Emergency Transvenous Cardiac Pacing

INTRODUCTION
Emergency cardiac pacing is done to restore or ensure cardiac depolarization, most commonly in the setting of AV block and symptomatic bradyarrhythmias. This is commonly done either transcutaneously or transvenously in the ED, though it can also be done transthoracic, esophageal, and epi or endocardial. Transvenous cardiac pacing is both safe and effective in EP hands, and is used when transtheutaneous pacing fails, prolonged pacing is needed, the patient is at high risk for AV block, or in tachyarrhythmias where overdrive pacing is needed.

Transvenous cardiac pacing is done through a right internal jugular or left subclavian approach. In general, ED transvenous pacing is done via the right IJ to preserve the left subclavian for permanent pacemaker placement if needed.

GOALS OF THE PROCEDURE
- Restore or ensure cardiac depolarization
- Terminate tachydysrhythmias

INDICATIONS
- Symptomatic sinus node dysfunction
- Second- and third-degree heart block
- Afib with slow ventricular response
- MI with: new LBBB, bifascicular block, alternating BBB
- Implanted pacemaker malfunction
- Supraventricular dysrhythmias
- Ventricular dysrhythmias

CONTRAINDICATIONS
- Prosthetic tricuspid valve
- Severe hypothermia (relative)

COMPLICATIONS
- Arterial puncture
- Venous thrombosis/thrombophlebitis
- Pneumothorax/anatomic injury
- Ventricular arrhythmia
- Misplacement of the pacing catheter
- Myocardial/pericardial perforation
- Entanglement of pacing catheter
- Myocarditis/endocarditis
EQUIPMENT

- Sterile PPE (sterile gown & gloves, mask, face shield, hair net)
- Tranvenous pacemaker kit
- Ultrasound
- Sterile ultrasound probe cover
- Antibiotic patch
- Tegaderm
- 1 deadhead
- 2 saline flushes (if sterile drop on field, if not sterile squirt into the catheter kit)
- Generator
- Non-sterile helper (RN or MD)

ANATOMY

- Review the internal jugular vein and/or subclavian vein central venous catheter placement guides as needed

STEPS

Note: The most important part of inserting a transvenous pacemaker is to prepare the kit and introducer sheath prior to vessel cannulation. The introducer sheath set-up and CVC placement is almost identical to placing a Cordis – recommend reviewing this procedure if you are not familiar with the assembly and placement.

3 general steps:

- Assemble kit
- Place CVC introducer sheath and float pacemaker
- Manage the generator (usually done with the help of a non-sterile assistant

Assembling the kit

1. Assemble introducer sheath and click dilator into place as you would for a Cordis placement
2. Identify the contamination field
3. Identify the pacer wire
   a. Remove the balloon protector (black cover)
   b. Check balloon with 0.75cc of air
      i. Float in saline to check for air leak
4. Feed pacer wire through the contamination shield while it is collapsed
5. Attach yellow electrodes to pacer wires
   a. The distal electrode is the blue wire (-)
6. With the patient in trendelenberg, place the introducer sheath CVC as you normally would, remove the wire and introducer, place the deadhead, flush the line, and secure
   a. Prefer right IJ over left subclavian
   b. Can use ultrasound guidance as is your normal practice
7. Maintain sterility for floating the pacer once the your assistant is done setting up the generator
8. Hand the adapter and balloon end of the pacer wire to your generator assistant

Managing the generator

1. The generator is located in a case in the med room in Resus (by the IO Kit) and should contain a fresh battery
2. Turn on the generator
3. Set the controls (see figure)
   a. Rate = 60-80bpm
      i. At least 30bpm greater than patient’s current rate to be able to identify capture
   b. Output = Max (approx 5 Amps)
   c. Sensing = Asynchronous
4. Connect cables to generator
   a. Insert (+) electrode to (+) slot on generator
   b. Tighten the connection
   c. Insert (-) to (-) spot if you are doing a “blind” placement or to the alligator clip if you are using the EKG method (See ‘floating the pacemaker’ section)
      i. Attach alligator clip to one of the anterior leads on the EKG

Floating the pacemaker

Note: There are two main ways to float the pacemaker. The first “blind” method uses the patient’s monitor leads to identify capture by a change in rate from the initial intrinsic rate to the set rate on the generator. The second “EKG method” uses the (-) electrode connected to an EKG via the alligator clip to identify injury current (ST elevation) on the EKG. The first is obviously faster in a crash situation, but with a caveat that even a successful placement of a pacemaker does not always generate capture, so pay attention to how far you have advanced the wire or use US guidance to avoid complications.

Blind Method

1. Make sure the patient remains in Trendelenberg
2. Insert the pacer wire into the CVC (into where the dilator was)
3. Advance the wire using the protector sheath to at least 10-15cm (2-3 markings) before blowing up the balloon
4. Have your assistant blow up the balloon with 0.75cc of air
5. Have your assistant turn on the generator with the above settings
6. Float the wire (approx 25-30cm) until the patient’s heart rate reflects the rate set on the generator if you are using a “blind” approach
7. Have your assistant deflate the balloon
8. Attach the Tuohy-Borst cap of the protector sheath to the introducer sheath and “click” into place
   a. Note the depth of the pacer wire
9. Identify pacer threshold (see below)
EKG Method:

1. Establish a sheath introducer in the selected vein. Attach the still-compressed sterile sleeve to the introducer hub. Check the balloon for integrity and then advance the catheter into the sleeve. (Full sterile drapes should be used but are not depicted here.)

2. Instruct an assistant to make the following nonsterile connections. Attach the proximal (+) lead to the positive terminal of the connecting cable and the distal (-) lead to the V₁ lead of an ECG machine with an alligator clamp. (Alternatively, an insulated wire with an alligator clip on each end may be used.)

3. Close the stopcock after inflation. Inflate the balloon with 1.5 ml of air (after advancing the catheter).

4. Advance the catheter approximately 10 to 12 cm so that the tip lies within the superior vena cava. Then inflate the balloon with 1.5 ml of air. Close the stopcock valve to keep the balloon inflated.

5. Advance the pacing catheter quickly and smoothly. Monitor the V₁ lead on the electrocardiogram to ascertain the location of the tip of the pacing catheter. The P wave and QRS complex will vary in size depending on which chamber the tip is in, and the sum of the electrical forces will be negative if depolarization is moving away from the catheter tip and positive if depolarization is moving toward it. ST-segment elevation will occur when the tip contacts the endocardium.

6. When the pacing catheter is in the desired position, deflate the balloon by unlocking the stopcock and allow the syringe to spontaneously refill with air. Extend the sterile sleeve so that it fully covers the pacing catheter. If your sheath and sleeve have valves, close them by turning clockwise to keep the wire and sleeve in place.
EKG Method

1. Make sure the patient remains in Trendelenberg
2. Insert the pacer wire into the CVC (into where the dilator was)
3. Advance the wire using the protector sheath to at least 10-15cm (2-3 markings) before blowing up the balloon
4. Have your assistant blow up the balloon with 0.75cc of air
5. Have your assistant attach the (-) alligator clip to one of the anterior leads (V1-V3) on the EKG
6. Advance (approx 25-30cm) until injury current is identified (ST elevations on EKG)
7. Have your assistant deflate the balloon
8. Attach the Tuohy-Borst cap of the protector sheath to the introducer sheath and “click” into place
   a. This will keep your pacer wire sterile in case you need to adjust in the future
   b. Note the depth of the pacer wire to monitor for migration
9. Have your assistant turn on the generator at the above settings
10. Identify pacer threshold (see below)

Identify pacer threshold

Goal of pacing with the least amount of output needed

1. Decrease the output until capture is lost, then multiply by 2.5x for maintenance output
   a. Usually approx 2-3 Amps
2. Repeat 2-3 times to confirm setting

Confirmation

- Chest x-ray
- EKG (to look for % capture)
- Vital signs
- +/- Ultrasound

VIDEO


- Chris Davis: [https://www.youtube.com/watch?v=hbuxE0m5Lk4](https://www.youtube.com/watch?v=hbuxE0m5Lk4)

DEEP DIVE

- Further Reading
  - Roberts & Hedges’ Clinical Procedures in EM. 6th edition. Pg 277-

- **Tranvenous pacemaker placement pearls:**
  - The pacer wire must be threaded through the protector sheath PRIOR to inserting into the CVC
  - Familiarize yourself with the kit on a regular basis as this is a rare procedure and a complicated set-up
  - Even in an emergent situation, sterility must be paramount as you are inserting the pacer wire directly into the myocardium