"PROFESSIONAL NURSING PRACTICE CAN ONLY ADVANCE AS MUCH AS INDIVIDUAL NURSES ARE AWARE THAT A KNOWLEDGE GAP EXISTS IN THEIR PRACTICE, FEEL EMPOWERED TO ACCESS FURTHER LEARNING, AND INTEGRATE EVIDENCE BASED COMPETENCIES INTO THEIR PROFESSIONAL PRACTICE TO PROVIDE SAFE, EFFECTIVE, EFFICIENT, PATIENT CENTERED, EQUITABLE CARE."
Indications for Pacing

- **Symptomatic bradycardia**
  - Sinus node dysfunction
  - AV conduction system dysfunction - #1
  - Drug induced bradycardia
### Indications for Pacing

- Symptomatic bradycardia
- Symptomatic heart blocks
- Chronic bifascicular and trifascicular blocks
- Sick Sinus Syndrome
- Neurocardiogenic Syncope
- Hypertrophic Cardiomyopathy
- Cardiac support for treatment of arrhythmias requiring ablation and/or medications resulting in bradycardia
- Pacing for termination of tachyarrhythmias (part of ICD therapy)
- CHF (biventricular pacing)

### Types of Cardiac Pacing

- Temporary Transvenous Pacing
- Transcutaneous Pacing
- Epicardial Pacing
- Permanent Pacing
  - Single chamber
  - Dual chamber
  - Biventricular
- Rate adaptive pacing
Temporary Pacemakers

Transcutaneous Pacer
Pacer Parts

Battery / Brains  Leads

Implantation of Permanent Pacer

Where are those leads?
Right ventricular pacing mimics what type of bundle branch block?

Left Bundle Branch Block
Left Bundle Branch Block

$V_1 = QS$

$V_6 = \text{wide } R$

QRS = .12 sec or more

$V_1 = rS$

Component of TTVP Generator

- On / Off Button
- Positive / Negative wire connections
- Heart Rate Dial
- MA
  - Milliamps
- Mode
  - Demand / Asynchronous
- Battery
- Sensitivity
TTVP Documentation

- MA 2
- Rate 70
- Full Demand
- Dressing dry and intact to ______ insertion site (with or without sutures)
- Pulse and circulation check distal to the insertion site
- All connections secured and tight
- Rhythm: Ex. 1:1 AV pacing with Capture

Post TTVP Considerations

- Wires secured to pacer pack
- Wires secured to patient
- All connections tight
- Occlusive dressing changed every 24 hours
- Special care with confused patients
Permanent Pacemaker Insertion

- Electrophysiology Lab or Cardiac Catheterization Lab or Operating Room
- Local anesthesia
- Strict adherence to infection control procedures
- Pacer “can”
  - Battery and brains
- Leads
### Bipolar vs. Unipolar

**Unipolar**
- Ability of the pacemaker to send a stimulus to the myocardium
- Identified by a pacemaker spike on the ECG

**Bipolar**
- Ability of the pacemaker to send a stimulus to the myocardium
- Identified by a pacemaker spike on the ECG

### THREE ACTIONS

<table>
<thead>
<tr>
<th>Pace</th>
<th>Capture</th>
<th>Sense</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ability of the pacemaker to send a stimulus to the myocardium</td>
<td>• Ability of the pacing stimulus to depolarize chamber being paced</td>
<td>• Ability of the pacemaker to recognize and respond to intrinsic cardiac depolarization</td>
</tr>
<tr>
<td>• Identified by a pacemaker spike on the ECG</td>
<td>• Identified by a pacemaker spike that is immediately followed by a P wave or a QRS complex on the ECG</td>
<td>• Identified by pacing when no intrinsic beats and not pacing when intrinsic beats are present</td>
</tr>
</tbody>
</table>
Pacing

- Identify automatic pacing interval (pacing rate)
  - Two consecutive pacer spikes
- Spikes should appear regularly unless pacer is inhibited by sensed intrinsic activity

Capture

- Pacing stimulus results in depolarization of chamber being paced
- Each spike should be followed by a QRS unless it falls in heart’s refractory period
Sensing

- Pacemaker sees and responds to intrinsic activity
- Must be given opportunity to sense
  - Must be in demand mode
  - There must be intrinsic activity to be sensed

Revised NASPE/BPEG Generic Code for Antitachycardia Pacing

<table>
<thead>
<tr>
<th>Position I</th>
<th>Position II</th>
<th>Position III</th>
<th>Position IV</th>
<th>Position V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber(s) Paced</td>
<td>Chamber(s) Sensed</td>
<td>Response to Sensing</td>
<td>Rate Modulation</td>
<td>Multisite</td>
</tr>
<tr>
<td>O=None</td>
<td>O=None</td>
<td>O=None</td>
<td>O=None</td>
<td>O=None</td>
</tr>
<tr>
<td>A=Atrium</td>
<td>A=Atrium</td>
<td>T=Triggered</td>
<td>R=Rate modulation</td>
<td>P=Paced</td>
</tr>
<tr>
<td>V=Ventricle</td>
<td>V=Ventricle</td>
<td>I=Inhibited</td>
<td></td>
<td>S=Shocks</td>
</tr>
<tr>
<td>D=Dual (A+V)</td>
<td>D=Dual (A+V)</td>
<td>D=Dual (T+I)</td>
<td>D=Dual (P+SV)</td>
<td></td>
</tr>
</tbody>
</table>

(Bernstein et al., 2002)
UNDERSTANDING PACEMAKER FUNCTION

LET’S DO THE PACEMAKER DANCE
**AAI Pacing – Atrial Inhibited**

**AAI**
- Paces the Atrium

**AAI**
- Senses the Atrium

**AAI**
- Atrial sensing inhibits atrial pacing

---

**Pacing Modes AAI**

<table>
<thead>
<tr>
<th>LR</th>
<th>LR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LR</th>
<th>LR</th>
<th>LR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LR</th>
<th>LR</th>
<th>LR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VVI Pacing – Ventricular Inhibited

VVI
Paces the Ventricle

VVI
Senses the Ventricle

VVI
Ventricular sensing inhibits ventricular pacing

VVI Pacing

Ventricular pacing diagram with annotations indicating pacing and sensing.
Dual Chamber Pacers

- Provide AV synchrony
  - Maintains atrial kick
  - Improves hemodynamics in those with heart blocks
- Tracks atrial activity
  - Ventricular pacing occurs in response to atrial activity
  - Improved hemodynamics
- Decreased incidence of pacemaker syndrome

Basic Pacemaker Timing

- AV Interval
  - Period of time between an atrial event (sensed “P” wave or atrial pace) and a paced ventricular event
- VV Interval
  - Period of time from ventricular complex to ventricular complex
- VA Interval
  - Ventricular complex to atrial activity
  - Also called AEI or atrial escape interval
Basic Pacemaker Timing

- Refractory Period
  - Brief period of time when pacer is not allowed to look for intrinsic events
    - Absolute Refractory Period
      - Nothing can be sensed
    - Relative Refractory Period
      - Allows sensing but pacer will not respond

Basic Pacemaker Timing

- Low Rate
  - Lowest rate allowed by the pacer before a paced beat is initiated
- High Rate
  - Upper rate limit
  - Highest rate that can be achieved and still maintain AV synchrony
**DDDR Pacing**

**DDDR**

**Paces** both Atrium and Ventricle

**DDDR**

**Senses** both Atrium and Ventricle

1. Atrial sensing **inhibits** atrial pacing and **triggers** ventricular pacing
2. Ventricular sensing **inhibits** ventricular and atrial pacing

---

**DDD Pacemaker with 4 Timing Cycles at Work**

**Fundamental Intervals**

1. LRI = Lower Rate Interval
2. VRP = Ventricular Refractory Period
3. AVI = Atrioventricular Interval
4. PVARP = Postventricular Atrial Refractory Period

**Derived Intervals**

- TARP = Total Atrial Refractory Period
- AVI + PVARP
- Upper Rate Interval = URI
- AEI = Atrial Escape Interval = LRI - AVI
DDD Pacing:
AV Sequential Pacing State

DDD Pacing:
Atrial Pacing State
DDD Pacing:
Atrial Tracking State

BASIC DUAL-CHAMBER PACING
THE DDD MODE
THE ATRIAL TRACKING (PV) STATE

DDD Pacing:
Atrial Sensing and Ventricular Sensing State
TROUBLESHOOTING PACEMAKERS

Questions To Ask

IS THE PATIENT OK?
Troubleshooters Toolbox

- Rhythm strip
  - V1 or the lead that best allows evaluation of the pacemaker
- Pacemaker information
  - Type
- Programmed parameters
  - Intervals
  - Special features
- Calipers
- Magnet
- Chest x-ray

Questions to Ask

- Are there pacemaker spikes?
Questions to Ask

1. Is there evidence of pacemaker capture after a pacemaker spike?

Questions to Ask

1. Does the pacemaker sense appropriately
   - Inhibit the pacemaker when a natural beat occurs?
   - Activate pacing when no intrinsic beat occurs
### Primary Potential Problems

- Failure to Pace / Fire / Release Impulse
- Failure to Capture (depolarization)
- Failure to Sense
  - Oversensing
  - Undersensing

### Troubleshooting Pacemakers

- Failure to Pace
  - Pacer does not fire when indicated
  - Pacer spike is not present when expected
  - Recognized by pauses longer than the automatic interval or the absence of pacer spike at the end of the escape interval
Troubleshooting Pacemakers

51

- Causes of Failure to Fire
  - Pacer turned off
  - Loose or broken connection
  - Lead displacement
  - Battery depletion
  - Oversensing

Troubleshooting Pacemakers

52

- Interventions for Failure to Fire
  - Emergently treat patient as condition requires
  - Check connections if temporary
  - Replace battery or pulse generator
  - Lead repositioning or replacement
  - Convert pacer to asynchronous mode – to assess for sensitivity issues
## Troubleshooting Pacemakers

<table>
<thead>
<tr>
<th>Failure to Capture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacemaker fires but depolarization does not occur</td>
</tr>
<tr>
<td>Recognized by spike not followed by depolarization</td>
</tr>
</tbody>
</table>

### Causes of Failure to Capture

- Lead displacement
- Increased pacing thresholds
- AMI
- Chamber perforation
- Impulse occurs during intrinsic refractory period
Troubleshooting Pacemakers

- Interventions for Failure to Capture
  - Emergently treat patient as condition requires
  - Position patient on left side
  - May need lead repositioned or replaced
  - Increase MA
  - Replace battery or pulse generator
  - Chest x-ray, Labs
  - Monitor for tamponade, diaphragmatic pacing

- Failure to Sense (Undersensing)
  - Pacer fails to recognize intrinsic activity
  - Recognized by pacer spikes falling closer to the intrinsic beats than the escape interval; spikes land indiscriminately throughout the cardiac cycle

![ECG waveform with notations for troubleshooting pacemakers]
Sensitivity: “The Fence”

- Sensitivity too low (fence too high)
  Pacer can’t see QRS
- Sensitivity too high (fence too low)
  Pacer “hallucinates”

Troubleshooting Pacemakers

- **Causes of Undersensing**
  - Asynchronous mode
  - Intrinsic ventricular activity in refractory period
  - Lead placement or AMI
  - Low QRS voltage
  - Break in connection
  - Faulty generator
  - Battery failure
Troubleshooting Pacemakers

□ Interventions for Undersensing
  □ Emergently treat patient as condition requires
  □ Position on left side
  □ Lead positioning or replacement may be necessary
  □ Make sure pacer is not on asynchronous
  □ Increase sensitivity
  □ Check connections
  □ Treat PVC’s
  □ Change pacer rate – dependent of patients own rhythm
  □ Chest X-ray to verify position and check for lead fractures
  □ Change from bipolar system to unipolar system to increase sensing signal

Troubleshooting Pacemakers

□ Failure to Sense (Oversensing)
  □ Pacemaker recognizes extraneous electrical activity or the wrong intrinsic electrical activity as the inhibiting event
  □ Recognized by the absence of pacer spikes and failure to fire
Troubleshooting Pacemakers

- Causes of Oversensing
  - Sensitivity set too high
  - Electromagnetic interference
  - Myopotentials
  - T wave potentials

- Interventions for Oversensing
  - Decrease sensitivity
  - If MA is high – decrease
  - Chest X-ray to assess lead placement
  - Remove from EMI
  - Ensure that all equipment is properly grounded
  - Switch from unipolar to bipolar
TRUE OR FALSE: WHEN YOU PLACE THE MAGNET OVER A PERMANENT PACEMAKER THE PACEMAKER SHOULD PACE.

Magnet Mode

- Beware of the Magnet!
- FUNCTIONS DIFFERENTLY WITH ICD’S
- Turns sensing circuit off
- Pacemaker paces asynchronously
- Identifies battery end of life
- Determines lead location
  - RV Pacing
  - LV Pacing
- Risk of pacemaker impulse occurring on the T wave
- Should not be used without caution
- Avoid use in those patients susceptible to ventricular arrhythmias:
  - Fresh MI
  - Hypokalemia
LET’S PRACTICE
Let’s Practice DDDR Pacer

Let’s Practice DDDR Pacer
Let’s Practice VVI

Let’s Practice VVI Pacer
Let's Practice DDDR
Let’s Practice DDDR

Let’s Practice VVI Pacer
Let’s Practice DDDR Pacer

BE THE BEST THAT YOU CAN BE EVERY DAY. YOUR PATIENTS ARE COUNTING ON IT!

THANK YOU!!!

Nurses Make a Difference
Thank You!

www.cardionursing.com