Catheter Locks, Dressings, & Coatings

What Works? Evidence-Based Strategies

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Agenda and Objectives

Clinical Burden

Epidemiological impact of CRBSI and economic data from VA/Hospital systems.

Locks (ALT)

Antibiotic Lock Therapy vs. non-antibiotic/antiseptic options like Taurolidine.

Barrier Tech

Evidence review for CHG-impregnated dressings and sustained release gels.

Site Ointments

The KDOQI bundle: Mupirocin vs. Triple Antibiotic protocols in clinical practice.

Coatings

Material science in coatings: Minocycline/Rifampin, Silver, and Bio-polymers.

Synthesis

The Evidence Matrix: Defining the optimal "Access Prevention Bundle."

The "Catheter First" Reality

- **Critical Prevalence:** Over 85% of US patients initiate hemodialysis via CVC.
- **Infection Risk:** CRBSI is the leading cause of morbidity in this cohort.
- HD CVCs carry a 2–3× higher risk of infection-related hospitalization vs. AV access
- **Infection Rates:** Estimated 1.1 to 2.5 episodes per 1,000 catheter days.
- **Financial Impact:** CRBSI management costs exceed $20,000–$30,000 per episode.
- **Patient Outcome:** Associated with a 2-fold increase in mortality risk.

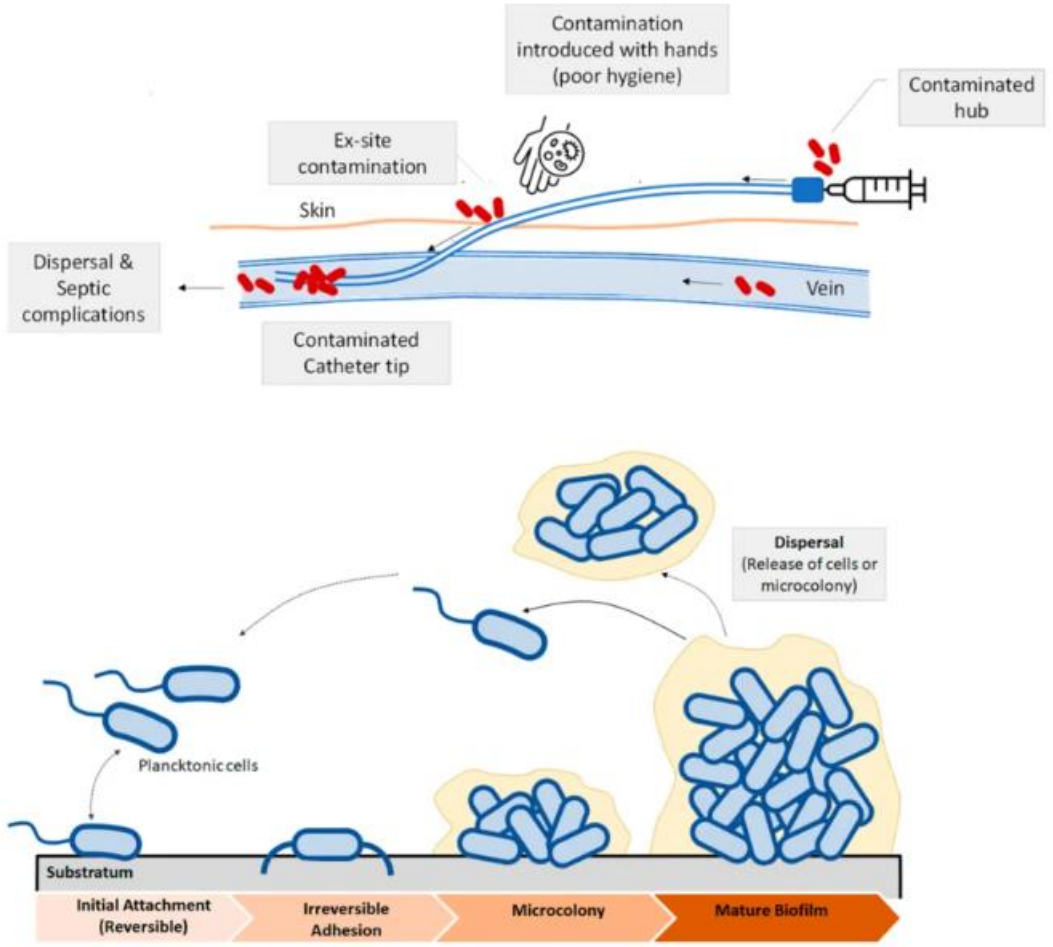


Mechanism of Infection: Biofilms

Two Primary Pathways

- **Intraluminal Path:** Hub contamination leading to internal biofilm
- **Extraluminal Path:** Migration from the skin exit site

Biofilm Maturity: Develops within 24–48 hours; extremely resistant to standard antibiotics



(Top) Schematic view of biofilm formation in different regions of a venous catheter. Microbial contamination may come from the catheter hub, the patient's skin, due to the lack of skin antisepsis or from the bloodstream. (Bottom): Biofilm development and dispersal of bacteria or microcolonies.

Catheter Locks

- **Standard of care: Heparin lock** (1,000–5,000 U/mL) — maintains patency but does NOT prevent infection
- Heparin may actually promote biofilm formation and antagonize some antibiotics
- Categories of lock solutions:
  - **Anticoagulant only** (heparin, citrate)
  - **Antibiotic locks** (gentamicin, cefazolin, vancomycin ± combinations)
  - **Non-antibiotic antimicrobial locks** (taurolidine, ethanol, EDTA, methylene blue)
  - **Combination locks** (antimicrobial + anticoagulant)



Catheter Locks - Can we do better than Heparin?

- Sheng et al. (2020) — 49 RCTs, 7,020 patients
- Compared to heparin 5,000 U/mL:
  - Antibiotic locks (with citrate, EDTA, heparin, or urokinase) and ethanol locks → **significantly reduced CRBSI**
  - **Antibiotics + low-dose heparin (500–2,500 U/mL) ranked BEST overall**
  - Lower bleeding risk with low-dose heparin and citrate-based locks vs. heparin 5,000 U/mL
  - No lock solution reduced catheter malfunction or all-cause mortality vs. heparin
- **Key takeaway: Antimicrobial + low-dose anticoagulant = optimal combination**



Catheter Locks: Antibiotic Potency

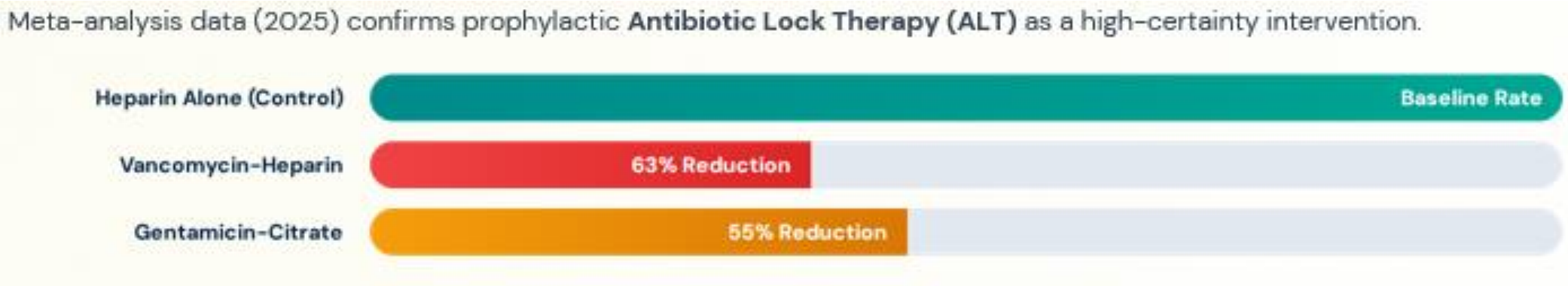
•Antibiotic locks (gentamicin, vancomycin) are effective but raise concerns:

- Antimicrobial resistance with prolonged prophylactic use
- Not FDA-approved for lock use; pharmacy compounding required
- Potential systemic toxicity (aminoglycoside ototoxicity)

•Trimethoprim/Ethanol/Ca-EDTA lock (Rijnders et al., CID 2019):

- 270 patients, 43,738 CVC-days
- **4.56-fold reduction in CLABSI vs. heparin** (0.09 vs. 0.41/1,000 CVC-days, p 0.03)
- BUT: increased thrombolytic use (40% vs. 12%, p 0.001)

•Kidney Disease Outcomes Quality Initiative (KDOQI) 2019: Antimicrobial lock solutions recommended especially in patients with recurrent CRBSI despite optimal aseptic technique



Taurolidine: The New Favorite

Taurolidine: Taurolidine is a broad-spectrum antimicrobial and antifungal agent, derived from the amino acid taurine

Mechanism: Non-antibiotic bactericidal (inhibits cell wall adhesion).

Zero Resistance: No risk of developing MDRO/MRSA strains.

Patency: Often combined with 4% citrate for effective anticoagulation.

Taurolidine is the preferred "standard" prophylactic lock in institutional guidelines to mitigate antimicrobial resistance concerns.

•LOCK-IT-100 Trial (Agarwal et al., CJASN 2023):

- Phase 3, randomized, double-blind, active-controlled
- 795 patients, 70 US sites
- Taurolidine 13.5 mg/mL + heparin 1,000 U/mL vs. heparin alone
- Primary endpoint: Time to CRBSI (adjudicated)
- Results:
  - **CRBSI: 2% (taurolidine/heparin) vs. 8% (heparin) — p 0.001**
  - Event rate: 0.13 vs. 0.46 per 1,000 catheter-days
  - HR 0.29 (95% CI 0.14–0.62) → 71% risk reduction
  - **Trial stopped early for efficacy** by DSMB
- **No difference in catheter patency or catheter removal rates**
- **Safety profile comparable to heparin alone**



- Protecting the exit site is the primary defense against extraluminal migration and skin-flora entry.

Dressings & Site Care

CHG Dressings

•Chlorhexidine-impregnated dressings (e.g., BioPatch):

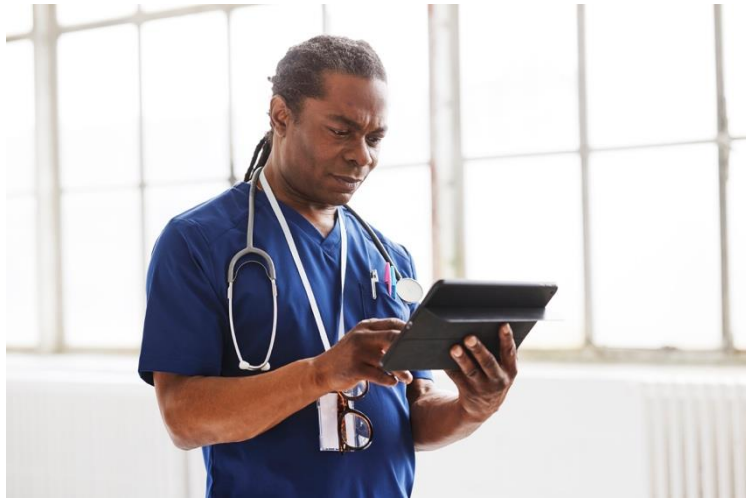
- Meta-analysis (Safdar et al., 2014): **9 RCTs → 40% reduction in CRBSI** (RR 0.60, 95% CI 0.41–0.88) **and 48% reduction in catheter colonization**
- Wei et al. (2019): **12 RCTs, 6,028 patients → confirmed CRBSI reduction** (OR 0.60, 95% CI 0.42–0.85)
- SHEA/IDSA 2022: Recommend CHG-containing dressings for CVCs in patients >2 months
- Caveat for HD: Unclear additional benefit for well-healed, long-term tunneled catheter exit sites



CHG Dressings vs Gauze: Does It Matter?

- Transparent vs. gauze dressings:
  - **No significant difference in CRBSI or exit-site colonization** (KDOQI 2019)
  - Choice based on clinical circumstances (use gauze if bleeding/diaphoresis)

- Dressing change frequency:
  - Transparent: at least every 7 days
  - Gauze: every 2 days
  - Change immediately if damp, loose, soiled, or nonocclusive



Exit Site Prep and Ointments

KDOQI Guideline 4.2

Apply antimicrobial ointment (Mupirocin or Triple Antibiotic) to the exit site at **each** hemodialysis

CDC recommendation: Use topical antibiotic/antiseptic ointment at HD catheter exit site after insertion and after each dialysis session (Category IB)

- Exception: NOT recommended for non-dialysis CVCs (risk of fungal superinfection)

•Chlorhexidine-based skin antisepsis preferred (KDOQI 2019, CDC guidelines)

- Povidone-iodine with alcohol if chlorhexidine contraindicated

•Topical ointments at exit site:

- **Mupirocin, povidone-iodine, Polysporin triple-antibiotic ointment** → 75–93% reduction in CRBSI risk
- 6-year prospective follow-up with Polysporin triple ointment: bacteremia rates consistently 1.0/1,000 catheter-days, no resistance emergence
- **Medical-grade honey:** equivalent efficacy to mupirocin (bacteremia 12% vs. 10%, p = 0.78)

Antimicrobial Barrier Caps: Targeting the Hub

ClearGuard HD Antimicrobial Barrier Cap (chlorhexidine-releasing):

- Hymes et al. (AJKD 2017): Cluster-RCT, 40 facilities, 2,470 patients, ~350,000 CVC-days
  - **56% lower BSI rate vs. standard caps** (0.26 vs. 0.59/1,000 CVC-days, p = 0.01)
  - Sustained use (last 6 months): 69% lower BSI, 43% fewer BSI hospitalizations, 51% fewer BSI hospital-days
- Brunelli et al. (JASN 2018): ClearGuard vs. Tego + Curos
  - **63% lower BSI rate** (0.28 vs. 0.75/1,000 CVC-days, p = 0.001)
- No device-related adverse events in either trial





Attaching ClearGuard HD Caps to a central venous catheter.

- Pediatric data (Nau et al., 2024): BSI decreased from 1.18 to 0.23 episodes/100 patient-months
- Meta-analysis of antiseptic barrier caps (Gillis et al., 2023): 15 studies → **35% absolute relative reduction in infection**s (RR 0.65 (95% CI 0.55–0.76)) for CLABSI reduction

The Future



Advanced Catheter Coatings

•Concept: Modify the catheter surface itself to resist colonization and biofilm

•Key limitation: Most coatings are external/tunnel-only — do not address intraluminal biofilm

Minocycline/Rifampin: High efficacy in the first 2-3 weeks; great for high-risk transfers.

Silver/Platinum: Broad antibacterial ions integrated into the polymer matrix.

Heparin Bonded: Primarily targets fibrin sheath formation to preserve flow.

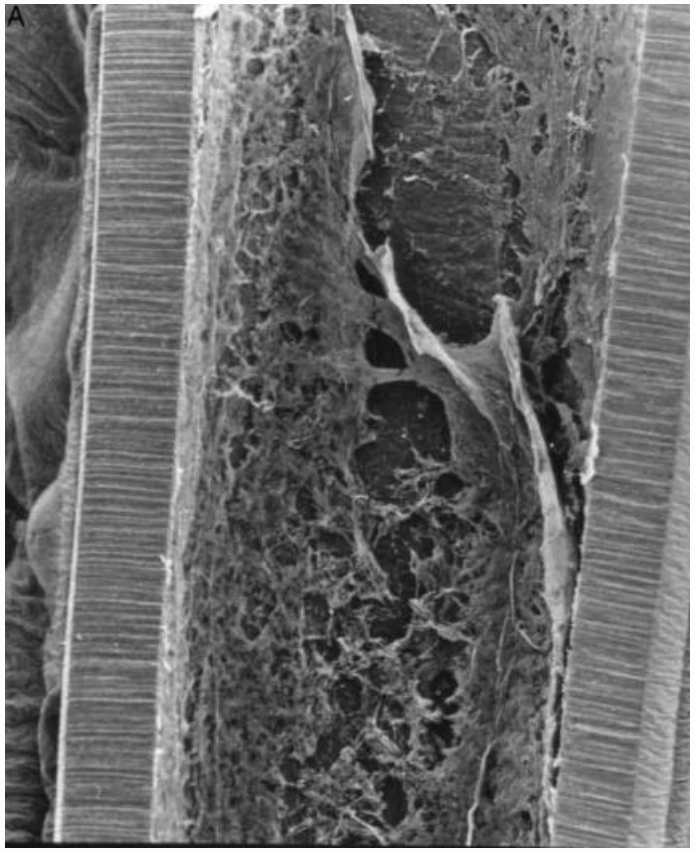


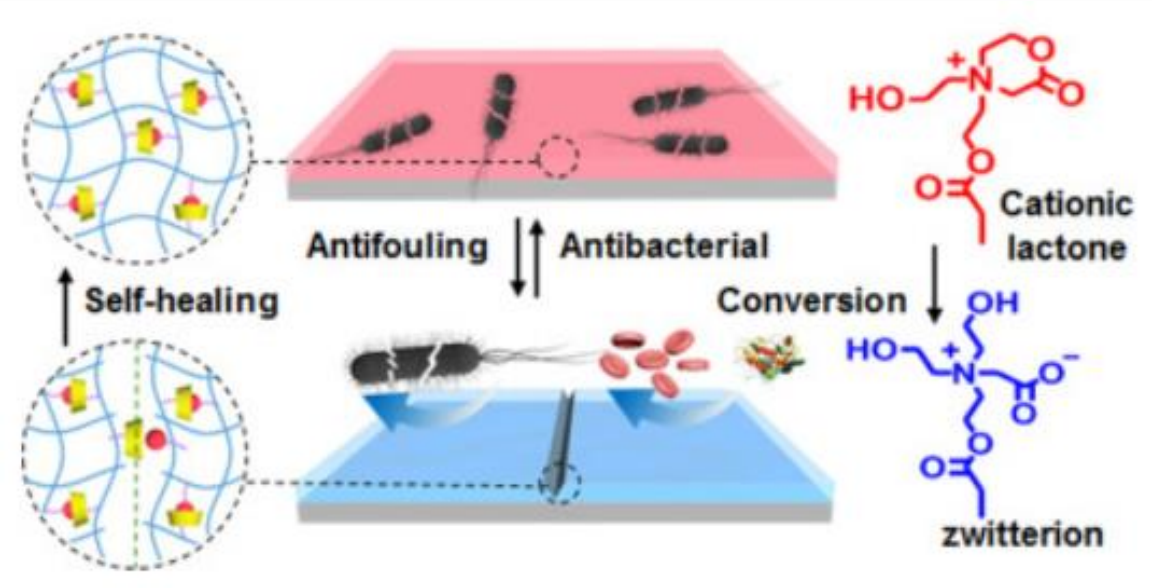
Image showing intraluminal biofilm in a central venous catheter obtained by electron microscope magnification 180

Smart Bio-Surfaces

Developing catheters that **react** to the environment:

Zwitterionic Hydrogels: Prevent protein adhesion entirely.

pH-Sensitive Release: Antibiotics release only when bacteria drop the local pH.



Summary Comparison of Interventions

Strategy	Pathway Targeted	Evidence Level	Key Effect Size
Taurolidine/heparin lock (Defencath)	Intraluminal	Phase 3 RCT (FDA-approved)	71% CRBSI reduction
Antimicrobial barrier caps (ClearGuard)	Intraluminal (hub)	Cluster-RCTs	56–69% BSI reduction
CHG-impregnated dressings	Extraluminal	Meta-analyses of RCTs	40% CRBSI reduction
Topical exit-site ointment (mupirocin/Polysporin)	Extraluminal	RCTs	75–93% CRBSI reduction
CHG skin antisepsis	Extraluminal	Guideline consensus	Standard of care
Antimicrobial catheter coatings	Extraluminal (surface)	Limited HD data	Promising but unproven in HD

Conclusion

"What Works?"

A combination of **Non-Antibiotic Locks** (Taurolidine) and **CHG-impregnated dressings** with regular **Exit Site Ointments** provides the most robust defense in 2026 practice.

Consistency in the Dialysis Access Bundle is paramount.

Questions?

Thank you for your time at VASA 2026.

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