

Kit:

- dressing pack (includes medium gloves, swabs, pot)
- sterile gown
- mask (and some say eye protection...)
- iodine
- 10ml syringe for anaesthetic
- 10ml 1% lidocaine
- 1 orange + 1 or more green needles + 1 drawing-up needle
- at least one more 20ml syringe
- central line pack (e.g. triple lumen) — includes introducer needle and syringe, *another pointless thing a bit like the introducer needle... is basically a long Venflon for external jugular venous cannulation*, wire, sheathed blade, dilator, line, flexible rubber line half-clamp, rigid suture clamp.
- ± extra blade with point (sometimes the blade supplied has no point and is difficult to use)
- at least 3 large sterile towels
- at least 50ml saline
- 3 three-way taps (for a triple-lumen line)
- e.g. 2/0 suture with curved cutting needle
- Mefilm dressing

Beware allergies: lidocaine, iodine.

Method:

1. check clotting
2. assistant highly advisable
3. some use ECG monitoring
4. ultrasound guidance helps substantially (veins are compressible; arteries aren't; the RIJV often lies on the carotid). Can either use portable US to mark out or simply learn where the vein is, or wrap the US probe in a sterile bag (e.g. the bin bag that comes with the dressing pack) that is *well filled* with jelly, and then the outside well covered with jelly, and then you can use the probe while you're sterile.
5. use treatment room or sideroom with plenty of space. Two trolleys may help, and/or plenty of space to the right of the patient's head.
6. verbal consent and explanation
7. set up patient lying flat, with head of the bed removed, and a slight head-down tilt (can do this just before you start if sufficient assistants available); turn head to left and slightly up
8. mark out landmarks (e.g. sketch on in pen): superior border of clavicle; 'inner' borders of the two heads of sternocleidomastoid (i.e. lateral edge of medial head + medial edge of lateral head); carotid pulsation (expect to be under medial head of SCM)
9. ensure kit set up with
 - lidocaine vials open
 - bin bag set up
 - gloves moved off pot
 - iodine poured out into pot
 - saline poured out into pot (ensure no iodine gets in the saline, as the saline is going IV!) — can squeeze out the little plastic containers of saline
10. go sterile
11. sterilize skin with iodine (including right up and including to the earlobe, and down below the clavicle); then dry the business area
12. more setup:
 - draw up lidocaine in 10ml syringe
 - draw up saline in 20ml syringe
 - sterile towels on patient (e.g. 1—chest; 2—laterally; 3—medially and over face). Works well to stick the towels to the wet bit from the peripheral iodine.
 - assistant to open line pack — easiest to leave line in pack and place pack face-up on right-hand towel
 - take cover off line tip
 - for each of the three lumina: uncap line, put saline syringe into line, unclamp line, flush line, reclamp, remove syringe, recap line — *except that you don't recap the central (distal) lumen line, which is the one that flushes right out of the tip of the central line, rather than emerging near to the tip.*
 - fill introducer syringe with saline and flush through introducer
 - ensure wire feeds easily through wire guide; insert wire into introducer needle and ensure it feeds easily through that; retract wire so it just pokes out of wire guide and is ready to go

- lay out: want introducer needle, wire, and line easily available at your right hand, so you can reach them without moving.
13. OK... **Keep left-hand fingers on carotid pulsation.** Ready to go.
 14. **SMALL NEEDLE IN.** Infiltrate lidocaine (orange needle for skin bleb; then deeper with green needle). **Infiltrate at 45° (i.e. steeply), starting a couple of cm above the clavicle and ~1cm to right of carotid. Should be able to reach RIJV with green needle/syringe. Common mistake: aiming too shallowly. Ensure you aspirate before injecting local.** If vein reached, fine. If not, may need to re-angle (perhaps with a fresh syringe full of saline, if you've used up all the local). Try more medially; RIJV may lie on top of carotid.
 15. When RIJV found, take a careful look at where the needle is.
 16. Remove green needle/syringe.
 17. **BIG NEEDLE IN.** Pick up introducer and insert introducer needle to the same point. Should be able to aspirate blood into saline-filled syringe. Should be non-pulsatile blood (\Rightarrow venous). **Pulsatile blood suggests arterial** (see below). When cannulated, advance slightly further, still at 45°, to ensure whole needle tip is in vein. Then flatten slightly and advance slightly further. You're in.
 18. Hold needle with left hand; remove syringe. Blood will probably flow. It may gush out a bit (e.g. if CVP is fairly high at +20 cmH₂O, blood may shoot *up to* ~20cm in the air above the right atrium, although flow resistance in the needle will reduce this). Put left thumb over tip to stem flow.
 - **If you're in the carotid artery**, expect pulsatile, high-force blood flow (e.g. since the density of mercury is 13.6 g/cm³ and the density of water is 1 g/cm³, we can calculate that if systolic BP is 120 mmHg = 120 × 13.6 mmH₂O = 1632 mmH₂O = 163 cmH₂O, you could get a jet of blood *up to* 1.6m vertically upwards, although flow resistance in the needle will reduce this; the maximum is more/less in hyper/hypotension). **If in doubt as to whether arterial or venous**, get an assistant to give you a blood gas syringe; fill that, ask them to check it quickly. (Typically, venous SaO₂ < 70%, arterial SaO₂ ~98% in healthy person; may need to compare to known arterial sample or pulse oximetry if arterial oxygenation really dodgy.)
 - **If you're in the carotid artery**, remove the needle and **press firmly** with a swab for >5 min (more if particular bleeding tendency). Then probably best to wait a while before trying again (haematoma makes things difficult) unless very urgent.
 19. **WIRE INTO BIG NEEDLE.** When happy with position, pick up the wire guide with your right hand and insert it into the introducer needle. Then feed the wire gently in. It should go easily. **The wire is long.** You just need to feed it far enough in that it's clearly beyond the needle tip.
 20. Pull the wire guide slightly back, exposing the wire between the introducer needle (in the patient) and the wire guide. Take hold of the wire. From now on, **NEVER LET GO OF THE WIRE.** Remove the wire guide (feeder) entirely. You now have only the introducer needle and the wire in the patient.
 21. If the wire is pulsatile, it may be in the right atrium (or conceivably in the right ventricle). Watch your ECG monitor, if you're using one (ectopics? pull back). If it's strongly pulsatile, pull back. *But veins can be pulsatile; (1) the RIJV can lie on top of the carotid and the carotid pulsation can be transmitted; (2) the JVP is a pulsation; you can feel it sometimes. If in doubt, do a blood gas.*
 22. **BIG NEEDLE OUT, LEAVING WIRE.** Using your three hands... oh dear... never mind. Have a swab ready in your left hand. Pull the introducer needle back over the wire, without pulling the wire backwards. As soon as the needle comes out, grasp the wire that is exposed in front of the needle tip (minding the tip! don't go too close to it). Remove the introducer needle, **keeping hold of the wire at all times**, and press on the wound as it will bleed.
 23. While pressing with your left hand, pick up and unsheath the blade. Make a cut in the skin a few mm long at the site of the wound (big enough that the dilator will fit).
 24. **DILATOR OVER WIRE.** Put the blade down and pick up the dilator. Thread the dilator onto the wire, **never letting go of the wire.** Have the dilator just in front of the wound. When ready, remove your (left-hand) swab; grasp the near end of the wire with your left hand, so you'll never let go of the wire, and slide the dilator down the wire into the vein at a fairly **shallow** angle, in one smooth motion if possible. **Keep the wire moving up and down slightly; the wire must move freely in the dilator at all times** (because the moment of dilation is the point at which you are most likely to kink the wire otherwise). Slide the dilator back out and **press** with the swab, while keeping hold of the wire, because now the wound will bleed substantially since there's a much bigger hole.
 25. **LINE OVER WIRE INTO VEIN.** Discard the dilator and pick up the central line. You should have *no cap* on the central (distal) lumen. Thread the central line over the wire until the wire emerges from the end. **Without ever letting go of the wire**, swap so you are gripping the proximal end of the wire.
 26. Slide the central line into the vein, keeping hold of the proximal end of the wire emerging from the central line. **If the line won't thread cleanly**, either the skin hole is too small, or the wire is kinked—so if the line goes past the skin and won't thread further, the wire must be kinked: remove line and wire.
 27. Try to position the line appropriately. It has markings on it. Try e.g. 15cm into the patient (for a RIJV approach to an average-sized patient).
 28. **WIRE OUT.** Remove the wire. You now have the central line in situ.
 29. Attach a syringe full of saline to the central line port. You should be able to aspirate blood. *Try not to aspirate blood into the syringe itself (because later you'll be flushing with the same syringe, and flushing with blood isn't ideal).* Flush with saline and slide the clamp to block off that lumen. Remove the syringe.
 30. Ensure the other two lumina aspirate blood and flush them.

31. To improve relations with the nurses, who will have to fit three-way taps to each lumen, fit three-way taps to each lumen (it's much quicker for you, since you're already sterile and have saline to hand). Ensure every port is flushed, and that you **don't ever flush air down into the line!**
 32. Now you're ready to sew. Clip the flexible half-clamp to the line near the wound (e.g. 2cm from it). Clip the rigid plastic suture guide onto that. The line already has another suturing point where the three lumina diverge. So you have two points along the line to sew, each with two suture holes. Lay the line up so it doesn't curve too much (this is why you sterilized right up to the ear).
 33. Work out where your four suture points will be. Infiltrate local anaesthetic. Suture through the skin and the holes in the plastic. Tie it well; you've spent a lot of effort getting this far.
 34. Place a Mefilm (transparent) dressing over the wound and a good length of the line.
- Write in notes.
 - CXR (portable, if patient sick). Line should be in a vein, not in an artery. Line tip should be in the SVC (just above the RA). *Remember that tip position has nothing to do with the pressure readings: as long as the port isn't blocked, there's a continuous valve-free column of liquid between the port tip and the manometer, and the manometer is at the height of the RA, then the pressure reading will be the RA pressure.* Exclude pneumothorax/haemothorax.
 - When position confirmed, tell nurses OK to use line.

If the wire gets lost inside the patient (e.g. feed line over wire with cap on and forget golden rule so wire gets pushed in), you and the patient are in deep shit. Will need interventional radiologist (or very occasionally cardiothoracic surgeon) to remove it URGENTLY.

Other techniques:

- **CVP reading.** Requires a bag of fluid high on a drip stand, manometer, patient flat, manometer zero adjusted to level of RA (mid-axillary line in 4th intercostal space when lying flat). Three-way tap is connected to (1) patient, (2) manometer, (3) fluid. Procedure; turn tap to connect fluid/manometer, to fill manometer. Then turn tap to connect manometer to patient. Fluid level should drop and reach an equilibrium. Should swing with (a) heartbeat, (b) respiration. Average is CVP. *If problems, flush line.*
- **Repositioning the line.** Most often, this means drawing the line back when it's in too far. Needs sterile area as before; cut suture, pull line back, infiltrate LA, resuture. May need either to move the 'suture clip' on the line, or to curl the line slightly, so it doesn't kink.
- **Blood samples from central line.** Sterile procedure; use sterile towel/sterile gloves. Keep caps sterile at all times. Withdraw and discard syringe full of blood and previous flush; withdraw blood samples; reflush with saline.

See also:

- Hocking (2000) Central venous access and monitoring. *Practical Procedures* 12: 13 (http://www.nda.ox.ac.uk/wfsa/html/u12/u1213_01.htm). [Very thorough.]
- McGee & Gould (2003) Preventing complications of central venous catheterization. *NEJM* 348: 1123. (PubMed ID 12646670). [This has excellent pictures.]

Update 2008:

These NEJM videos are excellent:

- <http://content.nejm.org/cgi/content/short/356/21/e21> [internal jugular]
- <http://content.nejm.org/cgi/content/short/357/24/e26> [subclavian]
- <http://content.nejm.org/cgi/content/short/358/26/e30> [femoral]