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Pacemaker Therapy

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Pacemaker Systems

- Pacemaker
  - Artificial pulse generator
  - Delivers an electrical current to the heart to stimulate depolarization
- Consists of:
  - Pulse generator (power source)
  - Pacing lead(s)

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Permanent Pacemakers

- Implanted into the SC tissue of the anterior thorax just below the right or left clavicle
- Indications (partial list)
  - Complete AV block
  - Second-degree AV block type II
  - Sinus node dysfunction

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Temporary Pacemakers

- Temporary pacing can be accomplished by various means
  - Transvenous
    - An electrode introduced into the right heart via a central vein
  - Epicardial
    - Pacing leads placed onto or through the myocardium
  - Transcutaneous
    - Electrodes placed on the patient's chest

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Temporary Pacing – Indications

- Hemodynamically significant bradycardia
- Bradycardia with escape rhythms unresponsive to drug therapy
- Overdrive pacing of tachycardia — supraventricular or ventricular — refractory to pharmacologic therapy or electrical countershock
- Bradyasystolic cardiac arrest

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Transcutaneous Pacing (TCP)

Indications

- May be used as a "bridge" until transvenous pacing can be accomplished or the cause of bradydysrhythmia is reversed
  - Drug overdose
  - Hyperkalemia
- May be considered in asystolic cardiac arrest
  - Less than 10 minutes in duration
  - Witnessed asystolic arrest

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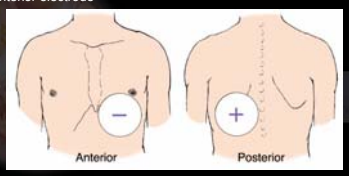
TCP – Procedure

- Apply two adhesive pacing electrodes to the patient's chest
  - Negative (anterior) electrode to left of sternum, halfway between xiphoid process and left nipple
  - Posterior (positive) electrode on left posterior thorax directly behind anterior electrode



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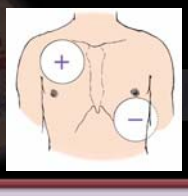
TCP – Procedure

- Anterior-lateral electrode position
  - Place anterior (negative) electrode on left anterior thorax, just lateral to the left nipple in the midaxillary line
  - Place posterior (positive) electrode on right anterior upper thorax in the subclavicular area



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TCP Procedure

- Pacing electrodes should:
  - Fit completely on the patient's torso
  - Have a minimum of 1 to 2 inches of space between electrodes
  - Not overlap bony prominences of the sternum, spine, or scapula

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TCP Procedure

- Connect the patient to the ECG monitor and obtain a rhythm strip.
- Verify the presence of a paceable rhythm.
- Connect the pacing cable to adhesive electrodes on the patient.
- Turn on the pacemaker generator.
- Set the pacing rate.
  - In a patient with a pulse, set the rate between 60 and 80.
  - In a pulseless patient, set rate between 80 and 100.

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TCP Procedure

- Set the output (milliamps) setting
  - In a responsive patient
    - Increase the current slowly
    - Sedation or analgesia may be needed
  - Asystole
    - Move quickly to maximum output

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Patient Responses to Current

• 20 mA	Prickly sensation on skin
• 30 mA	Slight thump on chest
• 40 mA	Definite thump on chest
• 50 mA	Coughing
• 60 mA	Diaphragm pacing and coughing
• 70 mA	Coughing and knock on chest
• 80 mA	More uncomfortable than 70 mA
• 90 mA	Strong, painful knock on chest
• 100 mA	Leaves bed because of pain

Flynn, JB: *Introduction to Critical Care Skills:* St. Louis, Mosby-Year Book, 1993.

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TCP Electrical Capture

- Observe for electrical capture
  - Usually evidenced by a wide QRS and broad T wave
  - In some patients, electrical capture is less obvious - indicated only as a change in the shape of the QRS

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TCP Mechanical Capture

- Mechanical capture occurs when pacing produces a measurable hemodynamic response
  - Palpable pulse
  - Measurable blood pressure

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TCP & Defibrillation

- If defibrillation is necessary, paddles should be placed 2 to 3 cm (3/4 to 1 inch) away from the pacemaker electrodes.
  - Some pacemaker models should be turned off or disconnected before defibrillating.

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TCP – Documentation

- Date and time pacing was initiated
- Include baseline and pacing rhythm strips
- Current required to obtain capture
- Pacing rate selected
- Patient's response to electrical and mechanical capture
- Medications administered
- Date and time pacing was terminated

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TCP – Limitations

- Patient discomfort
  - Varies with the device used and the current required to achieve capture
- Capture may be difficult to achieve in:
  - Patients with increased chest wall muscle mass
  - COPD
  - Pleural effusion
  - Dilated cardiomyopathy
  - Hypoxia
  - Metabolic acidosis

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TCP – Complications

- Coughing
- Skin burns
- Inability to capture
- Sharp pain or burning sensation with pacing
- Interference with sensing due to muscle contractions or patient agitation
- Failure to recognize pacemaker is not capturing
- Failure to recognize presence of underlying treatable VF

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TCP – Contraindications

- Children weighing less than 15 kg (33 lb) unless pediatric pacing electrodes are used
- Flail chest
- Bradycardia in setting of severe hypothermia
- Bradyasystolic cardiac arrest of more than 20 minutes in duration
  - Relative contraindication

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Pacemaker Malfunction

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Failure to Pace

- Recognized on ECG as an absence of pacemaker spikes and a return of the underlying rhythm for which the pacemaker was implanted
- Patient signs and symptoms may include:
  - Syncope
  - Chest pain
  - Bradycardia
  - Hypotension

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Failure to Pace – Causes

- Battery failure
- Fracture of the pacing lead wire
- Displacement of the electrode tip
- Pulse generator failure
- Broken or loose connection between the pacing lead and the pulse generator
- Electromagnetic interference
- Sensitivity setting set too high

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Failure to Pace – Possible Interventions

- Adjusting sensitivity setting
- Replacing pulse generator battery
- Replacing pacing lead
- Replacing pulse generator unit
- Tightening connections between pacing lead and pulse generator
- Performing an electrical check
- Removing source of electromagnetic interference

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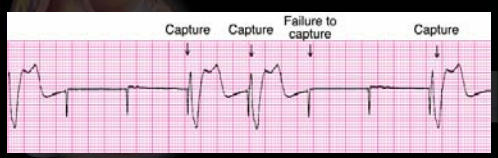
Failure to Capture

- Inability of pacemaker stimulus to depolarize myocardium
  - Recognized on ECG by visible pacemaker spikes not followed by P waves (atrial pacing) or QRS complexes (ventricular pacing)



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Failure to Capture

- Patient signs and symptoms may include:
  - Fatigue
  - Bradycardia
  - Hypotension

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Failure to Capture – Causes

- Battery failure
- Fracture of pacing lead wire
- Displacement of pacing lead wire (common cause)
- Perforation of myocardium by a lead wire
- Edema or scar tissue formation at electrode tip
- Output energy (mA) set too low (common cause)
- Increased stimulation threshold because of:
  - Medications
  - Electrolyte imbalance
  - Increased fibrin formation on catheter tip

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Failure to Capture – Possible Interventions

- Repositioning patient
- Slowly increasing output setting (mA) until capture occurs or maximum setting is reached
- Replacing pulse generator battery
- Replacing/repositioning of pacing lead
- Surgery

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Failure to Sense (Undersensing)

- Sensitivity
  - Extent to which a pacemaker recognizes intrinsic electrical activity
- Failure to sense
  - Occurs when the pacemaker fails to recognize spontaneous myocardial depolarization

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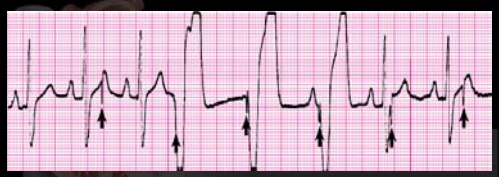
Failure to Sense (Undersensing)

- Recognized on ECG by pacemaker spikes that follow too closely behind patient's QRS complexes



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Failure to Sense – Causes

- Battery failure
- Fracture of pacing lead wire
- Displacement of the electrode tip
  - Most common cause
- Decreased P wave or QRS voltage
- Circuitry dysfunction
  - Generator unable to process QRS signal
- Increased sensing threshold from edema or fibrosis at electrode tip, antidysrhythmic medications
- Severe electrolyte disturbances
- Myocardial perforation

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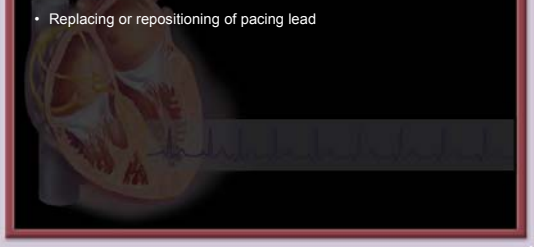
Failure to Sense – Possible Interventions

- Increasing sensitivity setting
- Replacing pulse generator battery
- Replacing or repositioning of pacing lead



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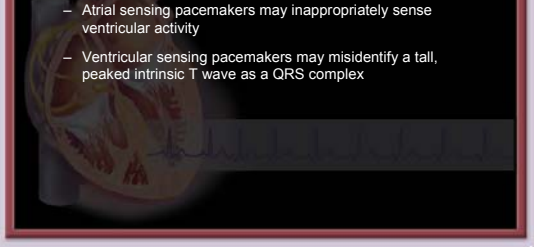
Oversensing

- Pacemaker malfunction that results from inappropriate sensing of extraneous electrical signals
  - Atrial sensing pacemakers may inappropriately sense ventricular activity
  - Ventricular sensing pacemakers may misidentify a tall, peaked intrinsic T wave as a QRS complex



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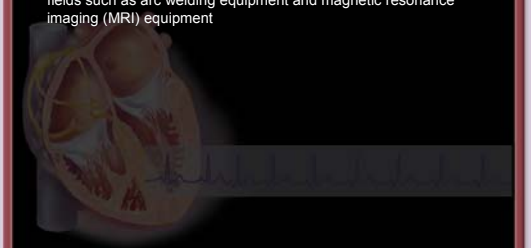
Oversensing

- The patient with a pacemaker should avoid strong electromagnetic fields such as arc welding equipment and magnetic resonance imaging (MRI) equipment



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Oversensing – Possible Interventions

- Adjustment of the pacemaker's sensitivity setting
- Possible insertion of a bipolar lead if oversensing due to unipolar lead dysfunction