A Primer on Central Venous Access: Peripherally-Inserted Central Catheters, Tunneled Catheters, and Subcutaneous Ports

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Disclosures
- No conflicts of interest relevant to this presentation

Outline
- Review available devices
- Knowledge of clinical needs
- Device insertion techniques
- Management of catheter insertion and post-insertion complications

Types of Central Lines
- Peripherally inserted central catheters (PICCs)
- Nontunneled central venous catheters (CVCs)
- Open-ended tunneled catheters
- Tunneled valved catheters
- Implantable subcutaneous ports
  - Chest ports
  - Arm ports

Clinical Algorithm for Appropriate Catheter Selection

PICCs and Non-tunneled Catheters
- Indications:
  1. Rapid fluid or blood-product infusion to maintain hemodynamic stability
  2. Infusion of hypertonic or sclerosing solutions
  3. Administration of medications that cause venous inflammation
      • Chemotherapeutic/cytotoxic agents
      • Inotropic medications
  4. Total Parenteral Nutrition
  5. Active infection or uncorrectable coagulopathy precluding placement of more permanent device
PICCs (cont.)

- **Contraindications**
  1. No suitable upper arm veins
  2. Known central venous occlusion
     - Consider midline PICC
     - Hyperosmolar or vesicant infusate?
  3. Patient currently undergoing HD or in whom HD is anticipated, **INCLUDING PATIENTS WITH FUNCTIONING RENAL TRANSPLANTS!**

End-hole PICCs

- Catheter materials (silicone, polyurethane)
- Catheter diameters (1.1 to 7 French)
- Number of lumina (1-3)
- Catheter tips (end-hole, valved)

Valve-tipped PICCs

- Do not require routine heparinization to prevent catheter thrombosis

**Technique: Venous Cannulation**
Guidewire passage into the inferior vena cava confirms venous cannulation.

2. Pass 0.018” guidewire to cavoatrial junction

3. Place peel-away sheath over guidewire

4. Measure distance from skin to right atrium

5. Trim PICC to appropriate length

6. Pass PICC through peel-away sheath

7. Peel sheath away

PICC Insertion Complications
- Hemorrhage (<1%)
- Arterial puncture
- Nerve Injury
- Air embolism
- Cardiac arrhythmia
- Catheter malposition

Catheter tip malpositioned in azygos arch
Post-insertion Complications
- Infection
- Thrombosis
- Catheter occlusion
- Dislodgement
- Malpositioning
- Catheter fracture

PICC-Associated Bloodstream Infection
- Historically, PICCs perceived as posing lower risk of bloodstream infection than CVCs
- Infection rates for PICCs are reported to be 1-2 per 1000 catheter days
- Compare to 3.7-5.3 per 1000 catheter days for non-tunneled CVCs

PICC-associated Bloodstream Infections
- Determine true number of lumina that are required based on the number of infusates
- Multi-lumen PICCs increase risk of bloodstream infection and accelerate time to infectious complications

PICC-Associated Thrombosis
- Pericatheter fibrin sheath formation
- Peripheral venous thrombosis
- Central venous thrombosis

Chopra V, O’Horo JC, Rogers MA, Maki DG, Safdar N. The risk of bloodstream infection associated with peripherally inserted central catheters compared with central venous catheters in adults, a systematic review and meta-analysis. *Infect Control Hosp Epidemiol.* 2013;34(9):908-918
- Systematic review and meta-analysis of 23 studies and 57,250 patients
- PICCs placed in hospitalized patients were associated with infection rates similar to those related to other central venous catheters (incidence ratio rate 0.91, 95% confidence interval [CI], 0.46-1.70)

PICC-associated Thrombosis

- Peripheral venous thrombosis is not infrequent, overall thrombosis rate as high as 23-38%\textsuperscript{1,2}
- Symptomatic thrombosis rate 1-4\%\textsuperscript{2}
- Incidence of thrombosis by access site\textsuperscript{2}
  - Brachial vein 10\%
  - Basilic vein 14\%
  - Cephalic vein 57\%
- Treatment: Catheter removal and anticoagulation therapy alone

Subcutaneous Ports

- Indications:
  - Central venous access required intermittently for many months to years
  - Chemotherapy
  - Prolonged antibiotic therapy (i.e. cystic fibrosis)
  - Administration of blood products and TPN
  - Erythrocytapheresis for patients with sickle cell disease (Vortex Port System)

Subcutaneous Ports

- Contraindications:
  - Infection
  - Uncorrectable coagulopathy or thrombocytopenia (platelet count < 50,000/µL)
  - Leukopenia (WBC count ≤ 3000 cells/µL) or neutropenia (ANC ≤ 500 cells/µL)
  - Central venous occlusion
  - Inpatient port placement\textsuperscript{1,2}

Technique: Chest Port Placement

1. Buffered 1% lidocaine is infiltrated for local anesthesia
2. A 21-G Echo-Tip micropuncture needle is advanced into the internal jugular vein
3. A 0.018 inch guidewire is passed to the right atrium
4. Needle exchanged for 5 Fr transitional dilator and sheath (micropuncture sheath)
5. Inner dilator and 0.018 inch guidewire removed; 0.038 inch guidewire passed into IVC

6. Select incision site for reservoir pocket
2-3 finger-breadths below clavicle

7. Anesthetize pocket and tunnel site with 1% lidocaine with epinephrine

8. Incise skin with one smooth motion using #15 scalpel

9. Continue dissection into subcuticular layer

10. Use Kelly clamp to bluntly dissect reservoir pocket

11. Use tunneling device to tunnel catheter from reservoir pocket to venotomy site

12. Pass catheter through tunnel

13. Clamp catheter at pocket

14. Exchange 5 Fr transitional sheath for 8 Fr dilator + peel-away sheath combo

15. Remove guidewire and inner dilator; feed catheter through peel-away sheath

16. Cut catheter to length

17. Affix locking mechanism and port reservoir to catheter

18. Place port into pocket

19. Reduce catheter redundancy and remove remainder of peel-away sheath

20. Close reservoir pocket in layers using 3-0 and 4-0 absorbable suture

Port Complications

- Early Complications
  - Air Embolism
  - Pneumothorax
  - Arterial Puncture
  - Migration/Malposition

- Late Complications
  - Infection
  - Central vein thrombosis
  - Pericatheter fibrin sheath
  - Pinch-off syndrome/catheter fracture and embolization
Pericatheter Fibrin Sheath

- Very typical clinical scenario
- Inability to aspirate from catheter
- Catheter flushes with ease

Pinch-off Syndrome
Summary

- **Right line, right place, right time!**
  - It is imperative to take into account all patient, device, and provider factors to minimize catheter-associated bloodstream infections.
  - Careful policy and procedural oversight is essential to minimize PICC-associated thrombosis.
  - Outpatient placement of subcutaneous venous access ports reduces the rate of infection and wound dehiscence compared with inpatient placement.