CRBSI

Catheter Related Blood Stream Infection In HD Patients

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Agenda

- Introduction
- Epidemiology
- Indications & types of catheter
- Pathogenesis
- Risk factors
- Diagnosis
- Management
- Prevention

Introduction:

- The most important catheter related complications which determine catheter survival are infection and dysfunction.

- Infectious episodes are the leading cause for catheter removal and catheter related morbidity in dialysis patients.

- The frequent use of TCs in hemodialysis patients increases the risk of infectious complications, hospitalizations, and mortality.

- Catheter avoidance and reduction are the obvious strategies for avoiding these complications

- Unfortunately, systemic antibiotics alone can clear only about 30%□ 35% of the CRBSI with high rates of relapse and systemic complications.

Hemodialysis International 2018; 22:S75–S82

Prospective study of 526 incident patients starting RRT. 1 year follow up:

- The use of temporary vascular access for HD were associated with prolonged hospitalisation & repeated admissions.

Metcalfe Et Al. Q J Med 2003; 96: 899

Septicemia, access and cardiovascular disease in dialysis patients

- First cause of Morbidity.
- Second cause of mortality

shani A, Collins AJ, Herzog CA, Foley RN: Kidney Int 68: 311–318, 2005

Epidemiology:

- Vascular access for hemodialysis is the major risk factor for bacteremia in patients with ESRD.

- The relative risk for bacteremia in patients with dialysis catheters is sevenfold the risk for patients with AV fistulas.

- The risk increased more than two folds if the catheters were used in the first six months of the HD therapy.

- The risk of BSI is higher for temporary untunneled catheters (UTCs) compared to permanent tunneled cuffed catheters.

- Femoral catheters have the highest infection rates.

- Internal jugular carries a higher rate than the subclavian.

Infection and Drug Resistance >
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ORIGINAL RESEARCH

Catheter-Related Blood Stream Infections and Associated Factors Among Hemodialysis Patients in a Tertiary Care Hospital

Meskelu Kidu Weldetensae, Migbnesh Geberemedhin Weledegebriel, Afewerki Tesfahunegn Nigusse, Ephrem Berhe & Hailemariam Gebrearegay

Pages 3145-3156 | Received 20 Feb 2023, Accepted 15 May 2023, Published online: 22 May 2023

A retrospective cross-sectional study design was applied among patients in Ethiopia who underwent central venous catheter insertion for hemodialysis between January 2016 and June 2022 with no native arteriovenous fistula and stayed more than 48 hours.

In this study, 353 patients were included. The mean age was 39±17.9 years and the average duration of catheter stay was 58 ±95 days. A hundred thirty-five (38.2%) CRBSIs were documented with an incidence rate of 7.74 episodes per 1000 catheter days. The causative microorganism was predominantly gram-negatives (57.6%).

Weldetensae, M. K., Weledegebriel, M. G., Nigusse, A. T., Berhe, E., & Gebrearegay, H. (2023).

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ORIGINAL ARTICLES

Evaluation of Catheter-Related Bacteremia in Patients with End-Stage Renal Disease on Hemodialysis

Manuti, Jawad K.; Saadoon, Ali Mohammed; Lawn, Ali Ghafil A.; Jawad, Talal Shakir

Author Information

Arab Board Medical Journal 24(3):p 101-110, September-December 2023. | **DOI:** 10.4103/abmj.abmj_34_22

Methods: Three hundred patients with end stage renal disease in whom tunneled and non-tunneled catheters used for hemodialysis in the Dialysis Center of Alkadhumain Medical City from February 2020 to February 2021. Only 122 of them gave signs and symptoms of catheter related infection

Results: The most common bacteria identified in blood culture was Staphylococcus epidermidis, which was presented in 30 (24.5%) patients, Staphylococcus aureus which were presented in 12 (9.8%) patients. This followed by methicillin resistance Staphylococcus aureus and proteus mirabilis, which were found in 9 (7.3%) patients for each bacterium. Klebsiella pneumonia was presented in 8 (6.2%) patients. There were 42 (34.4%) patients have negative results on blood culture. Positive blood culture was associated with lower duration of symptoms

Indication of catheter insertion:

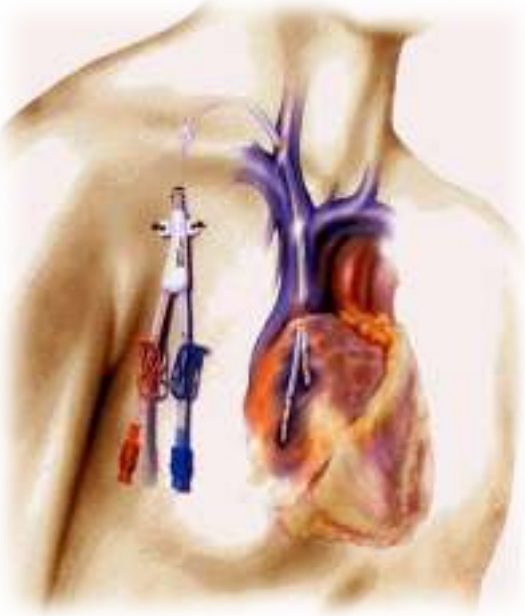
- Acute Kidney Injury .
- ESRD with no access.
- ESRD with failure of access.
- Peritoneal dialysis with complications.
- Transplant patients require HD.
- Plasmapharesis and Hemoperfusion.

Types of catheters:

1- Temporary non Cuffed catheter:

- Short.
- More ridged.
- Easy and fast insertion.
- Immediate use.
- Higher infection rate.
- Preferred IJ or femoral.
- Avoid subclavian.
- < 3wks for IJ.
- <5 days for femoral.

2- Cuffed tunneled catheter:



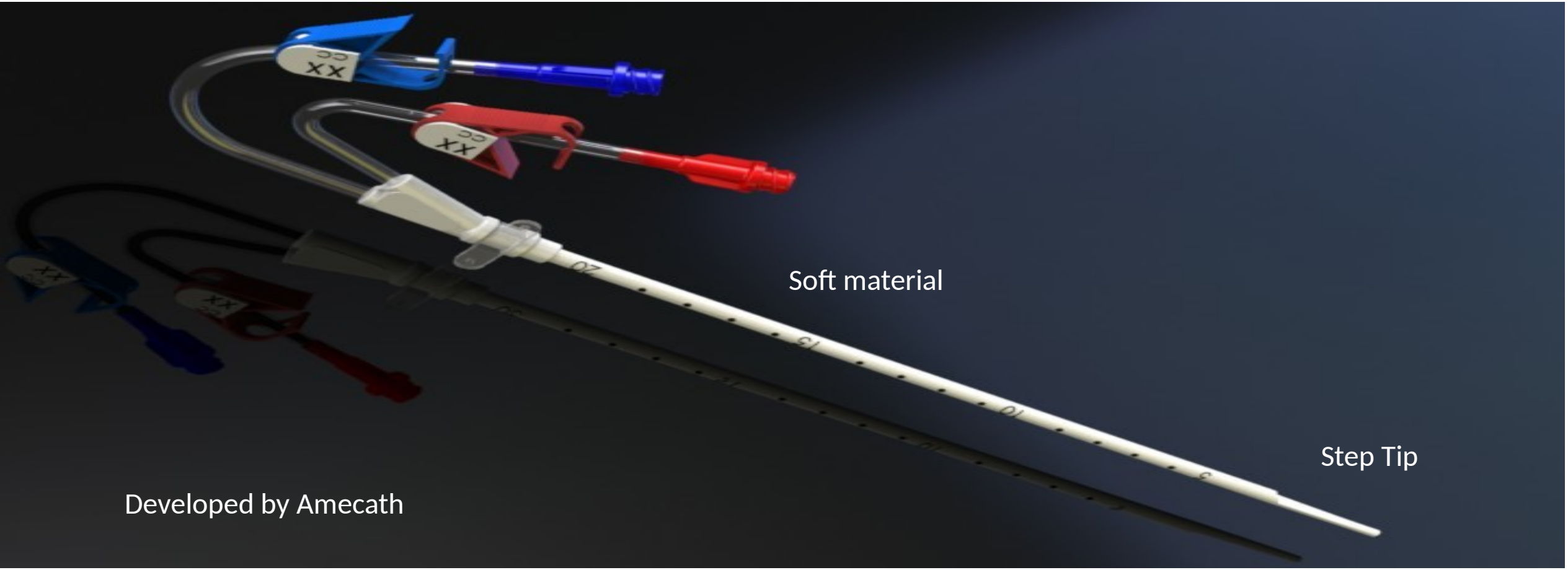
- Dacron cuff.
- Softer.
- Sheath for insertion.
- Different holes, length and material.
- Requires sedation.
- Lower neck insertion site.
- More bleeding.
- 1 year –Indefinite.

.Agarwal, Anil K, Asif Arif. NephSAP. Interventional Nephrology, ASN. 361-375.2009

3- The mid term catheter :

- The ideal catheter & solution for Developing countries and Emergency HD requirements
- Ease of insertion and Removal
- Higher BFR

A soft step tip mid-term catheter could be a solution



Unique stiffener valve guidewire

	Temporary	Mid-term	Long term
FLOW RATE	X	√	√
PATIENT COMFORT	X	√	√
DURABILITY	X	√	√√
EASY INSERTION	√	√	X
INEXPENSIVE	√	√	X
FREE OF INFECTION	X	√	√√
NO SVC THROMBOSIS/STENOSIS	X	√	√

Catheter type	Entry Site	Length	Comments
Peripheral venous catheters	Usually inserted in veins of forearm or hand	<3 inches	Phlebitis with prolonged use; rarely associated with bloodstream infection
Peripheral arterial catheters	Usually inserted in radial artery; can be placed in femoral, axillary, brachial, posterior tibial arteries	<3 inches	Low infection risk; rarely associated with bloodstream infection
Midline catheters	Inserted via the antecubital fossa into the proximal basilic or cephalic veins; does not enter central veins, peripheral catheters	3 to 8 inches	Anaphylactoid reactions have been reported with catheters made of elastomeric hydrogel; lower rates of phlebitis than short peripheral catheters
Nontunneled central venous catheters	Percutaneously inserted into central veins (subclavian, internal jugular, or femoral)	≥8 cm depending on patient size	Account for majority of CRBSI
Pulmonary artery catheters	Inserted through a Teflon® introducer in a central vein (subclavian, internal jugular, or femoral)	≥30 cm depending on patient size	Usually heparin bonded; similar rates of bloodstream infection as CVCs; subclavian site preferred to reduce infection risk
Peripherally inserted central venous catheters (PICC)	Inserted into basilic, cephalic, or brachial veins and enter the superior vena cava	≥20 cm depending on patient size	Lower rate of infection than nontunneled CVCs
Tunneled central venous catheters	Implanted into subclavian, internal jugular, or femoral veins	≥8 cm depending on patient size	Cuff inhibits migration of organisms into catheter tract; lower rate of infection than nontunneled CVC
Totally implantable	Tunneled beneath skin and have subcutaneous port accessed with a needle; implanted in subclavian or internal jugular vein	≥8 cm depending on patient size	Lowest risk for CRBSI; improved patient self-image; no need for local catheter-site care; surgery required for catheter removal
Umbilical catheters	Inserted into either umbilical vein or umbilical artery	≤6 cm depending on patient size	Risk for CRBSI similar with catheters placed in umbilical vein versus artery

Catheter-related complications

Catheter-related complications		
Catheter malfunction	-early (positional) ***-late (progressive occlusion)***	***major causes of catheter-related morbidity***
Catheter-related infections	***-blood stream infections*** -tunnel infections -exit-site infections	
Thrombosis of outflow vein		
Catheter breakage		

Major causes are written in bold italics.

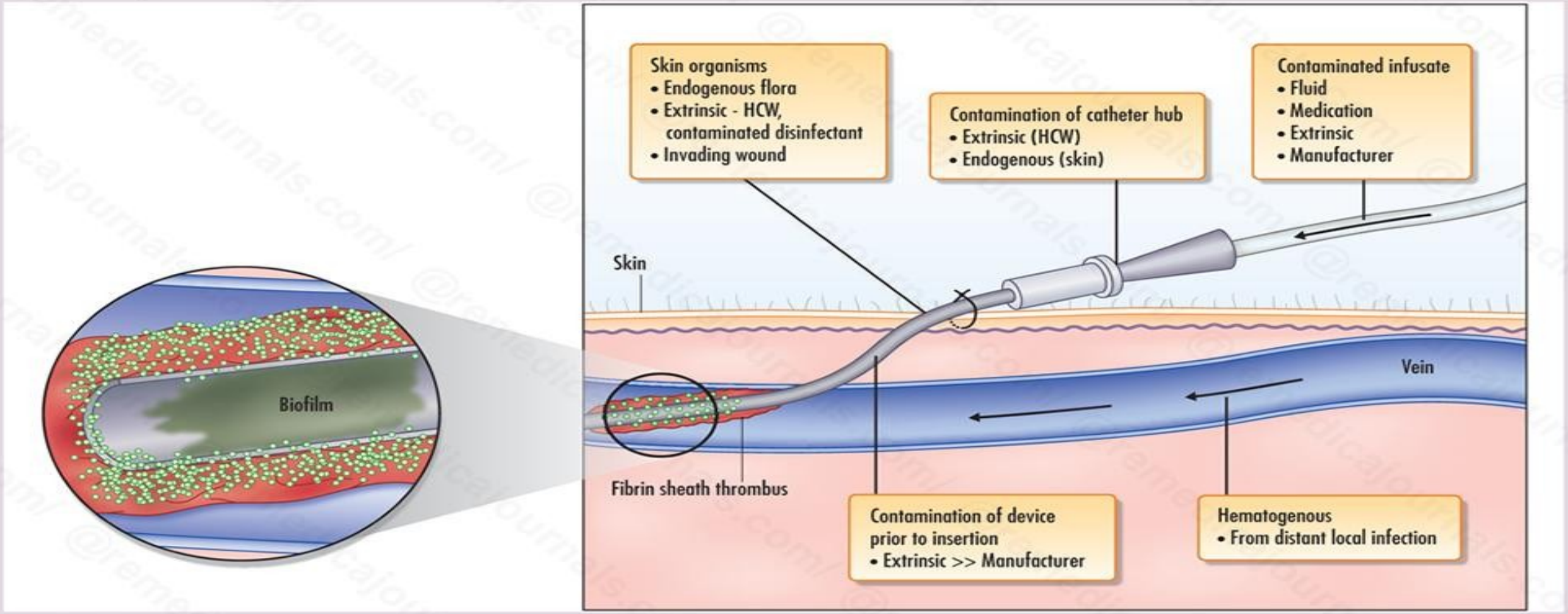
J Vasc Access 2017; 18 (Suppl 1): S34-S38

Pathogenesis:

- It has been shown that almost all indwelling vascular catheters are colonized by microorganisms
- These micro organisms are imbedded in a biofilm layer and can be present 24h after insertion .

Source of Infection:

Figure 2. Diagram of an intravenous catheter with biofilm growth.



HCW: healthcare worker.

Image courtesy of Remedica Journals
http://www.remedicajournals.com/The-Journal-of-Invasive-Fungal-Infections/BrowseIssues/Volume-5-Issue-2/Article-The-Story-of-Biofilms

The most commonly reported causative pathogens remain

- Coagulase-negative staphylococci
- Staphylococcus aureus
- Enterococci
- Candida
- Gram negative bacilli

- The rate of complications with Gram positive bacteremia is nearly twofold compared with those with Gram negative bacteremia.
- Staphylococcus aureus had been associated with most devastating metastatic complications among HD patients owing to its predilection to adhere to heart valves and bone

Risk factors:

Host- related factors

- Impaired host immunity
- Poor personal hygiene
- Occlusive dressing
- S. aureus nasal carriage
- Older age
- Diabetes mellitus
- Recent hospitalization.
- Hypoalbuminemia.
- Recent surgery.

Pathogen related factors

- Biofilm formation
- Resistance to antibiotic therapy
- Bacterial virulence
- S. aureus nasal carriage
- Contiguous infection

Catheter related factors

- Site of insertion
- Increased duration of catheter use
- History of bacteremia
- Lack of aseptic precautions during catheter insertion

Haemodialysis procedure-related factors

- Contamination of dialysate or equipment
- Inadequate water treatment
- Dialyzer reuse

Diagnosis

- Fever and chills are the most sensitive clinical features, associated with positive blood cultures in 60% to 80% of patients.
- Only 5% of patients with CRBSIs will have a concurrent exit-site or tunnel infection.
- Other clinical manifestations of CRBSIs include hemodynamic instability, altered mental status, catheter dysfunction, hypothermia, nausea/vomiting, and generalized malaise.

Lisa MM, Edward C, Christine D, Swapnil H, Joanne K, Mercedeh K, et al. Hemodialysis Tunneled Catheter-Related Infections. Can J Kidney Health Dis 2016;3:1–11.

Vascular access infection definitions

- Bloodstream

Infection Site	KDOQI Vascular Access[6]	CDC Guideline for Prevention of Device-Related Infection[6,7]	CDC Surveillance of Nosocomial Infections[6]
Bloodstream	Blood culture results positive for the presence of bacteria with or without the accompanying symptom of fever	Definite: same organism from a semiquantitative culture of the catheter tip (>15 colony-forming units/catheter segment) and from a blood culture in a symptomatic patient with no apparent other source of infection Probable: defervescence of symptoms after antibiotic therapy with or without removal of the catheter, in the setting in which blood cultures confirm infection, but catheter tip does not (or catheter tip does but blood does not) in a symptomatic patient with no other apparent source of infection	Patient has a recognized pathogen cultured from ≥1 blood culture that is not related to an infection at another site or Fever (>38°C), chills, or hypotension (at least 1 of 3) and common skin contaminant (diphtheroids, *Bacillus* or *Propionibacterium* species, coagulase-negative staphylococci, or micrococci) cultured from ≥2 blood cultures drawn on separate occasions (only 1 is necessary if appropriate antimicrobial therapy is instituted) and are not related to an infection at another site

.Agarwal, Anil K, Asif Arif. NephSAP. Interventional Nephrology, ASN. 361-375. 2009

Diagnosis (blood culture):

1- Blood Cultures from Peripheral vein + from the catheter **or** culture of the catheter tip (distal 5 cm)

OR

2- Cultures from the catheter + From Dialysis circuit or 2 quantitative blood cultures of samples obtained through the two catheter lumens

- If Same organism from both samples, CRBSI **Confirmed.**
- If both samples negative, CRBSI **Unlikely.**
- If **negative** peripheral blood culture & **positive** central blood culture, Probably **contamination** (don't treat except if Staph. Aureus), only Antibiotic lock therapy without systemic therapy for 10–14 days

Hemodialysis catheter infection complications:

- Infective endocarditis, septic arthritis, septic emboli, osteomyelitis, epidural abscess and severe sepsis, have been reported.

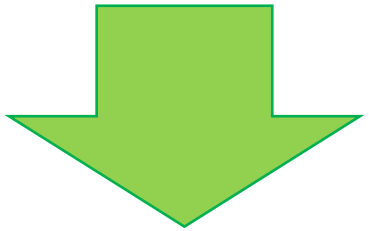
- S. aureus has been predominantly isolated from those patients as a result of the predilection of S. aureus for heart valves and bone

Management: (1)

No severe Sepsis & metastatic infections (Infective endocarditis, septic arthritis, septic emboli, osteomyelitis or epidural abscess)

&

-ve culture especially for S.aures, Fungi, pseudomonas or Mycobacteria



Catheter Salvage

Catheter Salvage:

- Start Empirical Antibiotics **+** Antibiotic Lock Therapy
- Reassess after 2-3 days: Clinically (fever) & Lab (WBC, CRP)
- If the conditions improved Continue systemic and antibiotic lock therapy for **4 weeks** , then Catheter Surveillance

- If there is no improving, Remove Catheter

Empirical Antibiotics

- The goal to cover Gram –ve + MRSA + Candida
- To cover Gram –ve by:

  Gentamycin (loading dose 2-3 mg/kg then 1 mg/kg /48-72 hrs post HDx) or Quinolones
- To cover MRSA by:

  Vancomycin (Loading dose 15-25 mg /kg, then 5-10 mg/kg after each HDx if pre-dialysis concentrations < 10mg/L & hold if concentations >25mg/L

- To cover Candida by:

  Fluconazole (200-400 mg/48 hrs or 100-200 mg/24 hrs)

- Empirical therapy for suspected catheter-related candidemia should be used for septic patients with any of the following risk factors:

1. total parenteral nutrition,
2. prolonged use of broad-spectrum antibiotics,
3. hematologic malignancy,
4. receipt of bone marrow or a solid-organ transplant,
5. femoral catheterization.

Types of Antibiotic Lock

- Cefazolin, Cephotaxim, Vancomycin, Tobramycin, Gentamyin.

Concentration: 5mg/ml.

mixed with Citrate, EDTA, Heparin, rtPA. .

Systemic AB with Antibiotic lock more effective for

- G. Neg.
- Less effective for Staph. Epidermidis.
- Worst for Staph aureus.

Maya ID, Carlton D, Estrada E, Allon M: Treatment of dialysis catheter-related Staphylococcus aureus bacteremia with antibiotic lock: A quality improvement report. Am J Kidney Dis 50: 289–295,2007

Dialyziability & Residual Renal Function Effect

- Vancomycin is not removed by HD; gentamicin is.
- Measure gent levels daily (levels will decrease sooner in patients with significant residual function).
- Monitor predialysis trough levels if possible

Lexicomp®
Smart data. Better decisions.

Management: (2)

If there is severe Sepsis & metastatic infections (Infective endocarditis, septic arthritis, septic emboli, osteomyelitis or epidural abscess)

&

+ve culture especially for S.aures, Fungi, pseudomonas or Mycobacteria

&

There is no another vascular access

Start Empirical Antibiotics as in salvage pathway then exchange catheter on guide wire If conditions improved & continue on systemic & Antibiotic lock

Management: (3)

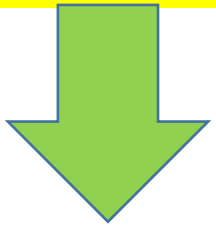
If there is severe Sepsis & metastatic infections (Infective endocarditis, septic arthritis, septic emboli, osteomyelitis or epidural abscess)

&

+ve culture especially for S.aures, Fungi, pseudomonas or Mycobacteria

&

There is another vascular access



Remove catheter

Catheter removal:

- Remove catheter and culture tip (5 cm)
- Start empirical antibiotics as in salvage pathway
- Insert temporary catheter in another site for short period of time if access is needed urgently for dialysis
- If access is not needed urgently, continue Antibiotics & Insert long term catheter ONLY if:

1- afebrile for 48-72 hours

2- CRP is normal

3- Blood cultures are -ve

Prevention - Catheter

- Strict aseptic circumstances.

- Avoid as much as possible:
  - using non-tunneled catheters.
  - using femoral

- Monitor the catheter:
  - visually when changing the dressing
  - or by palpation through an intact dressing on a regular basis.

Prevention – Exit Site

- Application of antibiotic ointment at the exit site until the insertion site has healed

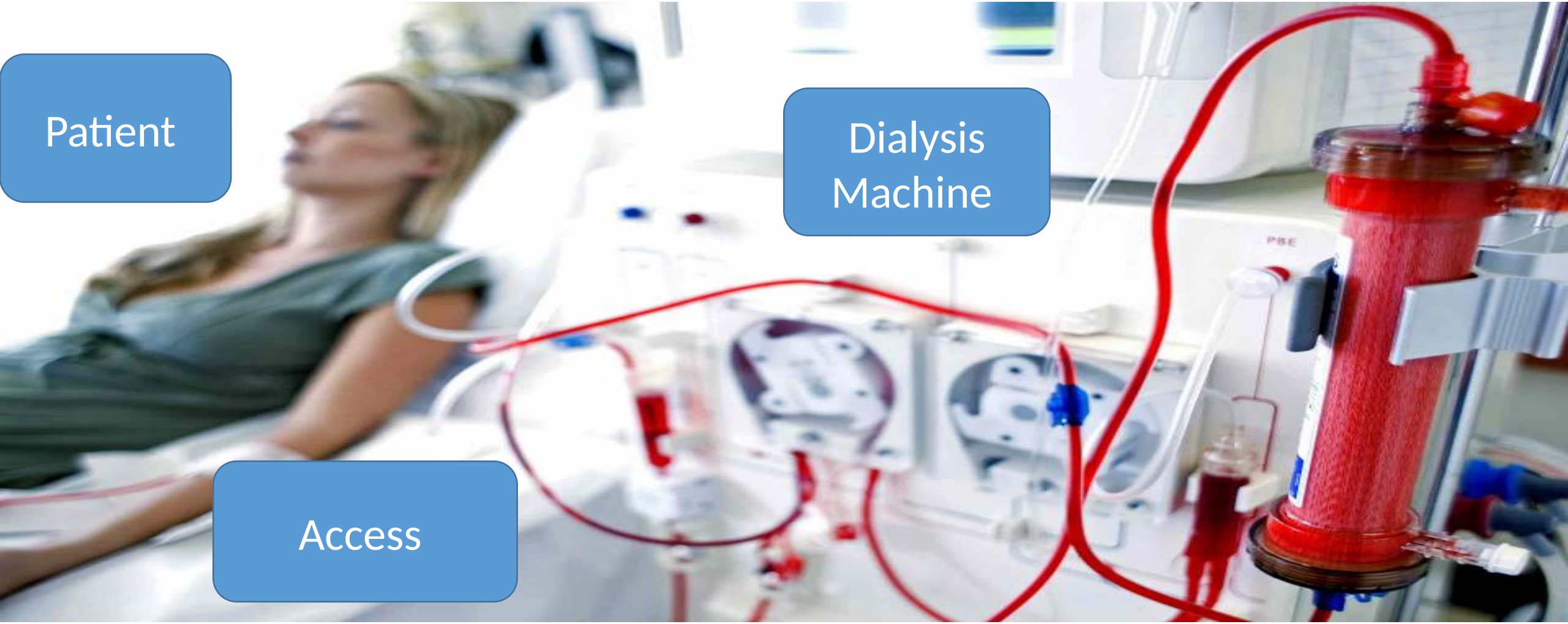
- The catheter exit site should be covered by a dressing as long as the catheter remains in place.

Prevention – Antimicrobial Lock

- Its use is debated.

- Its use may be saved to patients with:
  - history of multiple CRBSI
  - those with high risk of severe sequelae (patients with pacemakers, prosthetic valve or IV devices).

- **Citrate locks** have, for the time being, most extensively been studied. (The **4%** solution seems to offer at present the best benefit/risk ratio).



Establishing a Patent Vascular Access " Life Line" is the goal for standard of care for dialysis Patients

Conclusion

- Strict follow up of infection control policy in insertion and manipulations of dialysis catheters .
- Dialysis Access Care program
- More efforts in Patient education
- AVF First
- The mid term catheter may be a solution for Developing countries and Emergency HD requirements

THANK YOU