Temporary Pacemakers

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Topics to be covered

- Indications
- Pacemaker nomenclature
- Insertion Technique
- Complications
- Orientation to “the box” (Pacemaker)
- Troubleshooting

- Questions?
General indications for a temporary pacemaker

- Heart rate is slow, causing hemodynamic compromise
- Sick sinus syndrome
  - Sinus bradycardia or atrial fibrillation with slow heart rate response (generally <40 bpm)
- Heart block
  - 3rd degree
  - 2nd degree type 2 (Mobitz)
- Malignant Tachyarrhythmia caused by bradycardia
  - Torsades de Pointes
Clinical settings for temporary pacemaker

- Syncope
- Myocardial infarction
  - Especially inferior
- Shock due to bradycardia
- Myocarditis
- Lyme disease
2nd Degree AV block type 1

Wenkebach – not a reason for pacemaker
2\textsuperscript{nd} Degree AV block type 2 (Mobitz)
Inferior/Lateral/Posterior Infarct with 2:1 block
3rd degree heart block
Another 3\textsuperscript{rd} degree heart block
Atrial fibrillation ➔ Asystole
NSR → 20 second asystole
Pacemaker Nomenclature

- **Common Modes**
  - VVI – Single chamber (ventricle)
  - DDD – Dual chamber
  - AAI (uncommon) – Single chamber (atrium)

- **1st Letter** is chamber PACED
- **2nd Letter** is chamber SENSED
- **3rd Letter** is response
  - I = Inhibit
  - T = Triggered (Unusual)
  - D = Dual (Inhibit or Pace)

- **4th Letter** – R = Rate responsive (permanent pacers)
Components of a pacemaker system

- **Lead**
  - Wire connects to heart
    - Percutaneous
      - Ventricular wire sits in RV apex
    - Epicardial (post surgery)

http://www.oscor.com/images/lead%20pics/RU-STR-Polaris%20lead2%20copy.jpg
The Can
AKA “Pulse Generator,” “Battery”

Temporary
Single chamber  Dual chamber

Permanent single chamber

http://www.staff.vu.edu.au/CriticalCare/CriticalCare/Images%20_l1/spacer.gif
http://www.staff.vu.edu.au/CriticalCare/Critic
al%20Care/Images%20_l1/spacer.gif
http://upload.wikimedia.org/wikipedia/commons/thumb/b/b1/Pacemaker_GuidantMeridianSR.jpg/549px-Pacemaker_GuidantMeridianSR.jpg
Sites of insertion for a temporary pacemaker

- Right internal jugular
- Left subclavian vein
- Right subclavian vein
- Either femoral vein (Fluoroscopy required)
- Left IJ is possible but very difficult
Seldinger technique for percutaneous vascular access

General steps
• Trendelenberg position or leg elevation can facilitate access to IJ and subclavian veins
• Sterile Field
• Anesthetize skin with lidocaine
• Access vein with Cook needle
• Insert guidewire
• Remove needle
• Consider making a skin nick with scalpel
• Insert 6-8F introducer sheath with dilator over guidewire
• Remove dilator and guidewire
• Flush sheath using side port
• Advance temporary pacemaker to right ventricle
Complications of temporary pacemaker insertion

- Blood loss/hematoma
- Infection
- Arrhythmia (especially during insertion)
  - PVC’s are common
  - Heart block
    - Especially in patients with underlying LBBB
    - Bundle branch block
- Pneumothorax (about 1+% when subclavian access used)
- Cardiac perforation → Tamponade
Pneumothorax of Left Lung
Functions of a pacemaker

- **Sensing**
  - The device ‘sees’ a native heart beat

- **Pacing**
  - The device delivers a shock to stimulate a heart beat
VVI Explained

- A VVI pacemaker
  - Paces the ventricle
  - Senses the ventricle
  - In response to a sensed event it INHIBITS the pacing response
    - So if it doesn’t SENSE a native heart beat in a specified period, it will deliver a pace.
Timing cycles

VVI pacemaker
LR = lower rate limit
VRP = ventricular refractory period
Note that a sensed QRS starts the VRP and resets the LR

Braunwald, 7th ed.
The dials on the Temporary pacemaker

- **Rate**
  - Determines the lower rate limit of the device
  - Heart rate should not go lower than the set rate

- **Output**
  - In milliamps, the amount of ‘juice’ the device outputs with each pacer spike
Sensitivity

- Sensitivity $\rightarrow$ asynchronous
  - In millivolts, the amount of energy that has to be detected in order for the device to ‘sense’ a beat
  - Higher millivolts = less sensitive
    - More likely for the pacemaker to pace at the lower rate regardless of what the heart does on its own
  - Lower millivolts = more sensitive
    - More likely to pick up noise, and ‘sense’ a ventricular beat even though nothing actually happened
Sensitivity

Sensitivity low – Everything (QRS, T, U) can be sensed by the pacemaker as a QRS
Sensitivity

Sensitivity low – QRS and some T waves will be sensed by pacemaker as a QRS
Sensitivity

Sensitivity just right
QRS will be sensed, T waves will not

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif
Sensitivity

Sensitivity too high
Nothing will be sensed

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif
Testing thresholds

- **Output Threshold**
  - Set Sensitivity to ‘asynchronous’
  - Set Rate just above the native heart rate
    - 60-80 bpm
  - Start output at 5-10 mA, and gradually turn down until ventricular capture is lost
  - The last point before losing capture is the threshold
  - Pacemaker output should be set at 2-3x the threshold
Testing Thresholds

- Sensitivity Threshold
  - Not always necessary
  - Testing the amplitude of native QRS complexes as seen by the can
  - Set Rate just below native heart rate
  - Set Output at 2-3x the Pacing threshold
  - Start asynchronous, then slowly turn dial down. Pacemaker spikes will disappear when the sensitivity threshold is reached. The pacemaker can now ‘see’ the native QRS complexes.
  - The pacemaker should be set at a sensitivity 1/3 to 1/2 the sensitivity threshold
Troubleshooting Pacemakers

- Normal behavior that looks strange
- Failure to Capture
- Undersensing
- Oversensing
- Cross Talk (Dual Chamber only)
Normal behavior of VVI pacemaker

Native QRS
Normal behavior of VVI pacemaker

Paced beat with capture
Normal behavior of VVI pacemaker

Fusion beat – combination of native QRS and paced beat
Normal behavior of VVI pacemaker

Pseudofusion – pacing spike, normal QRS
Failure to Capture

Atrial pacing with intermittent ventricular capture

Braunwald, 7th ed.
Failure of output (oversensing)

VVI pacemaker sensing artifact as ventricular contractions (oversensing)
As a result, the pacemaker does not output
VVI pacemaker
3rd ventricular beat is a PVC, but it is followed by a pacemaker spike
4th beat is a probably a normal ventricular beat, but it is also followed by a pacer spike
Cross Talk

Dual chamber pacemaker in DDD mode
3rd atrial pacing spike is not followed by ventricular spike
Ventricular lead detects the atrial spike as a ventricular depolarization,
So the pacemaker fails to deliver a ventricular spike