Central Venous Catheters

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Objectives for CVC Placement

- Understand the indications and contraindications
- Determine appropriate CVC site selection
- Describe the procedural steps
- Recognize common CVC complications
Indications include medication administration, hemodynamic monitoring, poor peripheral IV access & venous access to place other devices.

There are no absolute contraindications. Relative contraindications depend on patient specific factors.

While the preferred CVC site varies between patients, subclavian and internal jugular veins have significantly fewer infectious and mechanical complications than femoral veins.

AHRQ Safety Practices recommend US guidance and use of maximal sterile barriers when placing CVCs.

Seldinger technique uses an access needle, guidewire and dilator to insert the CVC safely into the vessel.

Common immediate complications include arterial puncture, hematoma and pneumothorax. Common delayed complications include infection and thrombosis.
Indications

- Administer Meds
  - Infuse meds (ie, vasopressors, chemotherapy) or parenteral nutrition that cause phlebitis/sclerosis when given through peripheral IVs
- Hemodynamic monitoring
  - Measurement of central venous pressure, venous oxyhemoglobin saturation & cardiac parameters (via pulmonary artery catheter)
- Poor peripheral venous access
- Perform ultrafiltration, plasmapheresis/apheresis, HD or other blood filtering process
- Venous sheath access to place other devices
  - IVC filters, venous stents, cardiac pacemakers/defibrillators

Note that...
- ~8% hospitalized pts require CVCs
- >5 mil CVCs inserted annually in US
- >15% pts have CVC complications
Contraindications

No *absolute* contraindications. Important *relative* contraindications:

- Coagulopathy & Thrombocytopenia
  - Target values: INR <1.5, PTT <40, Plts >50K
  - No literature to support correcting these abnormalities
  - Expert opinion recommends most experienced individual available perform procedure
  - Avoid subclavian vein as difficult to monitor bleeding & effectively compress venipuncture site
- Infected area overlying target vein
- Anatomic distortion or injury proximal to insertion site
- Other indwelling intravascular hardware at site (ie, pacemaker, HD catheter)
- Fracture or suspected fracture of clavicle or proximal ribs (for Subclavian)
- Thrombosis of target vein
- Complications would be life-threatening (ie, PTX in hypoxic pt)
## Site selection

<table>
<thead>
<tr>
<th>Internal jugular</th>
<th>PROs</th>
<th>CONs</th>
</tr>
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<tbody>
<tr>
<td>Minimal risk of pneumothorax (especially with US guidance)</td>
<td>Not ideal for prolonged access</td>
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<tr>
<td>Head-of-table access</td>
<td>Risk of carotid artery puncture</td>
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<tr>
<td>Procedure-related bleeding amenable to direct pressure</td>
<td>Uncomfortable</td>
<td></td>
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<tr>
<td>Lower failure rate with novice operator</td>
<td>Dressings and catheter difficult to maintain</td>
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<tr>
<td>Excellent target using US guidance</td>
<td>Thoracic duct injury possible on left</td>
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<tr>
<td>Poor landmarks in obese/edematous patients</td>
<td>Potential access and maintenance issues with concomitant tracheostomy</td>
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<tr>
<td></td>
<td>Vein prone to collapse with hypovolemia</td>
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<td></td>
<td>Difficult access during emergencies when airway control being established</td>
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<table>
<thead>
<tr>
<th>Subclavian</th>
<th>PROs</th>
<th>CONs</th>
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<tbody>
<tr>
<td>Easier to maintain dressings</td>
<td>Increased risk of pneumothorax</td>
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<tr>
<td>More comfortable for patient</td>
<td>Procedure-related bleeding less amenable to direct pressure</td>
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<tr>
<td>Better landmarks in obese patients</td>
<td>Decreased success rate with inexperience</td>
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<tr>
<td>Accessible when airway control is being established</td>
<td>Longer path from skin to vessel</td>
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<tr>
<td></td>
<td>Catheter malposition more common (especially right SCV)</td>
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<td></td>
<td>Interference with chest compressions</td>
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<table>
<thead>
<tr>
<th>Femoral</th>
<th>PROs</th>
<th>CONs</th>
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<tbody>
<tr>
<td>Rapid access with high success rate</td>
<td>Delayed circulation of drugs during CPR</td>
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<tr>
<td>Does not interfere with CPR</td>
<td>Prevents patient mobilization</td>
<td></td>
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<tr>
<td>Does not interfere with intubation</td>
<td>Difficult to keep site sterile</td>
<td></td>
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<tr>
<td>No risk of pneumothorax</td>
<td>Difficult for PA catheter insertion</td>
<td></td>
</tr>
<tr>
<td>Trendelenburg position not necessary during insertion</td>
<td>Increased risk of iliofemoral thrombosis</td>
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</table>
Ultrasound Guidance

- Use high frequency probe (5-10MHz)
- Scan potential insertion sites
  - Evaluate venous patency with compression
  - Facilitate patient positioning to optimize vessel location
- Identify vein
  - Non-pulsatile, compressible (if hypotensive, artery may compress)
  - Often irregularly shaped compared to artery
  - Thinner vessel wall than artery
  - Often bigger than artery (if volume depleted, may be smaller)
- Complication rate 6x higher with ≥3 insertion attempts v. single attempt
  - US can improve 1st attempt success and ↓ cannulation attempts
  - US can ↓ time to venous cannulation, ↓ complications
**IJ vein Landmarks:**

- apex of triangle formed by SCM heads & clavicle
- lateral to carotid pulse
- aim for ipsilateral nipple
SC vein Landmarks:

- crosses under clavicle just medial to mid-clavicular point
- ~2cm lateral, ~2cm caudal to middle third of clavicle
Preparation

- Review labs or imaging
- Use clinical info to determine best site
- US site to confirm vessel patency
- Review allergies to meds & tape
- Obtain informed consent
- Position patient for procedure AND your comfort
  - Supine, Trendelenberg 15-30°
  - Rotate head 45° away from cannulation site
- Monitor if possible (telemetry, pulsox)
- O₂ available, consider use prior to draping patient
- ‘Universal Time-Out’
**Equipment for central venous cannulation; in order of use during procedure**

<table>
<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>2 percent chlorhexidine skin preparation solution</td>
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<tr>
<td>Sterile gown, gloves, face shield and cap</td>
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<tr>
<td>Sterile gauze pads: 4” x 4”</td>
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<tr>
<td>Sterile drapes</td>
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<tr>
<td>1 percent lidocaine; 5cc</td>
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<tr>
<td>25 Ga. needle with 3cc lock-tip syringe</td>
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<tr>
<td>Seeker needle: 3.5 cm 22 Ga. needle with 5cc slip-tip syringe</td>
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<tr>
<td>Introducer needle: 6 cm 18 Ga. large bore needle with 5cc slip-tip syringe</td>
</tr>
<tr>
<td>J-tip guidewire</td>
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<tr>
<td>Transduction catheter: 6 cm 18 Ga. catheter</td>
</tr>
<tr>
<td>Transduction tubing</td>
</tr>
<tr>
<td>Tissue dilator</td>
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<tr>
<td>Sterile catheter flush solution</td>
</tr>
<tr>
<td>Catheter</td>
</tr>
<tr>
<td>Sterile sleeve for the catheter</td>
</tr>
<tr>
<td>2-0 silk sutures</td>
</tr>
<tr>
<td>Sterile dressing</td>
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Sterile Technique

- Non-sterile mask & cap for everyone present
- Non-sterile cap on patient
- Proper hand hygiene
- Wear sterile gown & gloves
- Open sterile kit & get organized
  - Prepare/flush all ports of CVC
- Prep site
  - 30sec continuous scrubbing with Chlorhexidine
  - allow site to fully dry
- Use wide sterile drape
- Use sterile US probe cover
Procedure Steps

- Re-identify vein on US
  - Use non-dominant hand to hold US probe

- Anesthetize cannulation site
  - Use 1% lidocaine with 25g needle
  - Aspirate before injecting
    - (lidocaine causes vasospasm & systemic effects!)
  - Only 1-2 ml to avoid creation of distracting fluid pocket on US
Seldinger Technique

- Cannulate vein with US guidance (preferred)
  - Advance needle at 45° angle
  - Maintain negative pressure (aspirate) as advance needle until vein punctured

- Use non-dominant hand (set aside US) to grasp needle
  - Brace hand against pt’s body to stabilize & maintain needle position
  - Lower angle of needle

- Disconnect syringe with dominant hand
  - If no blood seen from hub:
    - Reconect immediately
    - Aspirate to ensure proper needle placement
    - Consider ↑ Trendelenburg
Seldinger Technique

- Insert guidewire through needle
  - Should thread easily, w/o resistance, don’t force it!
  - Never let go of wire
- Don’t over-insert guidewire
  - End of guidewire remains longer than pt’s head (IJ) or shoulder (SC)
  - If arrhythmia noted, pull wire back until rhythm normalizes
- Remove needle while controlling guidewire
- Use scalpel to make skin nick adjacent to wire
Seldinger Technique

- Advance dilator over guidewire
- Don’t over-insert dilator
  - Advance it ≤ 5cm from skin surface
  - Non-obese, shallow vessel only insert ~2cm
- Remove the dilator
**Seldinger Technique**

- Thread catheter over guidewire
  - Hold wire taut to make catheter slide on wire easier
  - Don’t accidentally pull wire back until catheter in

Catheter indwelling length depends on both insertion site & pt size

- **Average guidelines:**
  - RIJ 13cm, LIJ 18-20cm
  - RSC 15cm, LSC 18cm
  - Femoral 20cm or longer
Seldinger Technique

- Remove guidewire
- Aspirate blood from all ports & flush with saline
- Secure catheter with sutures
  - Do not overtighten sutures, can lead to skin necrosis then sutures come out
- Apply sterile dressing
  - Use Biopatch if available, “blue” side points up to “sky”
- Remove sterile drape carefully
  - Do not dislodge CVC, it can get caught in drape
Obtain CXR (IJ, SC) to confirm catheter tip position
  - Tip in right atrium or SVC
  - Malposition of tip increases venous thrombosis risk
  - CXR also allows evaluation for PTX

Clarify with RNs whether line ready to use or if CXR required
  - OK to draw urgent/emergent labs from functioning line w/o CXR results

Clarify line flushing orders—saline or heparin?

Write procedure note
Procedure Note

- Name of procedure performed
- Date & time
- Indication
- Clinician(s) involved
- Refer to Informed Consent & Universal Time-Out
- Note use of wide sterile barriers & proper hand hygiene
- Was US used?
- Vessel(s) cannulated, number of attempts
- Type catheter, # lumens, insertion length
- Patient status during & after procedure
- Whether post-procedure CXR ordered
- Relevant findings/events during procedure
Review of Complications*

<table>
<thead>
<tr>
<th>Immediate Complications</th>
<th>Delayed Complications</th>
</tr>
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<tbody>
<tr>
<td>Arterial puncture</td>
<td>Infection</td>
</tr>
<tr>
<td>Hematoma, Bleeding</td>
<td>Venous thrombosis, PE</td>
</tr>
<tr>
<td>Pneumothorax, Hemothorax</td>
<td>Catheter migration</td>
</tr>
<tr>
<td>Arrythmia</td>
<td>Catheter embolization</td>
</tr>
<tr>
<td>Air embolism</td>
<td>Myocardial perforation</td>
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<tr>
<td>Catheter malposition</td>
<td>Nerve injury</td>
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*Remember for informed consent

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<thead>
<tr>
<th>Complication</th>
<th>Risk of Complication at Catheterization Site*</th>
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<tbody>
<tr>
<td></td>
<td>Internal Jugular Vein</td>
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<tr>
<td>--------------------------------</td>
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</tr>
<tr>
<td>Pneumothorax (%)</td>
<td>&lt;0.1 to 0.2</td>
</tr>
<tr>
<td>Hemothorax (%)</td>
<td>NA</td>
</tr>
<tr>
<td>Infection (rate per 1000 catheter-days)</td>
<td>8.6</td>
</tr>
<tr>
<td>Thrombosis (rate per 1000 catheter-days)</td>
<td>1.2 to 3</td>
</tr>
<tr>
<td>Arterial puncture (%)</td>
<td>3</td>
</tr>
<tr>
<td>Malposition</td>
<td>Low risk (into inferior vena cava, passing through right atrium)</td>
</tr>
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Key References


Web-based resources


Web-based resources: Videos in Clinical Medicine
