



Hemodialysis catheter infection



Scary facts



- In 2006, 82% of patients in the United States initiated dialysis via a catheter
- The overall likelihood of Tunneled cuffed catheters use was 35% greater in 2005 compared with 1996



- TCCs have been found to be associated with as much as a threefold increased mortality compared with AVFs
- Sepsis-related death is 100 times greater in dialysis patients than in the general population
- Infection-related death and all-cause mortality are highest in those with TCCs



- The cost of placing a TCC is approximately \$13,000, and that of treating one TCC-related episode of bacteremia is as high as \$45,000
- A several-fold increase in cardiovascular risk is also noted with TCCs



- Primary TCC failure rate is 52% to 91% per year
- Poor quality of life, reduced dialysis adequacy, and central venous stenosis that may preclude subsequent AVF creation are additional complications associated with TCCs



Catheter related bacteremia



- Bacteremia frequently complicates catheter use in hemodialysis patients
- In a prospective follow-up of 108 patients with tunneled dialysis catheters, the first episode of catheter-related bacteremia developed in 35% within 3 mo and in 48% after 6 mo
- The frequency of catheter-related bacteremia has ranged from 2.0 to 5.5 episodes per 1000 catheter-days at several dialysis centers or 0.9-2.0 episodes per patient-year



- Serious complications, including infective endocarditis, septic arthritis, septic emboli, osteomyelitis, epidural abscess and severe sepsis, have been reported in 20% of cases
- *S. aureus* has been predominantly isolated from those patients as a result of the predilection of *S. aureus* for heart valves and bone



Predisposing factors

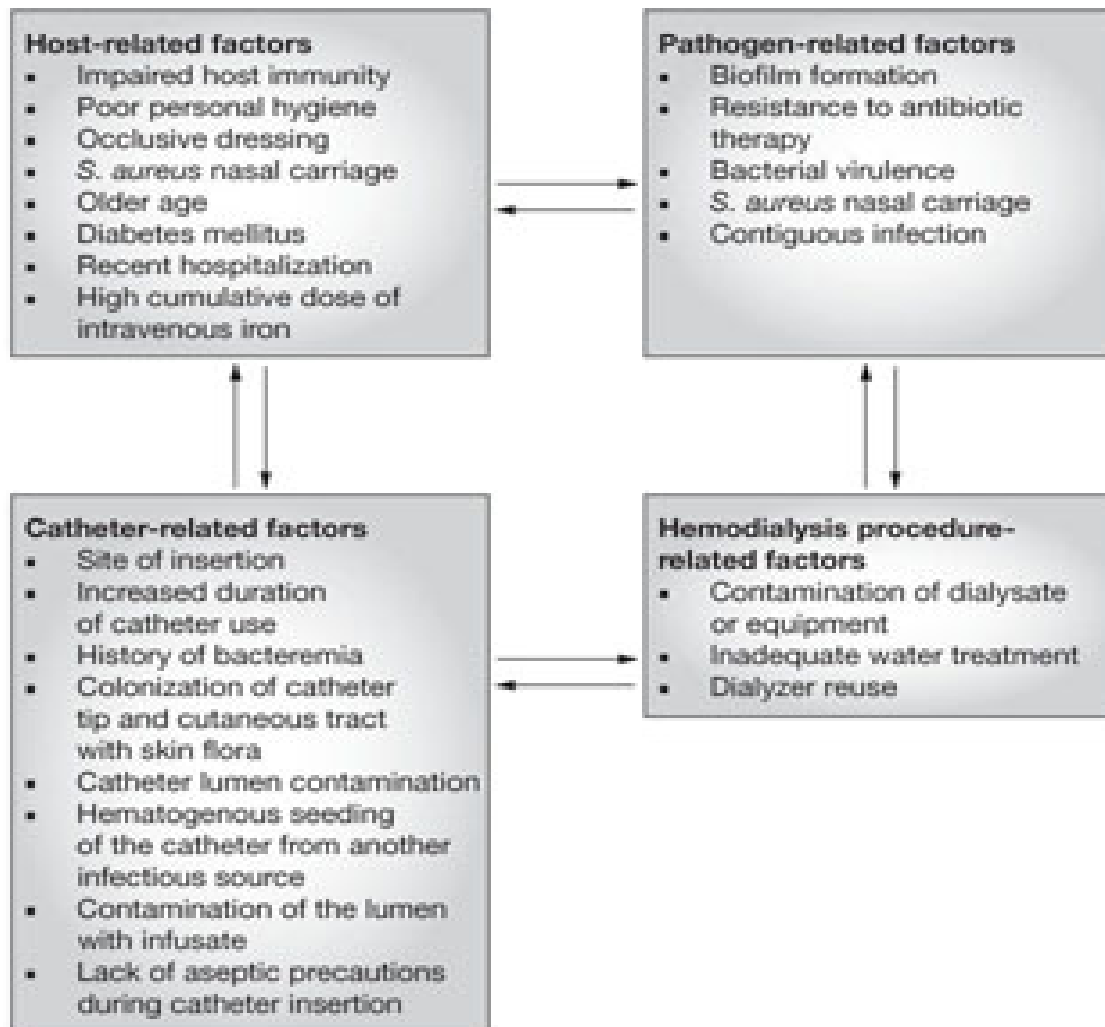


Figure 1 Relationships between factors associated with hemodialysis central venous catheter-related blood stream infections.



- The incidence of CRB associated with nontunneled catheters is highest for femoral catheters, followed by internal jugular catheters then subclavian catheters (7.6, 5.6, and 0.7 episodes per 1,000 catheter-days, respectively)
- The lower risk of infection with subclavian catheters might not apply to tunneled catheters, and the subclavian location is associated with the highest rate of future catheter-associated central venous stenosis
- Although the duration of primary catheter patency is substantially shorter for tunneled femoral catheters compared with tunneled internal jugular catheters, infection-free survival is similar in both groups



Pathogens



Table 1 Organisms responsible for hemodialysis central venous catheter-related bloodstream infections.

Organism	Percentage reported*
Gram-positive cocci	52–85%
<i>Staphylococcus aureus</i>	22–80%
<i>Staphylococcus epidermidis</i>	9–13%
Meticillin-resistant <i>Staphylococcus aureus</i>	6–29%
<i>Enterococcus faecalis</i>	2–18%
Gram-negative bacilli	20–28%
<i>Pseudomonas aeruginosa</i>	2–15%
<i>Enterobacter cloacae</i>	9%
<i>Escherichia coli</i>	10%
<i>Acinetobacter</i> species	13%
<i>Serratia marcescens</i>	1–2%
<i>Klebsiella pneumoniae</i>	6%
Polymicrobial	16–20%
Acid-fast organisms	Rare
Fungi	Rarely reported

*Percentages do not add up to 100% because data are drawn from different sources.



Diagnosis



- Often suspected clinically in a hemodialysis patient who presents with fever or chills, unexplained hypotension and no other localizing signs
- Mild symptoms include malaise and nausea, in the setting of a normal catheter exit site or tunnel, on physical exam
- More-severe symptoms include high fever with rigors, hypotension, vomiting and changes in mental status
- Older and more-immunocompromised patients might present with low-grade fever, hypothermia, lethargy, hypoglycemia, or diabetic keto acidosis



- Catheter related bacteremia can be complicated by catheter exit-site or tunnel infection
- Exit-site infection is indicated by the presence of erythema, swelling, tenderness and purulent drainage around the catheter exit and the part of the tunnel external to the cuff
- Symptoms of tunnel infection are swelling, erythema, fluctuance and tenderness over the catheter tunnel central to the cuff

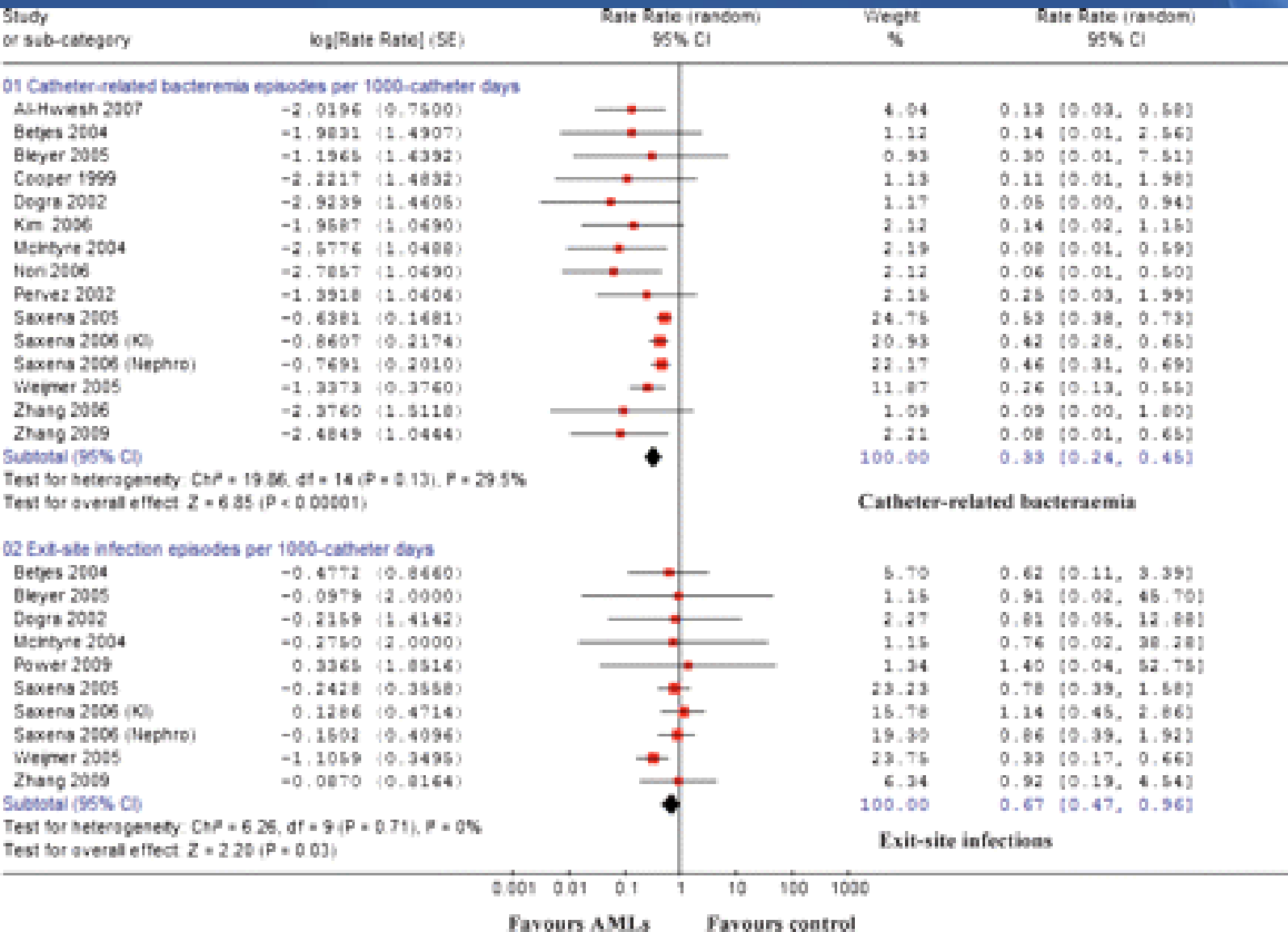


- Requires positive blood cultures obtained from the catheter and from a peripheral vein, with the quantitative colony count being at least four-fold higher in the catheter sample
- A more practical definition is the presence of positive blood cultures in a febrile catheter-dependent patient, in the absence of alternative sources of infection upon clinical evaluation

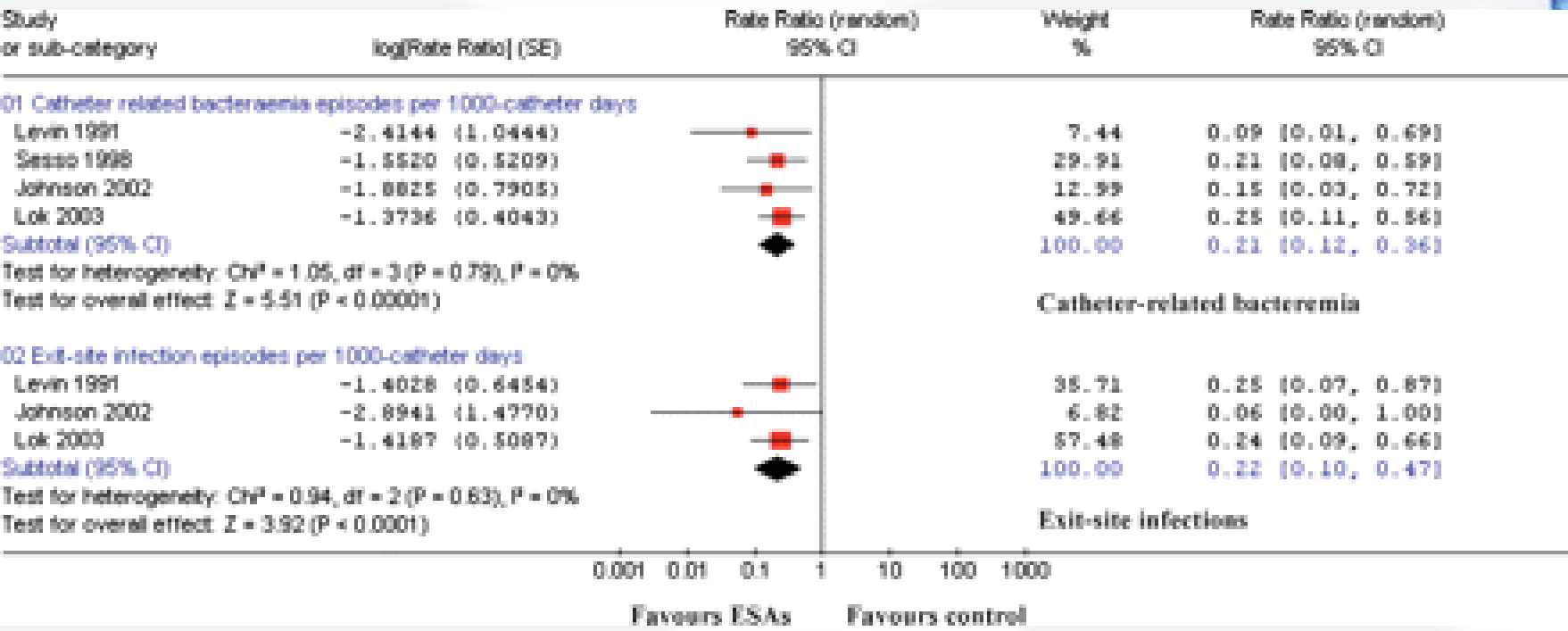


Prophylaxis

Antimicrobial lock



Exit-site antibiotic applications



- Neither antimicrobial coating of catheters nor peri-operative antimicrobial administration have been shown to reduce incidence of bacteremia or catheter site infection

Heparin coating

- A study compared 175 tunneled dialysis catheters placed in the internal jugular vein, including 89 heparin-coated catheters and 86 noncoated catheters
- Catheter-related bacteremia occurred less frequently with heparin-coated catheters than with noncoated catheters (34 versus 60%, $P < 0.001$)
- Cumulative catheter survival was similar in heparin-coated and noncoated catheters (hazard ratio, 0.87; 95% confidence interval, 0.55 to 1.36; $P = 0.53$)



Treatment



- Because of the high prevalence of MRSA and gram negative pathogens, empiric therapy should include Vancomycin and an antibiotic with broad-spectrum gram-negative bacterial coverage
- Antibiotic regimen should be modified as soon as the sensitivity reports are available
- Linezolid should be reserved for treatment of vancomycin-resistant organisms
- With these measures, outpatient management is feasible in greater than 80% of patients with catheter-related bacteremia



- Because of the bacterial biofilm formation, treatment of catheter-related bacteremia without catheter removal is relatively ineffective
- Different options include TCC salvage, TCC exchange over a guidewire with antibiotics or immediate TCC removal with delayed reinsertion and antibiotics

Criteria to attempt catheter salvage

- Difficult to replace catheters
- Blood sterile in 48–72 h
- No sign of tunnel infection
- No signs of metastatic infection
- Microorganisms medically treatable
- A hemodynamically stable patient

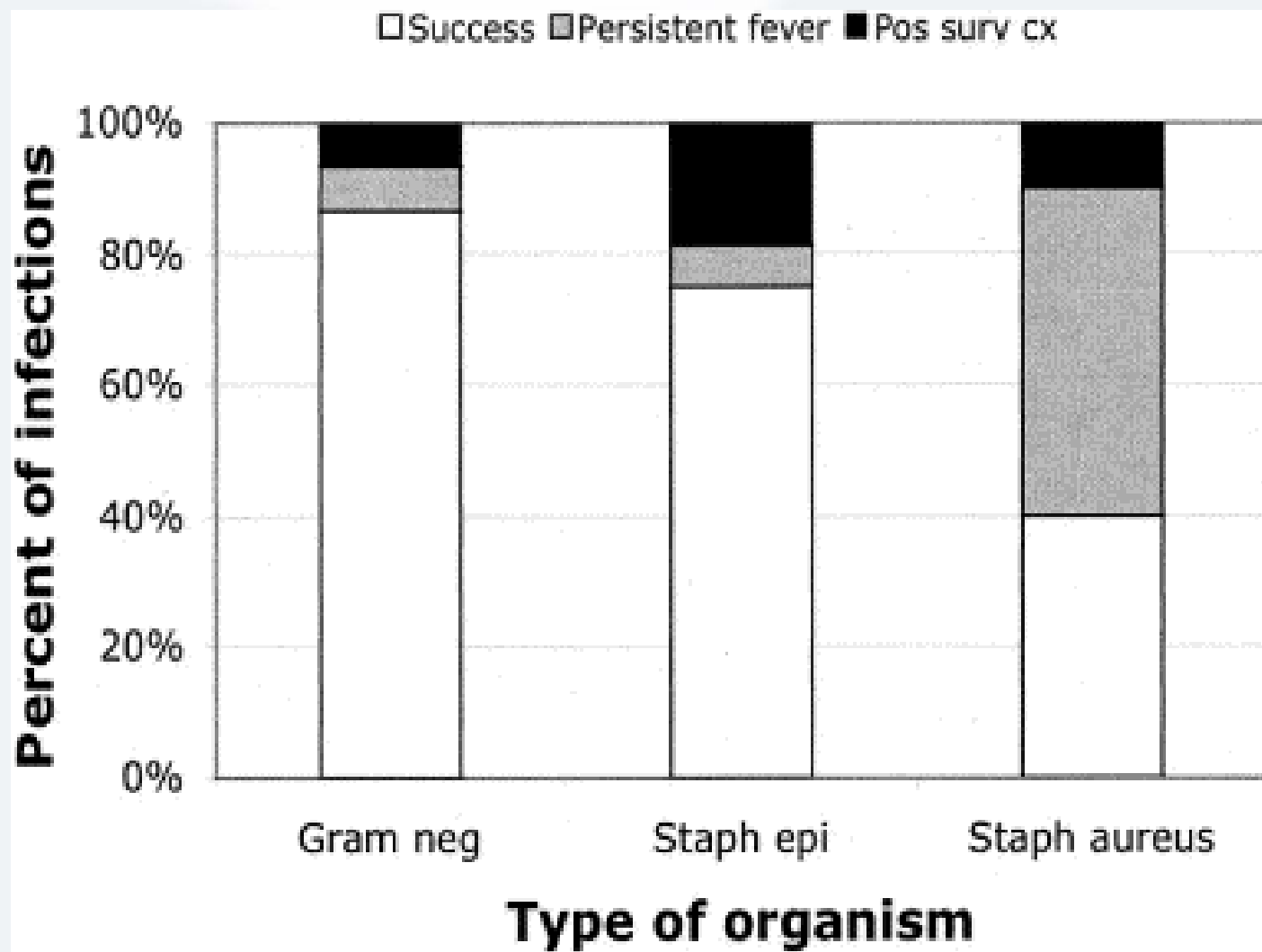


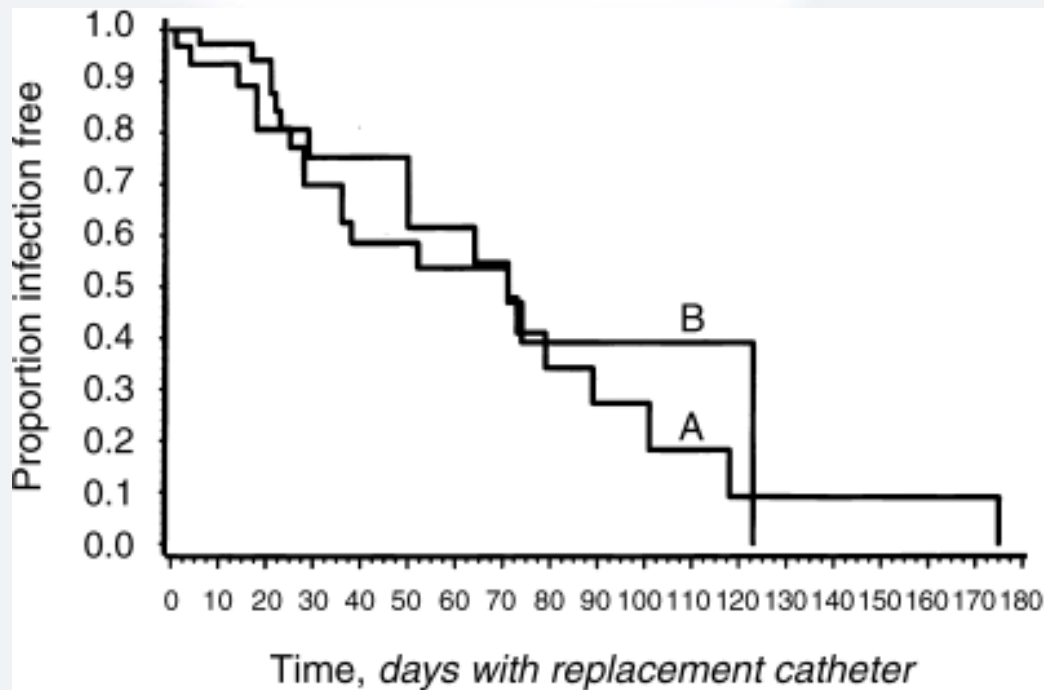


- There is a 5-fold higher risk of treatment failure when TCC salvage is attempted, and an 8-fold higher risk in cases associated with *S. aureus* bacteraemia
- Salvage should be used only as a treatment of last resort



- Studies that have evaluated antibiotic lock therapy for treatment have varied in the types of antibiotics and concentrations used, the addition of heparin to the solutions, and dwell times in the catheter lumen
- Reported success in small series ranged between 40% to 87% depending on the pathogen
- Stronger evidence however is available for exchanging catheter over a guidewire





Life-table analysis (Kaplan–Meier survival curves) for infection-free survival of the replacement catheter in patients whose dialysis catheter was replaced with one of two strategies (group A, replacement over a guidewire 31 pts; group B, removal of the catheter with delayed replacement 3 to 10 days later 38 pts, $P = 0.72$)



- A decision–analytic model was developed to assess the cost-effectiveness of each strategy for episodes of TCC-associated bacteremia presenting with minimal symptoms, in a hypothetical cohort of hemodialysis patients followed for a 3 month period
- Data regarding the probability of treatment failure due to recurrent infection for each strategy, secondary infectious complications and patient mortality were obtained from existing clinical trials and from the 1998 United States Renal Data System database
- Costs were substituted with the current 2000 New York hospital charges

Baseline analysis of three strategies of TCC-bacteremia management



Strategy	Cost-effectiveness ratio (\$)	Expected patient survival (3 month)	Expected total costs (\$)
TCC salvage	11 579	0.89	13 016
TCC guidewire exchange	6338	0.932	6800
TCC immediate removal	7088	0.93	7619

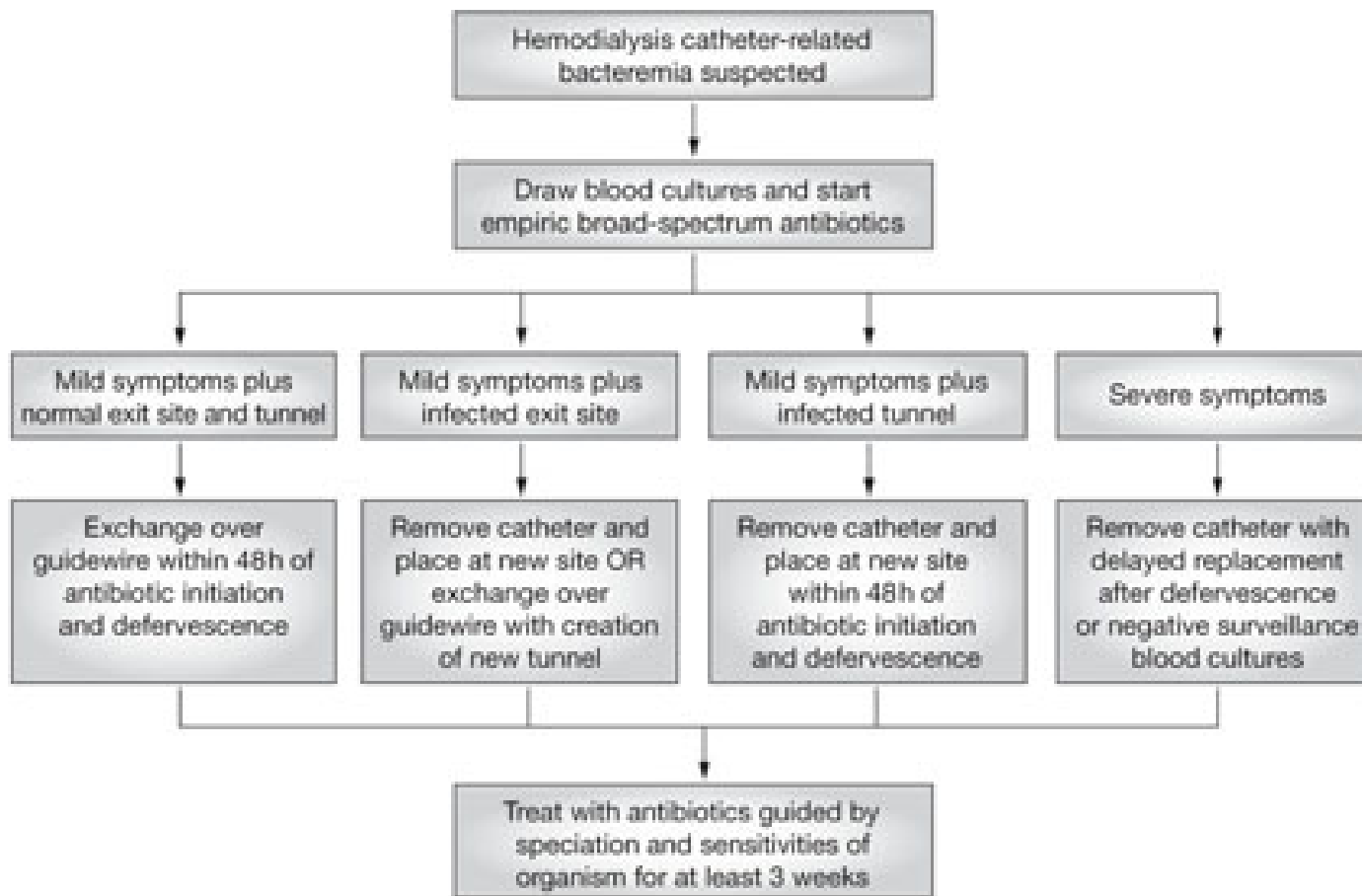


Figure 2 Management of central venous hemodialysis catheter-related bacteremia.



KDOQI recommendations for hemodialysis access



- Primary AVFs should be constructed in at least 50% of all patients with ESRD who elect to receive hemodialysis
- Ultimately 65% of prevalent patients should have native AVFs
- The use of tunneled-cuffed catheters should be discouraged as long-term vascular access
- Fewer than 10% of patients should be using them for permanent access

Educating patients



- Their risk of death is increased two to threefold
- Their risk of serious infection is increased five to 10 fold
- Their risk of experiencing a painful complication from infection (osteomyelitis, septic arthritis, endocarditis, or epidural abscess) that may require major surgery and be difficult or impossible to cure is significantly increased
- Their risk of needing access replacement is higher for TCCs
- Their risk of being sicker because of inadequate dialysis through a TCC is higher
- Their risk of spending more time in the hospital is higher because of TCC complications
- Their risk of death in the first year of dialysis is significantly increased with TCC use

Is it ever an acceptable alternative?



TCCs can be used

- As a bridge access device while awaiting maturation of an AVF
- In patients with severe comorbidities such as congestive heart failure and severe peripheral vascular disease
- In those with inadequate vascular anatomy
- In those with limited life expectancy
- In the very elderly
- As a last resort in patients with multiple access failures

