ACCESSI VASCOLARI PER EMODIALISI: APPROCCIO INTEGRATO E STRATEGIE OPERATIVE

Complicante infettive e terapia



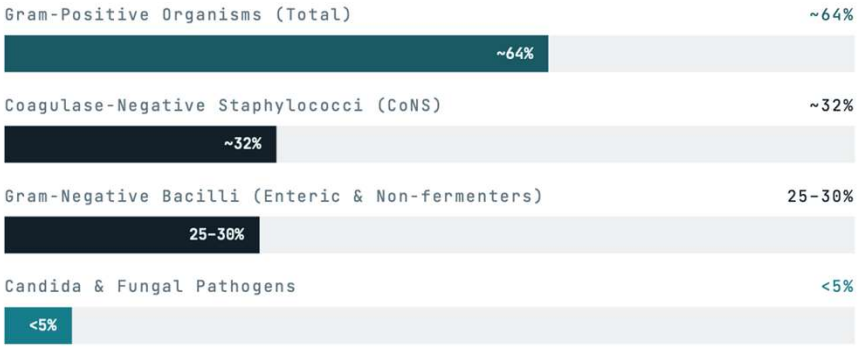
DR. Luca Bisi IRCCS San Gerardo dei Tintori Monza
08 ottobre 2026

- Infection is the second leading cause of death in ESRD; catheter access predicts all-cause and infection-specific mortality. Bello et al 2022
- Risk of infection ~3× vs AV graft and ~7× vs native fistula.
- Core tension throughout: **source control (catheter removal) vs vascular-access preservation.**
- **In recent years, the emergence and dissemination of multidrug-resistant organisms (MDRO) have intensified challenges in pre-venting and managing Hemodialysis Catheter-Related Bloodstream Infection (HD-CRBSI).**



Epidemiology

- Two routes: **extraluminal** (skin → cuff → bloodstream) and **intraluminal** (hub/cap contamination). (Ge et al., Frontiers in Cellular and Infection Microbiology, 2026)
- All indwelling catheters colonized within 24 h; biofilm on the catheter surface is the reservoir driving relapse.



PATHOGEN VIRULENCE

The Virulence Stratification

Low-virulence organisms like CoNS form dense intraluminal biofilms but carry lower risk of metastatic seeding, making antibiotic locks or guidewire exchange viable in stable patients. Conversely, high-virulence pathogens (*S. aureus*, *P. aeruginosa*, and *Candida*) carry high metastatic risk and mandate line extirpation.

Sibar et al 2026

The Biofilm barrier

PHASE 1: IMMEDIATE

Conditioning Film

Host plasma proteins (fibrinogen, fibronectin, laminin) coat luminal polyurethane within seconds to minutes.

PHASE 2: ADHESION

Microbial Anchoring

Staphylococcal MSCRAMMs and Candida Als adhesins bind host surface ligands to establish stable microcolonies.

PHASE 3: MATURATION

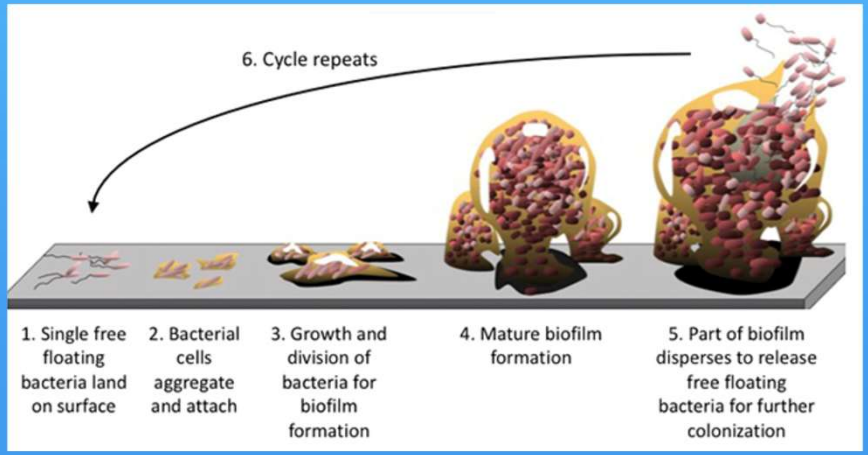
EPS Accumulation

Quorum-sensing drives dense matrix secretion, chelating Ca^{2+} and Mg^{2+} to build structured drug-tolerant sanctuaries.

PHASE 4: DISSEMINATION

Bacteremic Showers

Cyclical mechanical detachment releases showers during dialysis, causing metastatic seeding and severe shock.



Colombari et al. 2021

biofilm is why systemic antibiotics alone underperforme and why lock therapy or catheter exchange is often needed

Differentiating Exit-Site, Tunnel, and Definite CRBSI

SUPERFICIAL / EXTRALUMINAL

Exit-Site Infection

Erythema or discharge ≤2 cm

Local inflammation or purulence confined strictly within 2 cm of the skin exit site without systemic bacteremia. Driven by cutaneous flora migrating down the external surface of the catheter.

SUBCUTANEOUS / HIGH RISK

Tunnel Infection

Spread >2 cm or proximal to cuff

Tenderness, erythema, or fluctuance tracking >2 cm proximally from exit site toward the Dacron cuff. Subcutaneous tissue involvement precludes lock therapy and renders wire exchange hazardous.

ENDOVASCULAR / INTRALUMINAL

Definite CRBSI

Paired concordant cultures

Identical organism isolated from hub and peripheral venipuncture (or circuit site). Requires a quantitative colony ratio ≥3:1 (catheter vs. peripheral) or differential time to positivity (DTP) ≥2 hours.

Exit-site infection

local inflammation/discharge, no systemic illness; swab culture

Tunnel infection

inflammatory signs overlying the subcutaneous tunnel (± abscess/erosion)

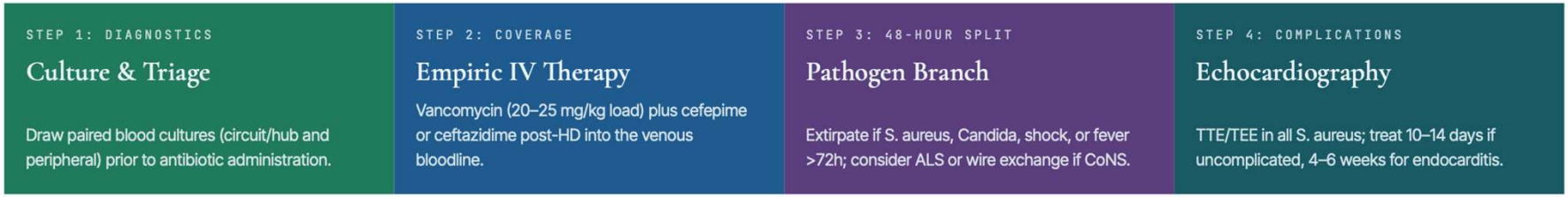
CRBSI

positive cultures without alternative source; exit and tunnel often look normal- the most serious form.

rt-PCR and Acute Decision Pathway

Real-time polymerase chain reaction (rt-PCR) demonstrates superior diagnostic performance, achieving 100% sensitivity and 78% specificity within 3.5 hours.

Studies indicate that rt-PCR-guided diagnostics can reduce empirical treatment for Gram-positive cocci,(Acquier et al., 2023). RT-PCR exhibits rapid, highly sensitive diagnostic potential for suspected HD-CRBSI, improving antimicrobial management and lowering resistance risk



Uncomplicatd vs compilated CRBSI

- Uncomplicated CRBSI defined by infection limited to the bloodstream, with prompt defervescence and clearance of bacteremia (e.g., within 48-72 hours) after initiating appropriate antibiotics, in a patient who is hemodynamically stable and has no evidence of metastatic infection (e.g., endocarditis, septic thrombosis) or deep-seated catheter involvement (tunnel infection).

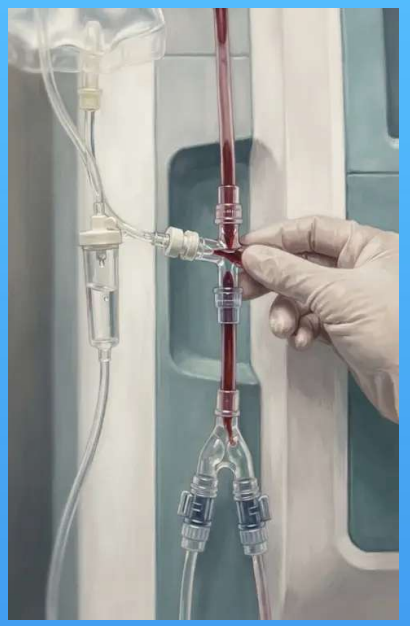
- Complicated CRBSI is characterized by persistent fever or bacteremia (>72 hours) despite appropriate therapy, HD instability (sepsis or septic shock), or the presence of metastatic infectious complications.



Empiric Selection and Definitive Pathogen De-escalation

- **Empiric broad-spectrum initiation.** Administer vancomycin with weight-based loading (20–25 mg/kg) plus broad-spectrum gram-negative coverage (cefepime 1–2 g, ceftazidime 1–2 g, or gentamicin 1–2 mg/kg) post-dialysis immediately after obtaining cultures.
- **Vancomycin trough maintenance.** Target post-dialysis serum trough concentrations of 15–20 µg/mL; persistent subtherapeutic levels risk inducing vancomycin-intermediate *S. aureus* (VISA) isolates.
- **Mandatory MSSA de-escalation.** Switch vancomycin to intravenous cefazolin (20 mg/kg post-HD, typically 1–2 g) for methicillin-susceptible *S. aureus*; cefazolin provides superior bactericidal clearance and reduces clinical failure.
- **Second-line gram-positive rescue.** Daptomycin dosed at 6–9 mg/kg post-dialysis serves as the definitive alternative for vancomycin-resistant or intermediate staphylococcal isolates.

Although the choice of antibiotic treatment may depend on individual preference, local or regional patterns, and/or recommendations from hospitals and organizations, according to ERBP, preference should be given to antibiotics with a pharmacokinetic profile allowing administration after each dialysis session only; this is the case for vancomycin, teicoplanin, cefazolin, ceftazidime and daptomycin.



For outpatient patients consider long acting antibiotic: dalbavancin specifically in catheter-related bloodstream infection (CRBSI); daptomycin's "long interval" (thrice-weekly post-dialysis) dosing is a separate, more conventional strategy.

None of these are FDA-approved for CRBSI — dalbavancin and oritavancin are approved only for ABSSSI — so all use in catheter infection is off-label.

Pallotta et al 2026

Antimicrobial stewardship in HD-CRBSI



- timely de-escalation: empirical broad-spectrum regimens should be rapidly streamlined to the most targeted
- therapeutic drug monitoring (TDM): TDM is indispensable for optimizing the efficacy and safety of key agents like vancomycin
- adherence to defined treatment durations: overtreatment increases resistance pressure without added benefit, while under treatment risks relapse.

	Recommended duration
Gram-negative bacilli or enterococcus	7–14 days
Uncomplicated S. aureus	4–6 weeks
Candida / fungemia	≥14 days (from first negative culture)
Tunnel infection, no bacteremia	10–14 days
Exit-site infection, no bacteremia	1–2 weeks
Persistent bacteremia/fungemia despite catheter removal	4–6 weeks
Endocarditis, suppurative thrombophlebitis, osteomyelitis/metastatic infection	6–8 weeks

KDOQI 2019; Sibar 2026

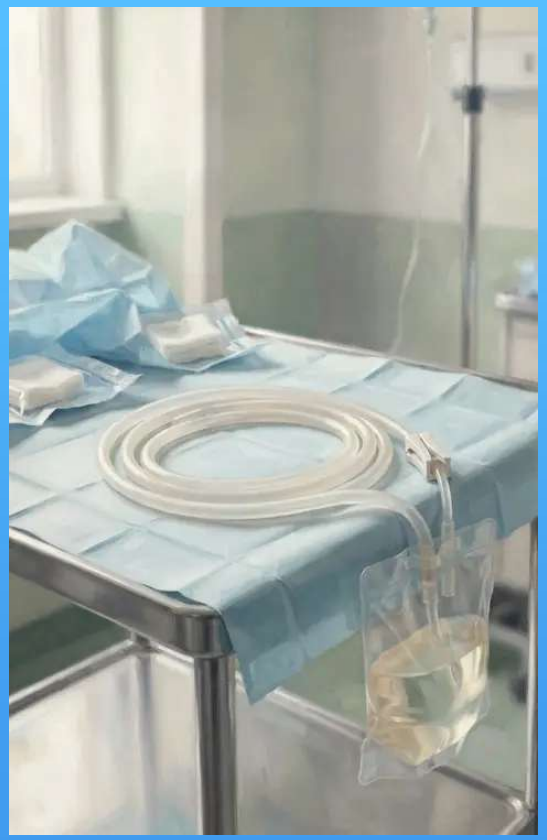
The Four Catheter Options (KDOQI 2019)

1.Catheter **salvage** (retain) + systemic antibiotics ± antibiotic lock.

2.Guidewire exchange at the same site. (after 48-72h of stability)

3.Removal + new catheter at a **new site**.

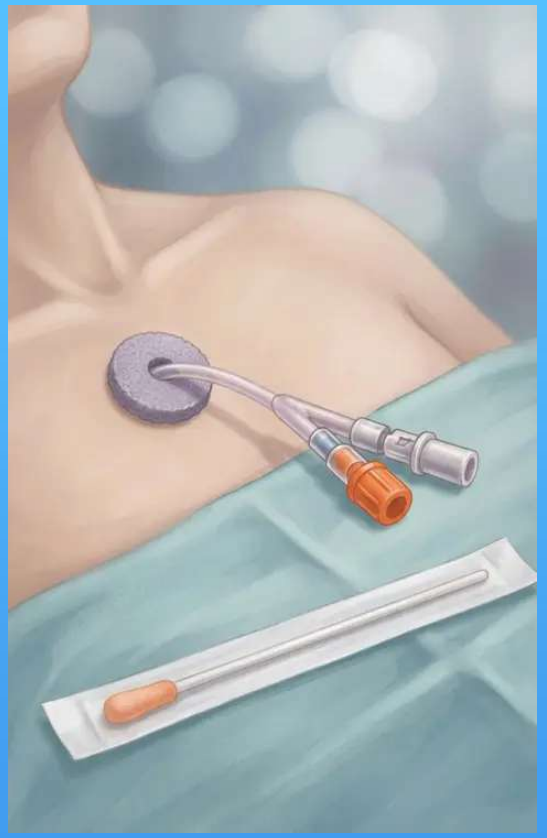
4.Removal with a **catheter-free interval** (temporary access as needed).



When Catheter MUST Come Out

Mandatory removal (US and European agreement):

- Hemodynamic instability / septic shock
- Persistent fever or bacteremia at 48–72 h of appropriate antibiotics
- Metastatic complications (endocarditis, suppurative thrombophlebitis)
- Tunnel infection with abscess/erosion
- High-virulence organisms: **S. aureus, Pseudomonas aeruginosa, Candida spp**



Strong agreement across KDOQI, IDSA/European practice, and recent reviews (Auguste & Chan, 2022; Ge et al., 2026; Lok et al., 2020)

Catheter Salvage: when it reasonable ?

- Candidate criteria: hemodynamically stable, uncomplicated CRBSI, low-virulence organism (e.g., coagulase-negative staphylococci), no tunnel/exit-site infection.
- Requires mandatory reassessment at 48–72 h and documented clearance of bacteremia (Ge et al., 2026)
- Salvage = continued catheter use with systemic antibiotics + antibiotic lock therapy.
- Salvage is also justified when alternative access cannot be established (August et. al 2022)

Antibiotic lock therapy (ALT) is an adjunct to systemic antibiotics for salvaging tunneled HD catheters when the catheter cannot be removed. (Almeida et al. 2022)

It involves instilling a high-concentration antibiotic/antimicrobial solution (~100-fold systemic levels) into each lumen between dialysis sessions for the full duration of systemic therapy.

Daptomycin locks achieve the highest eradication rate of CoNS from hemodialysis catheters *in vivo*. Blanco - Di Matteo et al. 2023

- **Antimicrobial/antiseptic locks** — taurolidine, trisodium citrate (4–46.7%), ethanol, EDTA, methylene blue (Lok et al., KDOQI Vascular Access Guideline, American Journal of Kidney Diseases, 2020).
- **Anticoagulant companions** — heparin, citrate, or urokinase/tPA to maintain patency.

Antibiotic Lock therapy & guide wire exchange: the evidence

- Meta-analysis (1596 patients): antibiotic lock (OR 2.08) and guidewire exchange (OR 2.88) both superior to systemic antibiotics alone for cure.
- Cochrane review: the certainty of evidence is very low — it is uncertain whether adjunctive ALT improves cure over systemic antibiotics alone, and there is no evidence favoring one lock solution over another (Almeida et al., Cochrane, 2022).
- A 2025 retrospective cohort (287 patients) found ALT allowed shorter antibiotic courses and shorter hospital stays but was associated with significantly higher 90-day microbiological relapse (20% vs 7%; adjusted OR 3.93), with CoNS BSI an independent predictor of relapse — reinforcing that removal is preferred when feasible and ALT is best as a short-term salvage strategy for low-virulence organisms with close surveillance

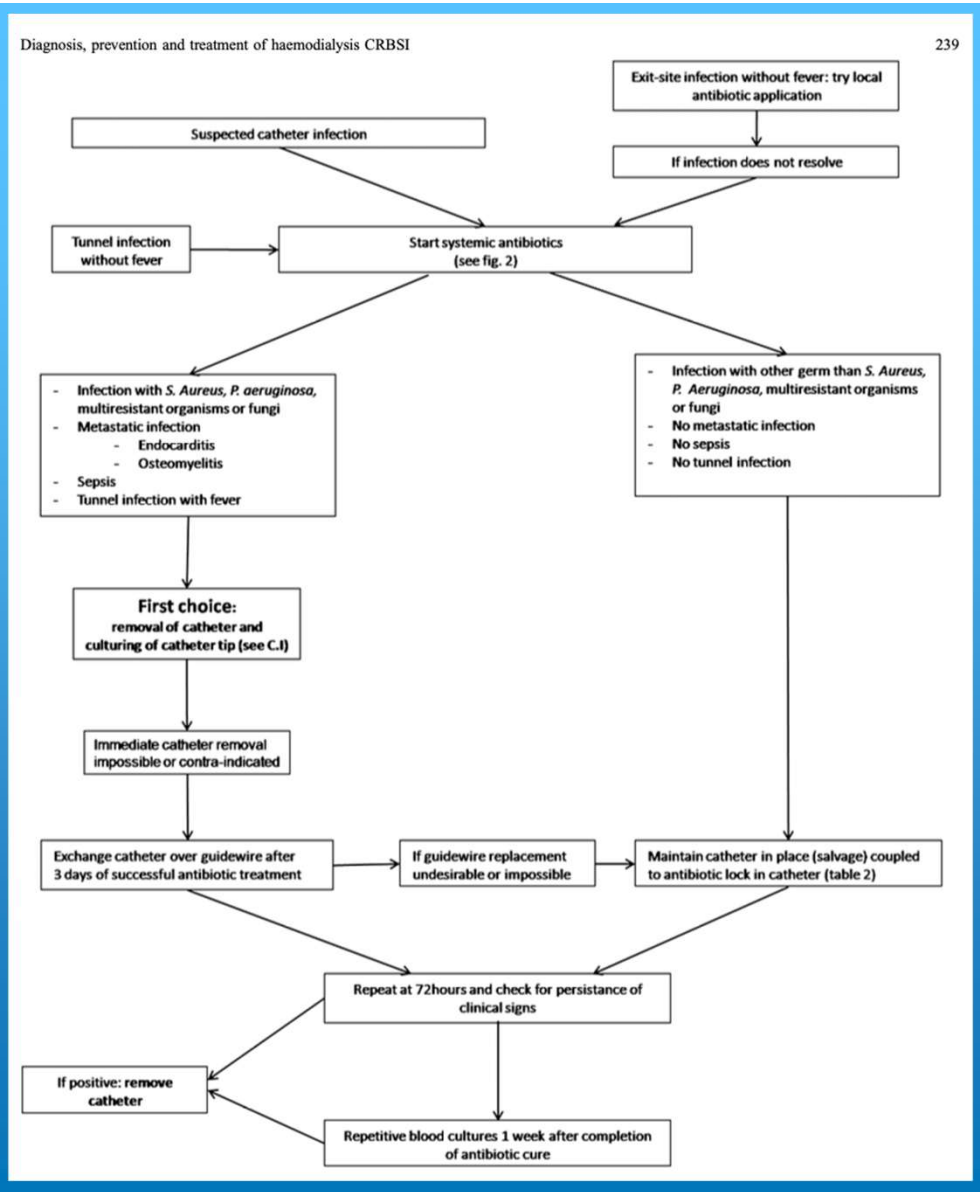
Antibiotic	Concentration (mg/mL)
Vancomycin	2.5–25
Gentamycin	4–40[b]
Tobramycin	5
Minocycline	3
Cefazolin	10
Ceftazidime	10

Yahav et al.

ERBP recommendations:

- D.2.1 When catheter salvage is attempted, the combination of an antibiotic lock and systemic antibiotic therapy should be applied.
- D.2.2 Salvage of the catheter in case of *S. aureus* infection should only be considered when catheter removal and replacement are expected to be problematic.

ERBP, CKJ 2010



Conclusion

1. **Culture before antibiotics** — paired catheter + peripheral/circuit samples anchor the diagnosis. even in Emergency Department
2. **Start broad (vancomycin + Gram-negative coverage), then de-escalate** to the organism and local antibiogram.
3. **Routine TEE** for S. aureus
4. **Remove the catheter** for instability, persistence >48–72 h, metastatic complications, tunnel infection, or *S. aureus*/*Pseudomonas*/fungi.
5. **Salvage only the right patient** — stable, uncomplicated, low-virulence organism — with systemic antibiotics **plus** an antimicrobial lock and 48–72 h reassessment. Check blood culture 1 week after completion of antibiotic treatment
6. **Prevention beats treatment:** bundles, hub disinfection, CVC reduction, and antimicrobial locks are the highest-yield interventions.