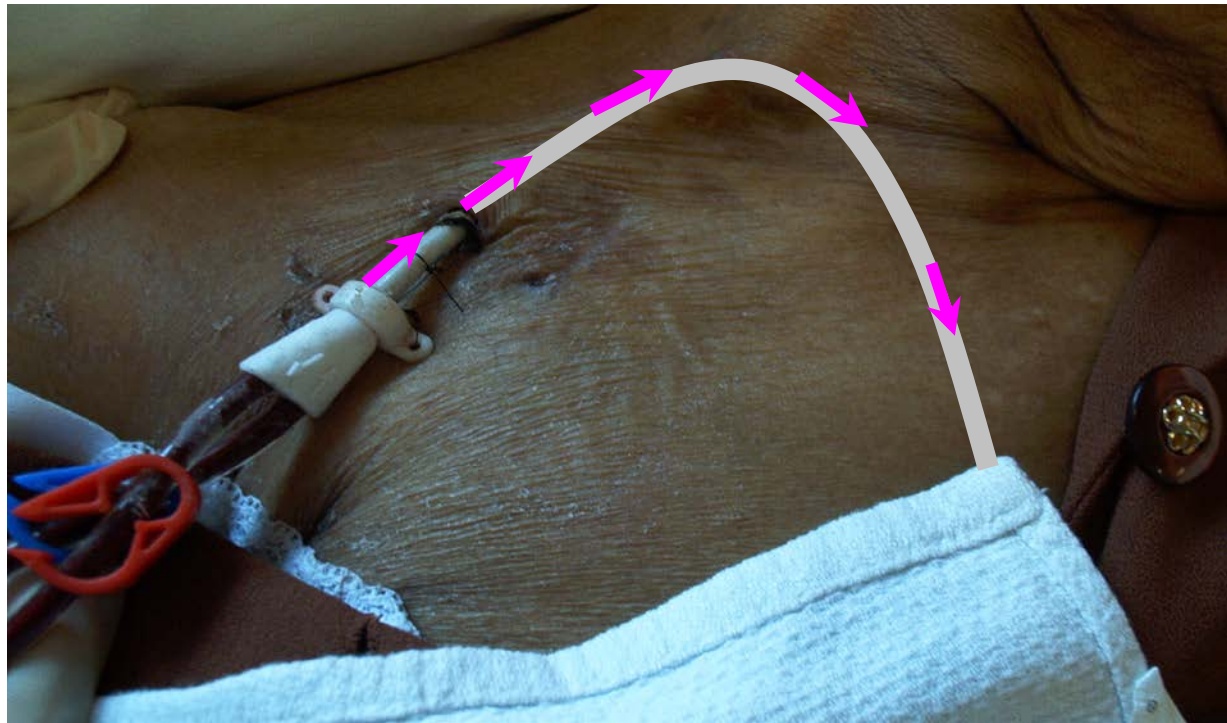
# Catheter Related Bacteremia: Key Risk Factors

- 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

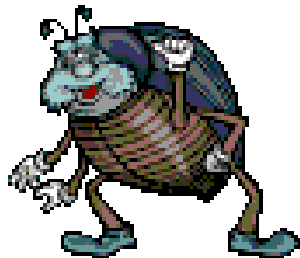
(via Intraluminal route of bacteria entry)

- 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!



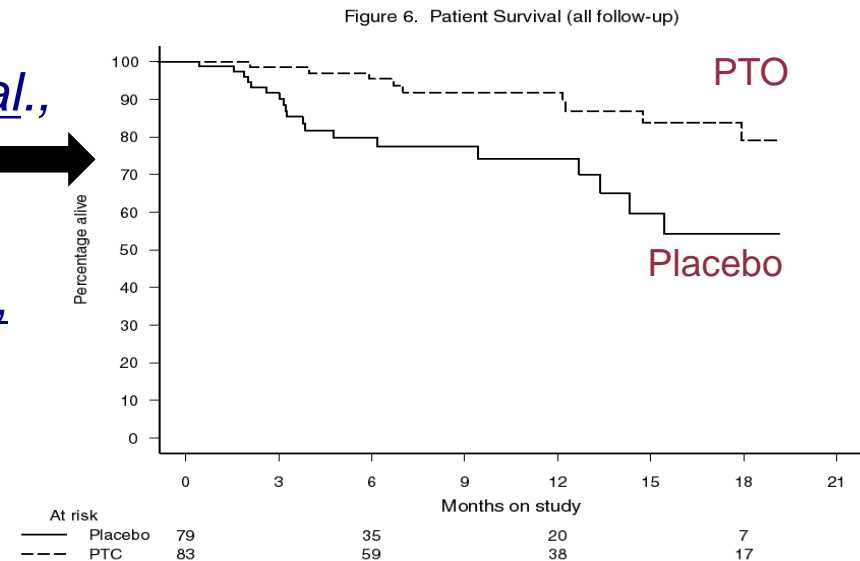
# Biofilm on a Catheter

- 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

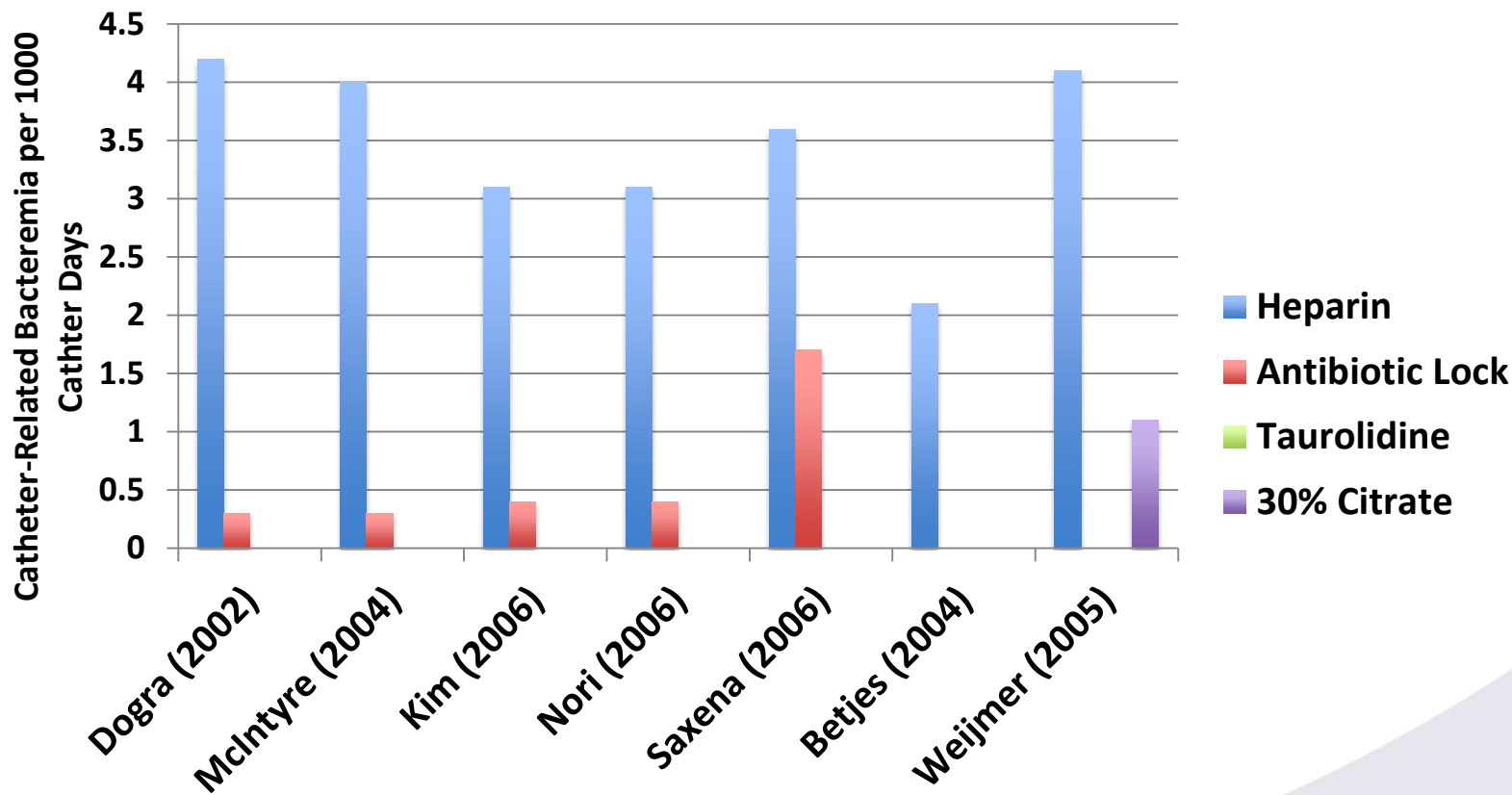
## RCT Evidence

- Prevention of hemodialysis subclavian vein catheter infections by topical povidine–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

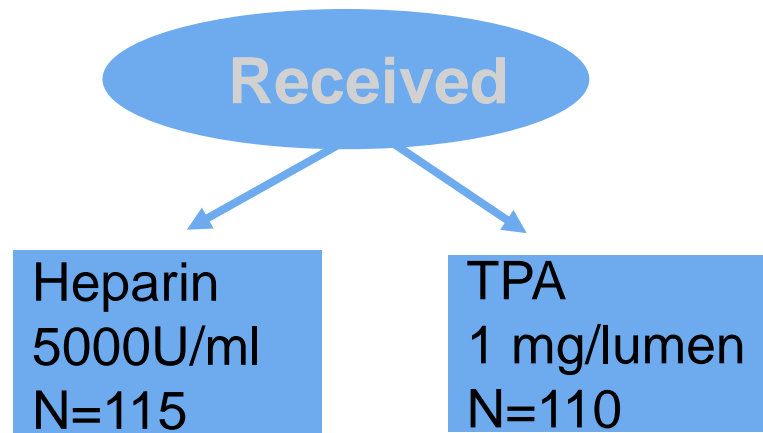
At least 4 meta-analysis & 2 systematic reviews on prophylaxis with ABL/AML : ↓ CRB ↓ ESI ↓ CVC loss



# PRECLOT Study: Prevent thrombosis to improve malfunction & infection

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

Multi-centre double blinded RCT



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)

# 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**