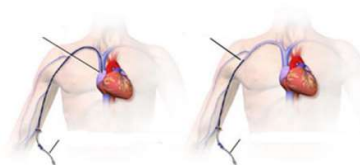


HEMODIALYSIS CATHETER RELATED BLOODSTREAM INFECTION

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- 02 CVC RELATED INFECTIONS
- 03 TREATMENT FOR CVC RELATED INFECTIONS
- 04 PREVENTION OF CVC RELATED INFECTIONS

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To achieve efficient dialysis, AV access should have sufficient blood flow.



AVF **AVG** **CATHETER**

History of CVC Development

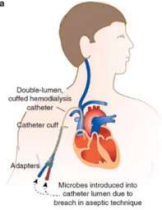
- In 1928, **Werner Fossmann**, a member of the Executive Board of the German Society of Surgery, he put himself under local anesthesia and inserted a catheter into a vein of his arm (*antecubital vein*), accessed the heart (*right atrium*) under guidance of radio contrast.
 - Developing a procedure that allowed cardiac catheterization and shared the 1956 Nobel Prize in Medicine (with Andre Frederic Cournand and Dickinson W. Richards)
- In 1953, **Sven- Ivar Seldinger** revolutionized this technique , that made the procedure more safe and easier by using flexible wire to guide a catheter to previous unreachable vascular areas of the body

1. Heiss RW. Werner Fossmann: A German Problem with the Nobel Prize. *Seminars in Anesthesiology* 1993; 30: 648.
2.

OVERVIEW OF CVC

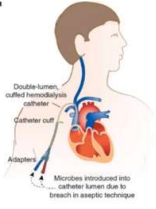
- **Central Venous Catheters for dialysis** are not only temporary accesses, but also utilized as a long-term vascular access for patients in whom an peripheral AV access cannot be readily created.
- One of the risk factors of catheter placement and using is catheter related infection, especially **bloodstream infection**.



OVERVIEW OF CVC

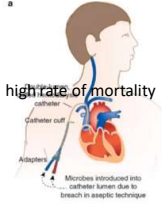
Central Venous Catheter :

- Used as vascular access for dialysis.
- **Significant role** in saving patients ' lives, indicated for dialysis, with previously immature fistula or graft.
- Short-term functioning.
- Catheter patients develop more complications, leading to higher morbidity and mortality.
- KDOQI, EBPG guidelines recommend: **limited use and as short-term as possible**




OVERVIEW OF CVC

- DOPPS study: **U.S 25%, BELGIUM 41%, UK 28%**.
- Indication: Acute Kidney Injury and Chronic Kidney Disease patients with unavailable vascular access or failed to create
- **Types of hemodialysis CVC:**
 - Uncuffed nontunneled catheter: Short-term use, not often chosen, **high rate of mortality**
 - Cuffed tunneled catheter: Long-term use, low rate of mortality.
- **Character of catheter (design and shape) : Concerning to:**
 - Efficiency (blood flow, recirculation and resistancy)
 - Risk (infection, thrombosis).



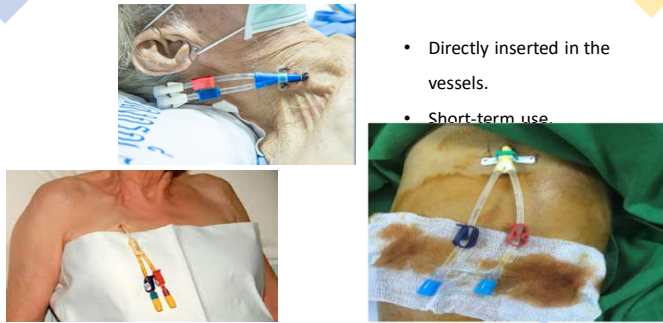
Uncuffed nontunneled catheter

- Single-lumen or dual-lumen venous catheter: polyethylene, polyurethane, **simple technique, directly.**
- Catheter length should be appropriate for the inserted position.
 - Femoral vein: 30-35cm, tip of catheter in the inferior vena cava
 - Jugular vein: 20-25cm tip of catheter at the conjunction of superior vena cava-right atrium.
- **Subclavian vein: Should not be chosen for catheter insertion** due to extremely high risk for later stenosis.
- **Ideal catheter diameter: 12-14 F.**
- Recommended period of using: Not over 7 days



Cuffed tunneled catheter

- Directly inserted in the vessels.
- Short-term use.



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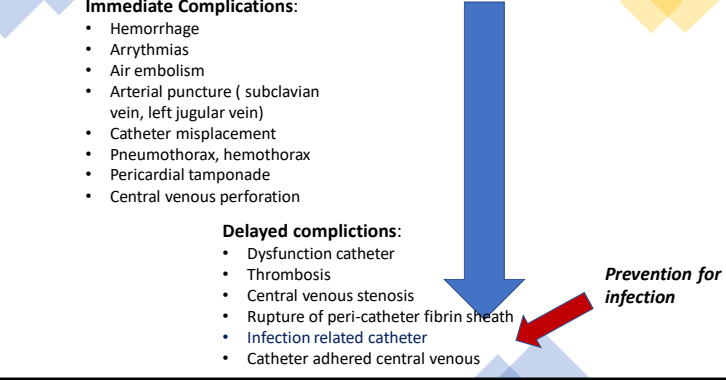
CV complications

Immediate Complications:

- Hemorrhage
- Arrhythmias
- Air embolism
- Arterial puncture (subclavian vein, left jugular vein)
- Catheter misplacement
- Pneumothorax, hemothorax
- Pericardial tamponade
- Central venous perforation

Delayed complications:

- Dysfunction catheter
- Thrombosis
- Central venous stenosis
- Rupture of peri-catheter fibrin sheath
- Infection related catheter
- Catheter adhered central venous




Catheter related infection is highest

Notes	AVF	AVG	Catheter
Primary dysfunction (%)	20-50	10-20	<5
Period of use (weeks)	6-12	2-3	Immediately
Rate of intervention	Very low(8/100 pts/yr)	Medium	High(2 times/pt/yr)
Blood flow	Excellent	Excellent	Medium
Rate of thrombosis (post dialized)	Very low	Medium	High
Rate of infection	Very low	Medium	High
Years for use (post dialized)	Longest(# 5 yrs)	Intermediate(# 2 yrs)	Shortest(< 1yr)

Catheter related infection is highest

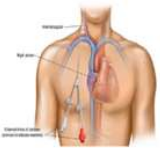
- **12% mortality in dialysis patient.**
- **19,5% ESRA patients are indicated CVC for initial hemodialysis**
- Hospital administration duration: 7 days



1. CDC Guidelines for Prevention of CRBSI 2011
 2. SC Pang, RY Tan et al. J Vasc Access 2018 (In Press)

CVC related infection – concerned risk factors

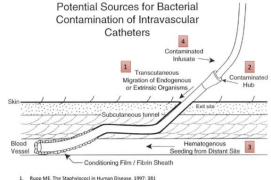
- **Patient**
- Chronic diseases
- Immunodeficiency
- Nutritional status
- Elderly
- Injured skin..



- **Catheter**
- Insertion process
- Inserted site caring
- Catheter property
- Duration of catheter use
- Staff 's skills

CVC related infection - pathology


- 1) Bacteria migrate from skin along the catheter track and/or from the catheter hubs down the lumen(s), this is the prominent source of microbes causing short-term catheter related infection in early phase of bloodstream contamination.**
- 2) Bacteria directly invade the catheter hubs through staffs ' hands or contaminated fluid or unsterile equipments.**
- 3) Hematomas, cell segments due to inserting technique, or from other site of body (less common)**
- 4) Contaminated infusion liquid, drugs**



L. Rupp ME. The Staphylococci in Human Disease. 1997: 381

CVC related infection

- Immediately after insertion, the surfaces of the intravenous CVC become coated with plasma proteins, particularly fibrin, fibronectin và laminins which become the environment for staphylococci to embed and develop.
- Staphylococcal glycalise complex facilitate bacteria invasion and widespread
- CRBSI causes more complications.



a

Double lumen catheter inserted into patient's chest

b

Microbes embedded into catheter lumen due to breach in aseptic technique

Staphylococcal glycalise complex

Attached cell

Cell-cell adhesion

Dispersed planktonic bacteria or fungi, plasma, and cell wall products enter the bloodstream

Staphylococcal glycalise complex

Catheter

1. Mermel LA, Kibbey Int 2014; 86:28

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Types of infection related CVC

Exit-site infection


Tunnel infection

Catheter-related bloodstream infection


Types of CVC related infection

Exit-site infection

- Syntomps: **swelling, erythema, tenderness, discharge or crusting at the skin exit site**, but no tunnel tenderness or purulence
- Treatment: **oral antibiotics, local antibiotics** (cream Mupirocin)




Types of CVC related infection

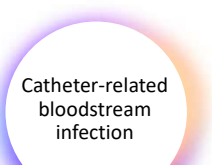


Tunnel infection

- Symptoms along the subcutaneous tunnel extending proximal to the cuff toward the insertion site and venotomy: **marked swelling, erythema, tenderness** along the catheter tract in association with purulent drainage from the exit site
- Treatments: **Intravenous antibiotics, remove the catheter**



Types of CVC related infection



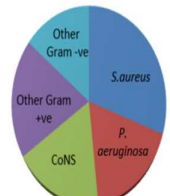
Catheter-related bloodstream infection

- The most common reason for catheter removal**
- Increase morbidity, hospitalization, mortality, cost of treatment
- Causes: Migration of skin flora, contaminated hubs or lumen(s) while operating, or bacteremia. Systemic symptoms: **high fever, chills, unstable hemodynamics**.
- Metastatic infection: osteomyelitis, septic arthritis, endocarditis, epidural abscess.
- Blood and catheter tip cultures: Blood cultures from catheter hub and from a peripheral vein to be positive with the same microorganism**

Microorganisms in hemodialysis catheter related infection

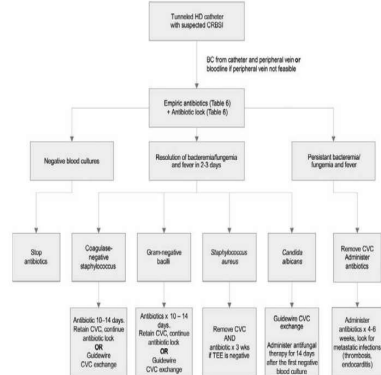
Microorganism species	Microorganism
Multi organism	
Gram-positive	Staphylococcus aureus Staphy. Epidermidis Enterococcus Corynebacterium
Gram-negative	Enterobacter Pseudomonas Acinobacter Citrobacter Cerratia Klebsiella Others
Mycobacteria	

Causative Organisms in ESIs



Revised with ESIs in the US (2006)

PRINCIPLES OF TREATMENTS FOR CVC RELATED INFECTION



```

    graph TD
      A[Tunneled CVC catheter with suspected CRBSI] --> B[BC from catheter and peripheral vein or bloodline if peripheral vein not feasible]
      B --> C[Empiric antibiotics (Table 4) + Antibiotic lock (Table 4)]
      C --> D[Negative blood cultures]
      C --> E[Resolution of bacteremia/fungemia and fever in 3-5 days]
      C --> F[Persistent bacteremia/fungemia and fever]
      D --> D1[Stop antibiotics]
      D --> D2[Continue negative staphylococcus]
      D2 --> D2a[Antibiotic 10-14 days, Repeat CVC, central antibiotic lock OR, Continue CVC exchange]
      E --> E1[Gram-negative bacilli]
      E1 --> E1a[Antibiotic x 10-14 days, Repeat CVC, central antibiotic lock OR, Continue CVC exchange]
      E --> E2[Staphylococcus aureus]
      E2 --> E2a[Remove CVC AND antibiotic 14 days if TEE is negative]
      E --> E3[Candida albicans]
      E3 --> E3a[Continue CVC exchange]
      E3a --> E3b[Administer antifungal therapy for 14 days after the first negative blood culture]
      F --> F1[Remove CVC Administer antibiotics]
      F1 --> F1a[Administer antibiotics x 6 weeks, look for metastatic infections (osteomyelitis, endocarditis)]
    
```

Figure 4. Catheter-related blood stream infection (CRBSI) among patients who are undergoing hemodialysis (HD) with tunneled catheters. BC, blood culture; CVC, central venous catheter; TEE, transesophageal echocardiogram.

PRINCIPLES OF TREATMENT FOR CVC RELATED INFECTION

1. **Empirical antibiotic therapy** should include vancomycin and coverage for gram-negative bacilli, based on the local antibiogram (e.g., third-generation cephalosporin)
2. **Adjunctive therapy:** Antibiotic Locks: Indicated for pts with CRBSI involving long-term catheters with no signs of exit-site or tunnel infection for whom catheter salvage is the goal
3. **Catheter removal:** Indicated for pts remaining fever, persistently positive blood cultures, or metastatic infections: osteomyelitis, septic arthritis, endocarditis, epidural abscess


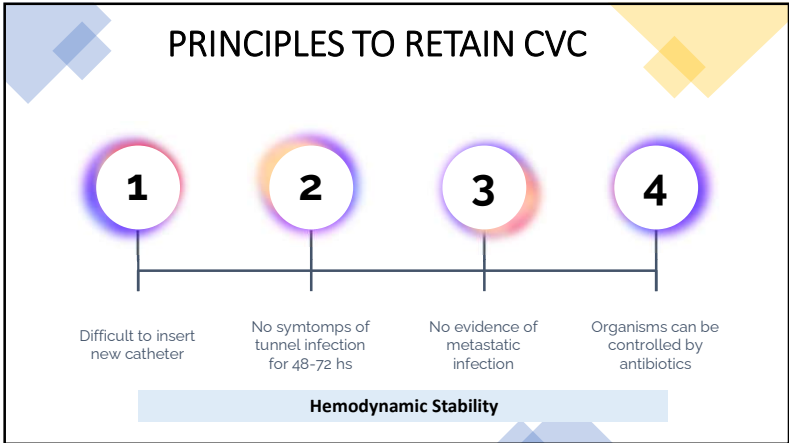
PRINCIPLES OF TREATMENT FOR CVC RELATED INFECTION

Antibiotics are dissolved with Heparin 2500-5000 unit/ ml or citrate 4% as the following concentration:

- Amikacin 25 mg/mL
- Amphotericin B 2.5 mg/mL
- Ampicillin 10 mg/mL
- Cefazolin 5 mg/mL
- Cefazolin 5 mg/mL plus gentamicin 1 mg/mL
- Ceftazidime 5 mg/mL
- Ciprofloxacin 0.2 mg/mL
- Daptomycin 5 mg/mL
- Linezolid 1 mg/mL
- Gentamicin 1 mg/mL
- Gentamicin 1 mg/mL plus vancomycin 2.5 mg/mL

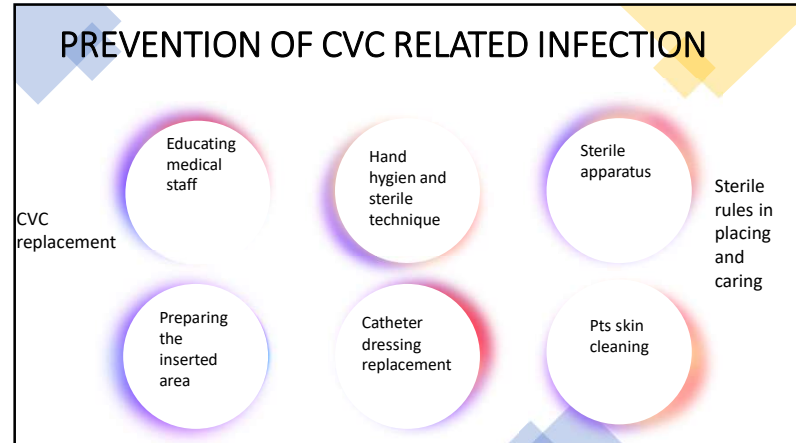
PRINCIPLES OF TREATMENT FOR CVC RELATED INFECTION

- **Catheter removal due to CRBSI : Not simple.**
- Catheter removal with inserting new catheter at another location after infection status is resolved.
- **Catheter salvage maneuvers: Only 30%.**
- Antibiotics dissolved in heparin or citrate :vancomycin 2.5 mg/ml, gentamicin 1 mg/ml và heparin 2500 U/ml.
- **→Resolving rate is 50-70% with antibiotic locks.**
- Catheter replacement over a guidewire post antibiotics use for 48hrs.

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PREVENTION OF CVC RELATED INFECTION

Using catheter:

- Clean caps or the catheter-bloodline port with povidone-iodine 3-5 ms before opening .
- Lumen and hub of catheter should not be directly opened into the air.
- A cap or a syringe is placed over the catheter while keeping the inferior area clean.
- Patients wear facemasks, medical staffs wear facemasks, sterile gowns, sterile gloves while inserting, opening caps and connecting catheters

- ### PREVENTION OF CVC RELATED INFECTION
- Remove the catheter as soon as possible
 - **NKF-K/DOQI guidelines:**
 - Temporary uncuffed catheter : Duration for using: Femoral vein: Not over 7 days, internal jugular vien: Not over 3 weeks .
 - Long-term indication → cuffed tunneled catheter.

CONCLUSION

- Prevention of catheter related infection needs the usually standard operation.
- Catheter should never ever be operated by untrained staff.
- After placing catheters, permanent blood vessels should be created urgently. Remove the catheter whenever the fistula is mature and functional.

