

سه شنبه، اکتبر ۲۵، ۲۰۱۶



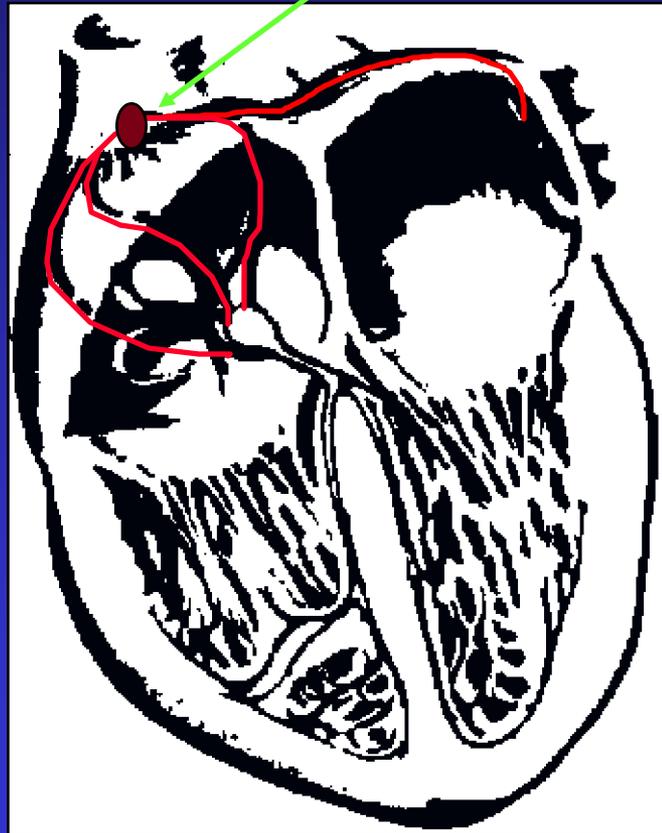
# Pacemaker

by: Dr Yazdannik

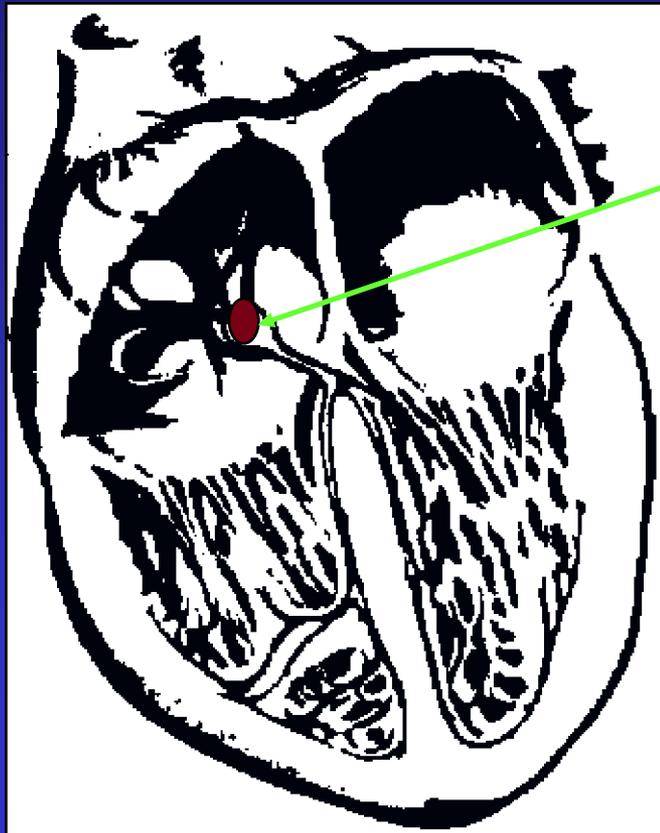
# “Normal Heart Rhythm” (Function)

# Normal Heart Function

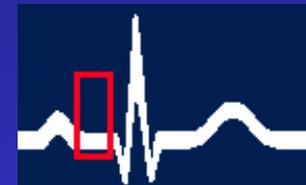
**Sinoatrial  
Node**



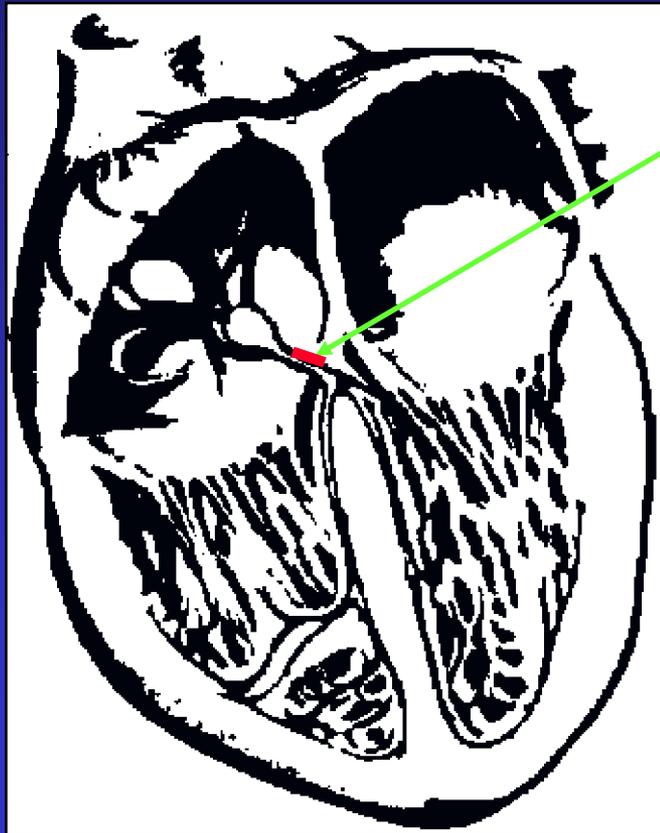
# Normal Heart Function



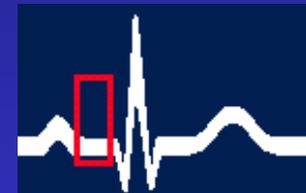
**Atrioventricular  
Node**



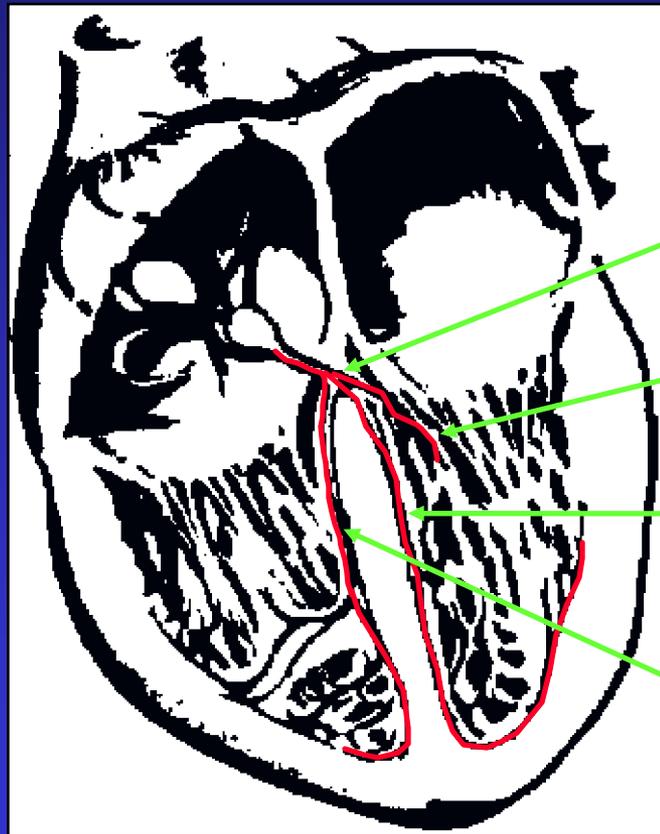
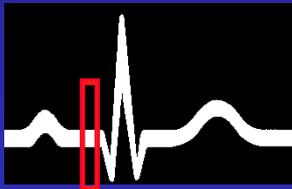
# Normal Heart Function



**Bundle of  
HIS**



# Normal Heart Function



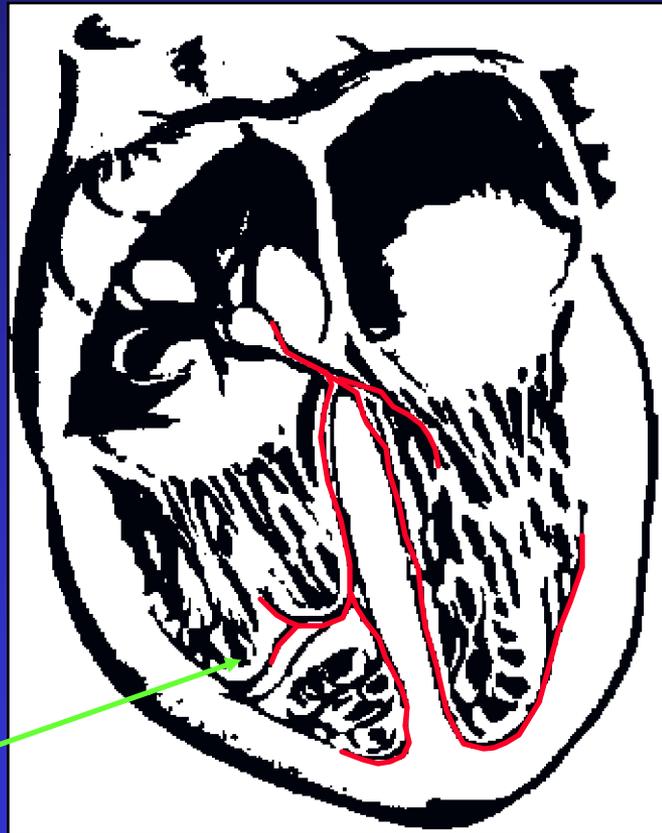
**Left Bundle Branch  
(LBB)**

**Anterior Fascicle of  
LBB**

**Posterior Fascicle  
of LBB**

**Right Bundle Branch  
(RBB)**

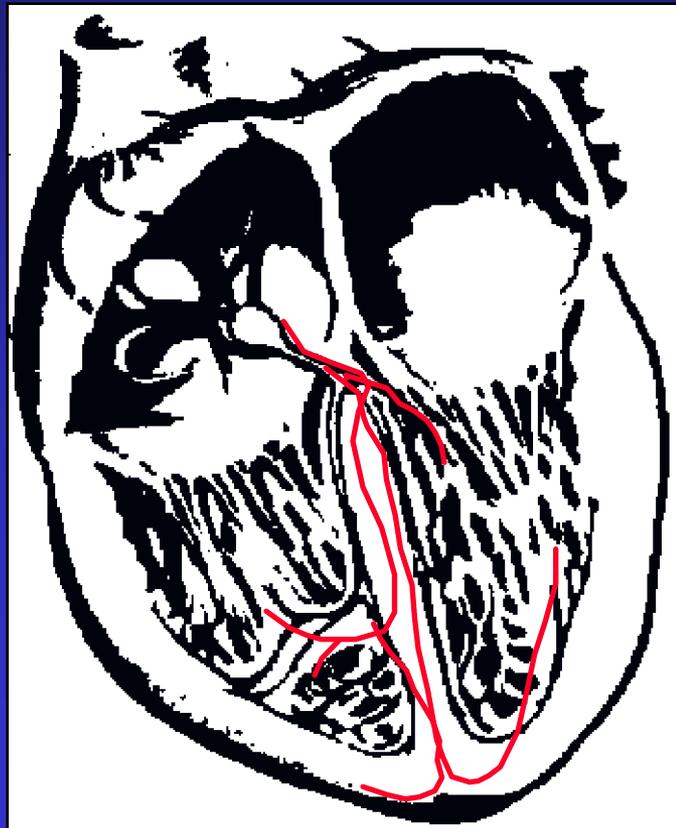
# Normal Heart Function



**Purkinje  
Fibers**

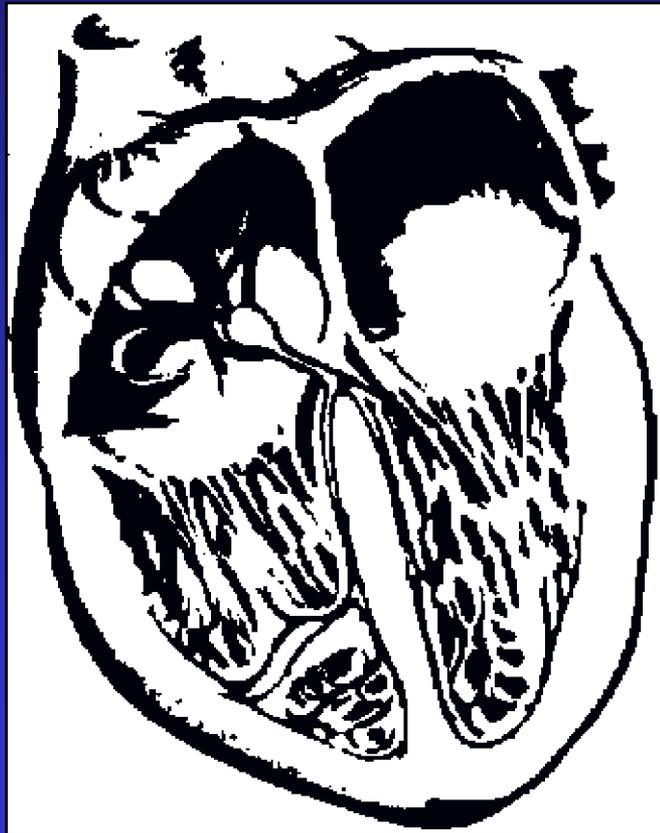


# Normal Heart Function



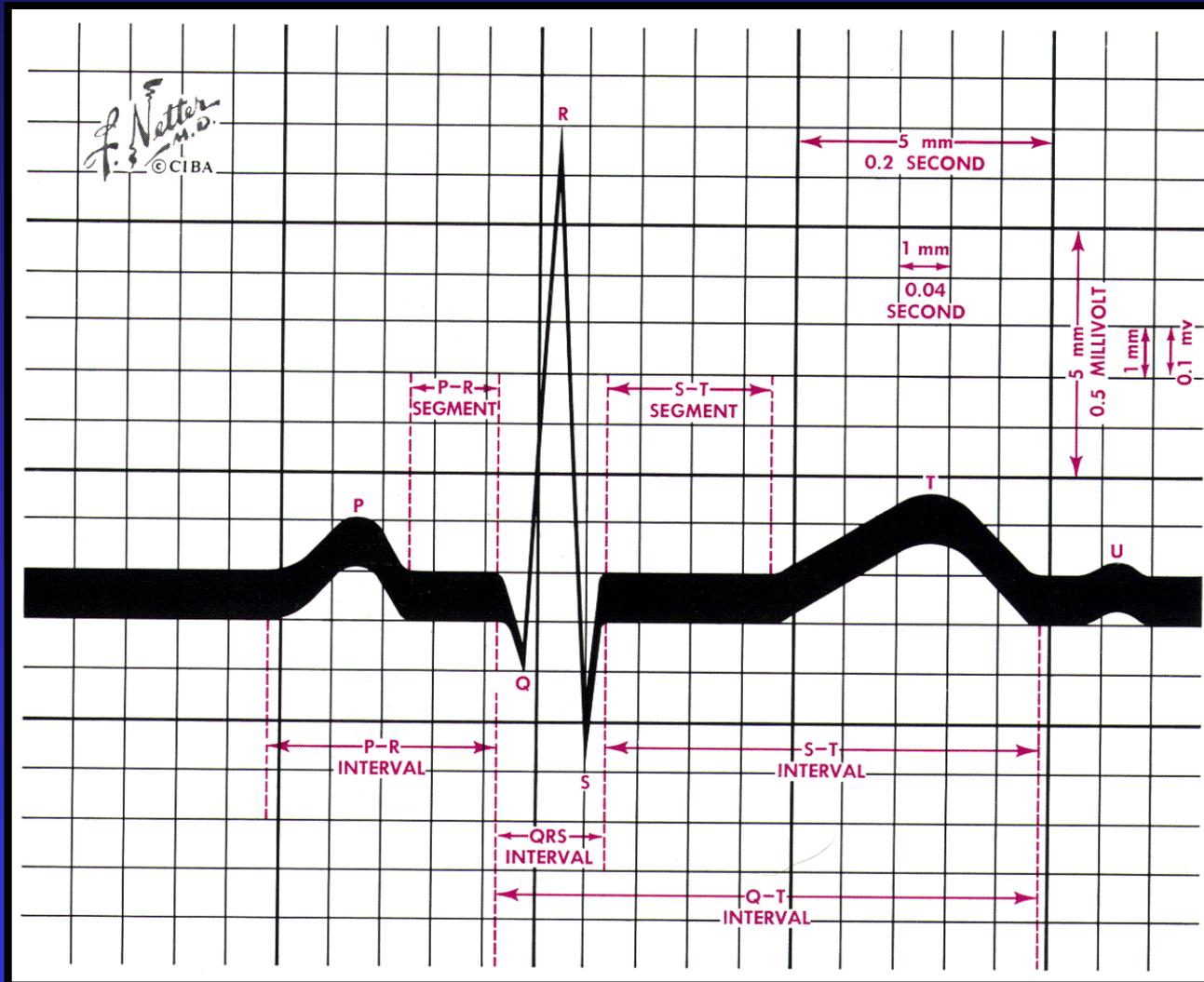
**Vent. Systole**

# Normal Heart Function



**Vent. Diastole**

# The ECG



# Normal Values

- PR Interval: 120 to 210 msec
- QRS Interval: 80 to 110 msec

# Rate:Interval Relationship

Interval (ms)	200	400	600	800	1000	1200	1400	1600
Rate (bpm/ppm)	300	150	100	75	60	50	43	37.5

At a paper speed of 25mm/sec

# What is a Pacemaker?

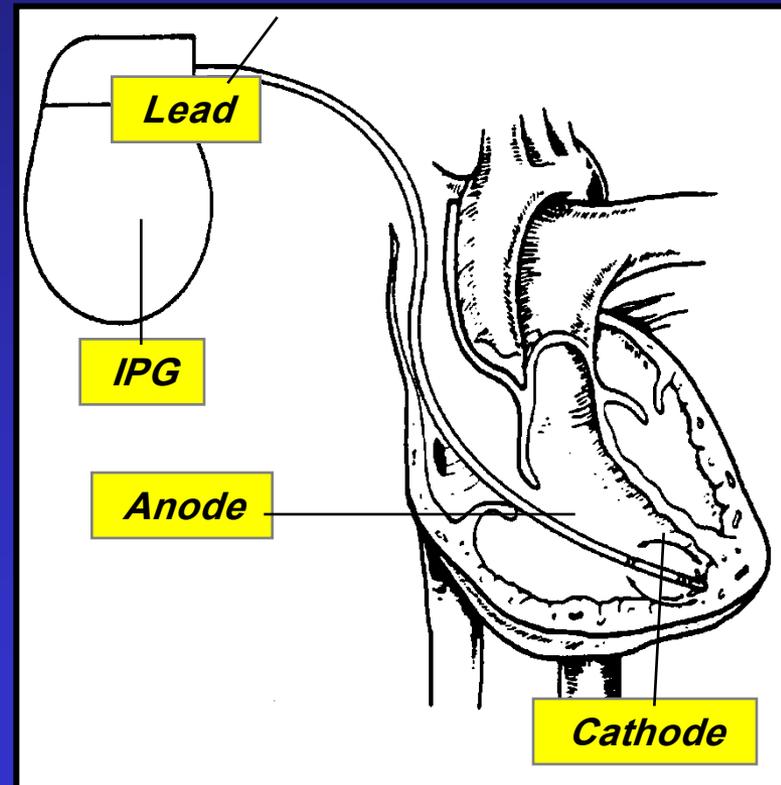
A Pacemaker System consists of a  
**Pulse Generator** plus **Lead (s)**

# Pacemaker Functions

1. Stimulate cardiac depolarization
2. Sense intrinsic cardiac function
3. Respond to increased metabolic demand by providing rate responsive pacing
4. Provide diagnostic information stored by the pacemaker

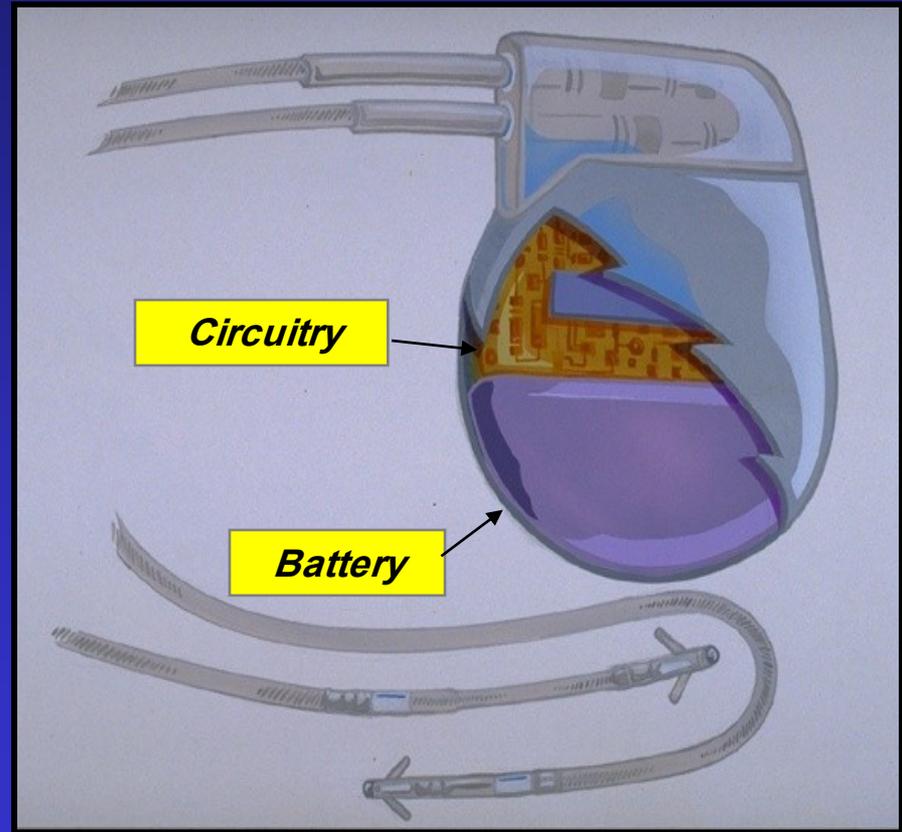
# Implantable Pacemaker Systems Contain the Following Components:

- Pulse generator: power source or battery
- Leads or wires
- Cathode (negative electrode)
- Anode (positive electrode)

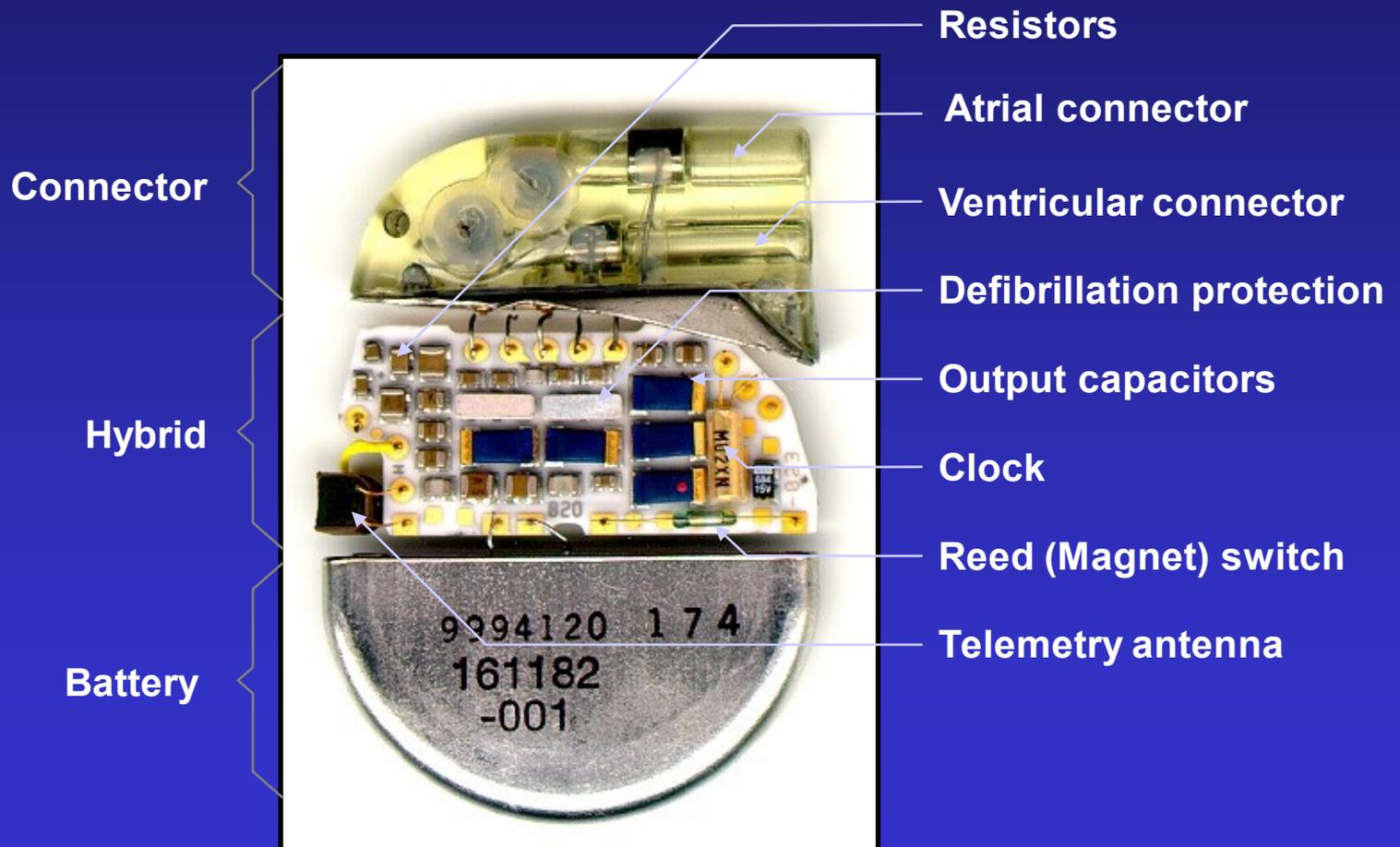


# The Pulse Generator:

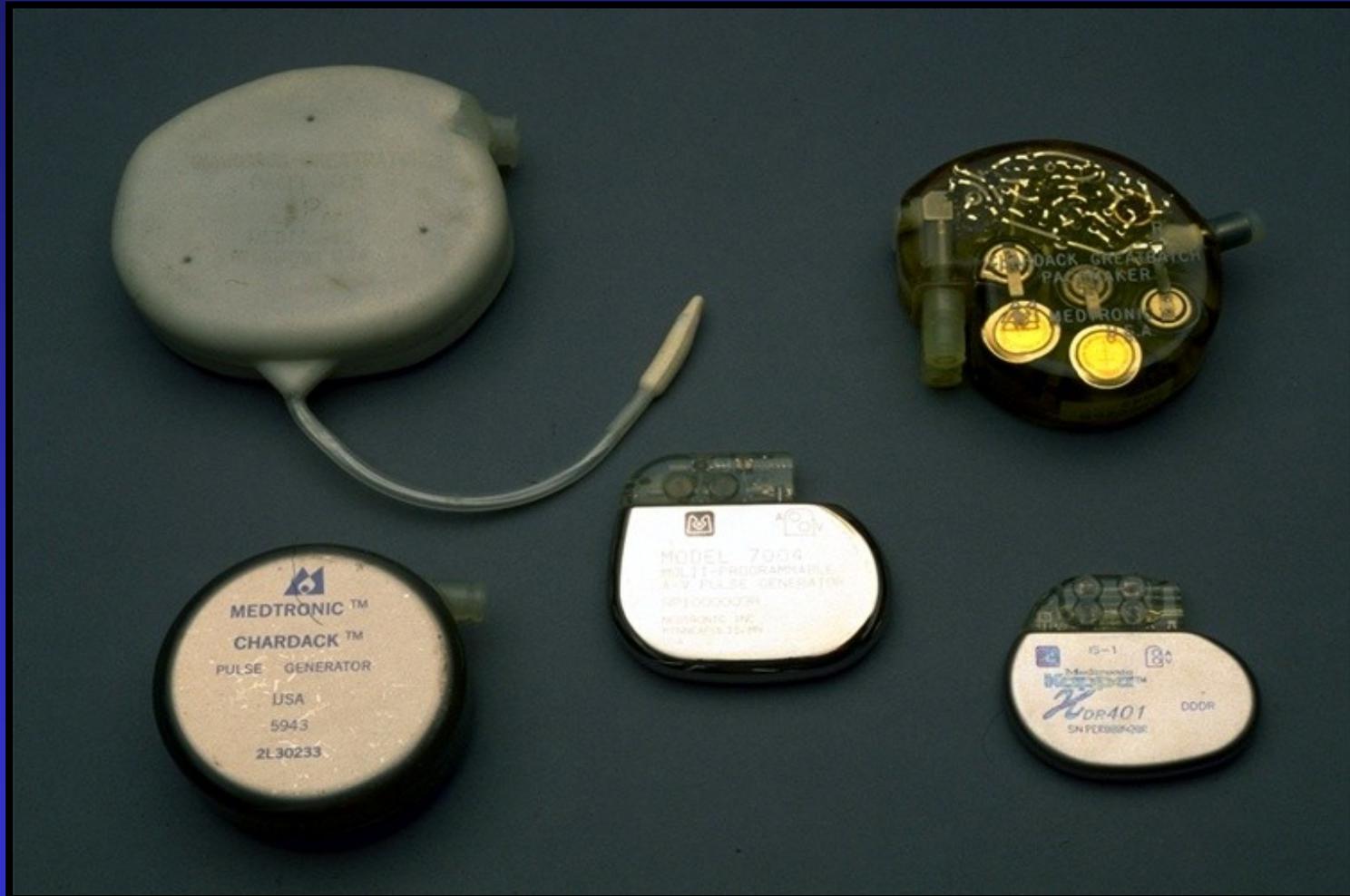
- Contains a battery that provides the energy for sending electrical impulses to the heart
- Houses the circuitry that controls pacemaker operations



# Anatomy of a Pacemaker

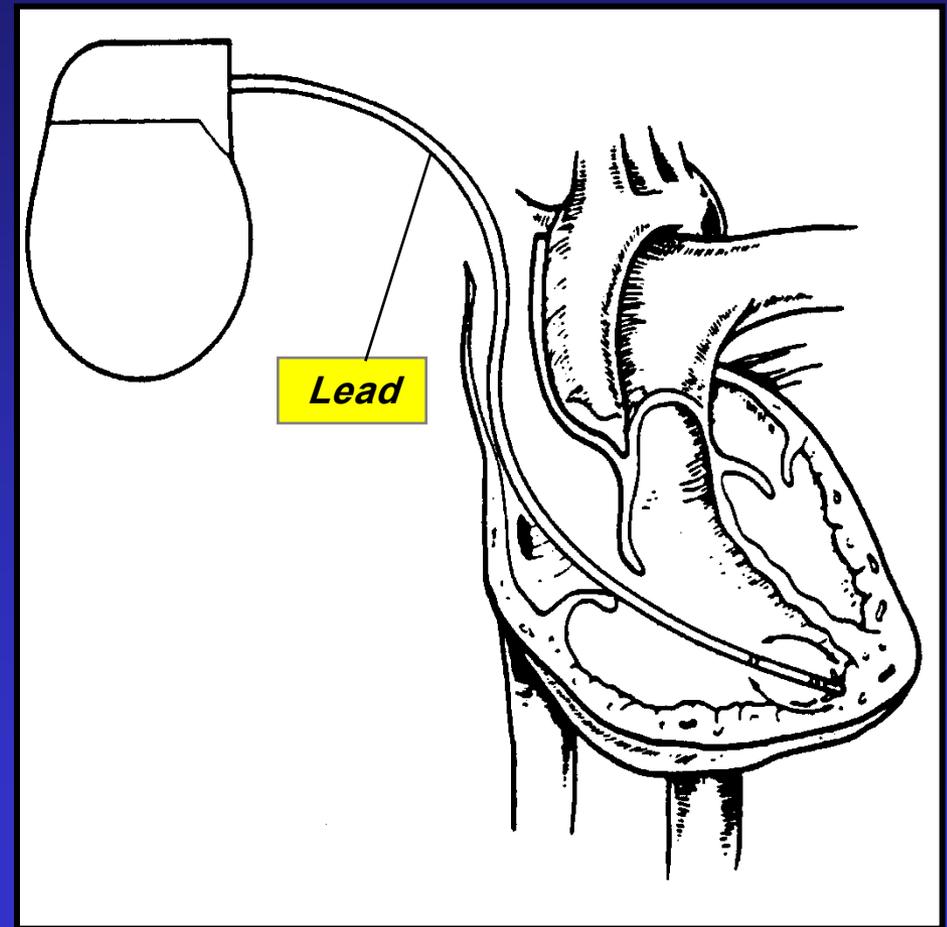


# What is a Pacemaker?



# Leads Are Insulated Wires That:

- Deliver electrical impulses from the pulse generator to the heart
- Sense cardiac depolarisation



# Pacemaker Indication Classifications

Class I – Conditions for which there is evidence and/or general agreement that permanent pacemakers should be implanted

Class II – Conditions for which permanent pacemakers are frequently used but there is divergence of opinion with respect to the necessity of their insertion

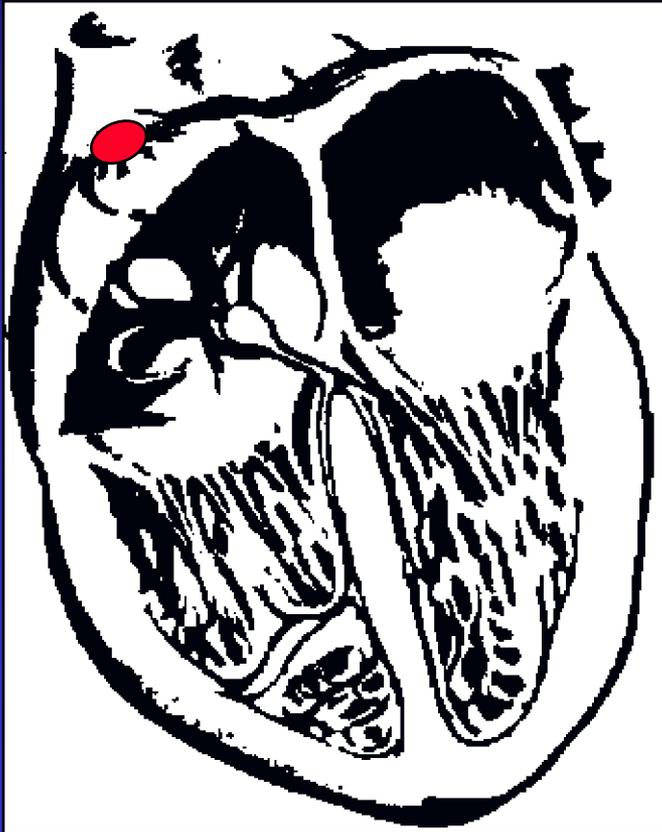
- Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy
- Class IIb: Usefulness/efficacy is less well established by evidence/opinion

Class III – Conditions for which there is general agreement that pacemakers are unnecessary

# Class I indications for Permanent Pacing in Adults

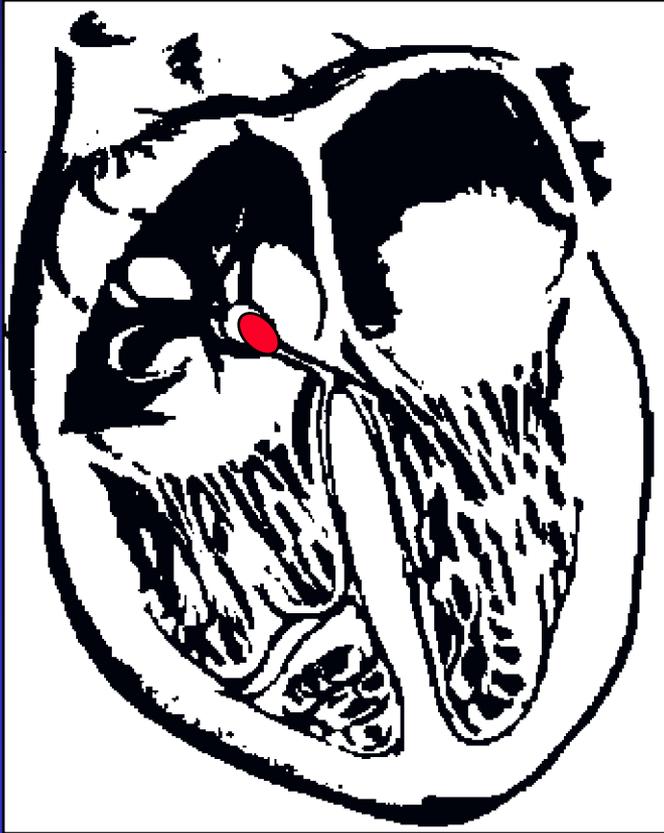
1. Third-degree AV block at any anatomic level\*
2. Symptomatic bradycardia resulting from 2nd degree AV block
3. Chronic bifascicular or trifascicular block with intermittent 3rd degree AV block or type II 2nd degree AV block
4. Sinus node dysfunction with symptomatic bradycardia
5. Recurrent syncope caused by carotid sinus stimulation

# Sinus Node Dysfunction



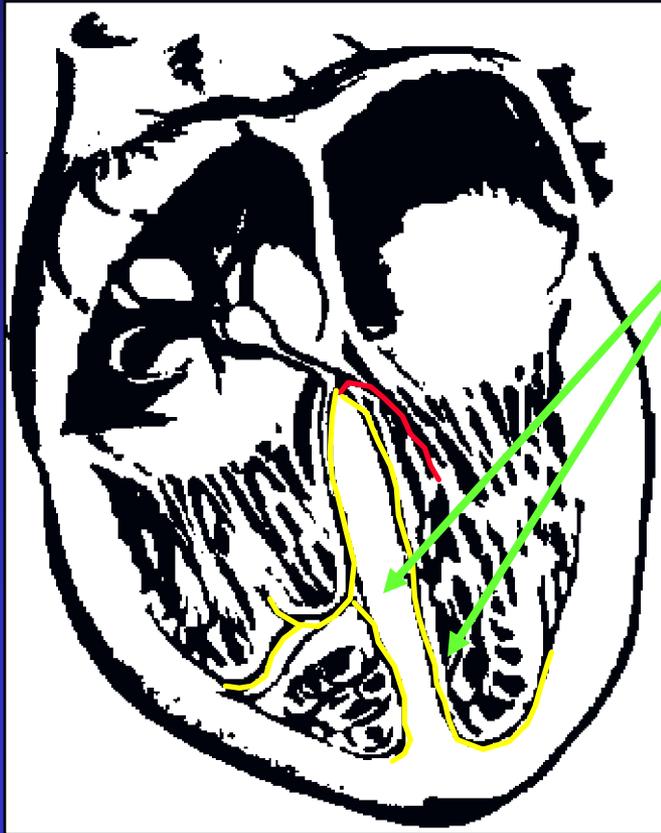
- Sick Sinus Syndrome
- Sinus bradycardia
- Sinus arrest
- SA block
- Brady-tachy syndrome

# AV Block



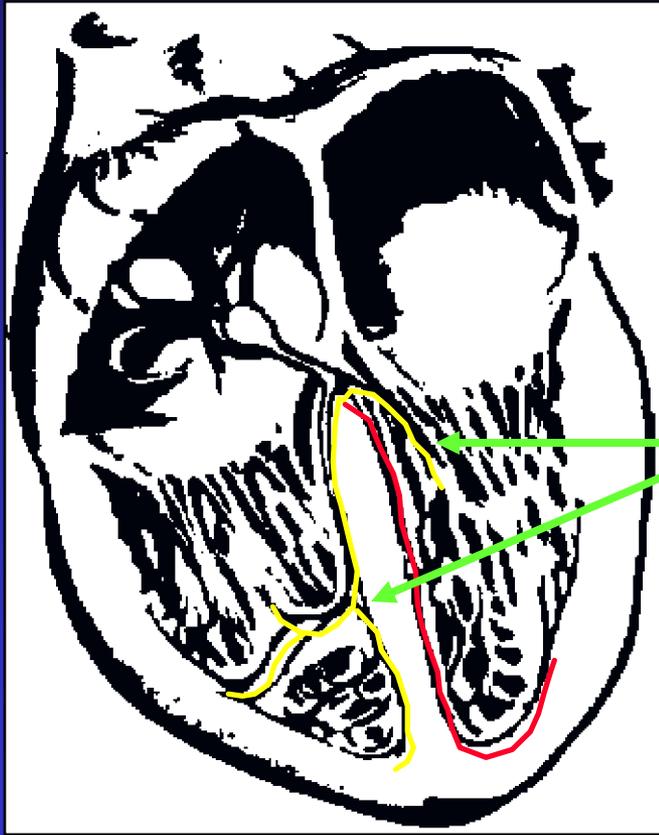
- First-degree AV block
- Second-degree AV block
  - Mobitz types I and II
- Third-degree AV block

# Bifascicular Block



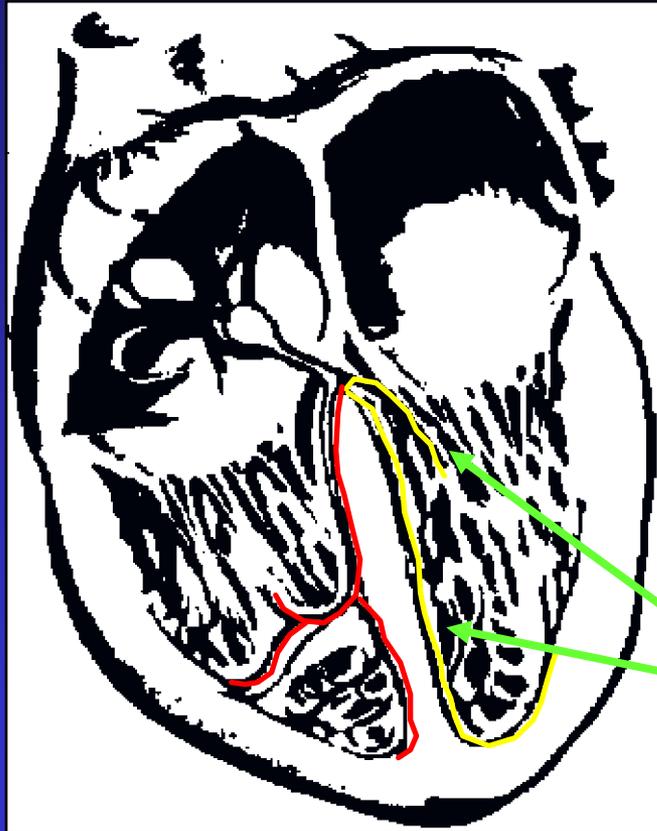
Right bundle branch  
block and left posterior  
hemiblock

# Bifascicular Block



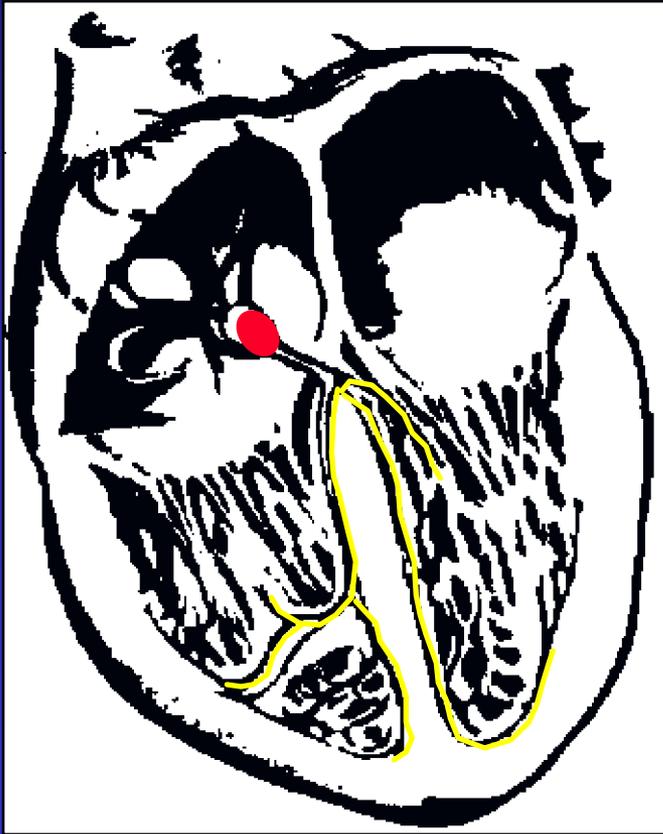
Right bundle branch block  
and left anterior  
hemiblock

# Bifascicular Block



Complete left  
bundle branch  
block

# Trifascicular Block



- Complete block in the right bundle branch and complete or incomplete block in both divisions of the left bundle branch

**How do pacemakers work?**

# NBG Code

<b>I Chamber Paced</b>	<b>II Chamber Sensed</b>	<b>III Response to Sensing</b>	<b>IV Programmable Functions/Rate Modulation</b>	<b>V Antitachy Function(s)</b>
<b>V: Ventricle</b>	<b>V: Ventricle</b>	<b>T: Triggered</b>	<b>P: Simple programmable</b>	<b>P: Pace</b>
<b>A: Atrium</b>	<b>A: Atrium</b>	<b>I: Inhibited</b>	<b>M: Multi- programmable</b>	<b>S: Shock</b>
<b>D: Dual (A+V)</b>	<b>D: Dual (A+V)</b>	<b>D: Dual (T+I)</b>	<b>C: Communicating</b>	<b>D: Dual (P+S)</b>
<b>O: None</b>	<b>O: None</b>	<b>O: None</b>	<b>R: Rate modulating</b>	<b>O: None</b>
<b>S: Single (A or V)</b>	<b>S: Single (A or V)</b>		<b>O: None</b>	

# Pacemaker Code

- Five letter code
  - First 3 letters refer to anti-bradycardic function
  - Fourth letter refers to programmability
  - Fifth refers to anti-tachycardic function
    - Last two letters may be left off the code if no programmable features or anti-tachycardic features exist

# Pacemaker Code

- First letter
  - Chamber of the heart that is paced
    - A = Atrium
    - V = Ventricle
    - D = Dual

# Pacemaker Code

- Second Letter
  - Chamber sensed
- Third Letter
  - Response to sensing of an electrical impulse
  - I = inhibited by a sensed event
  - T = triggered by a sensed event

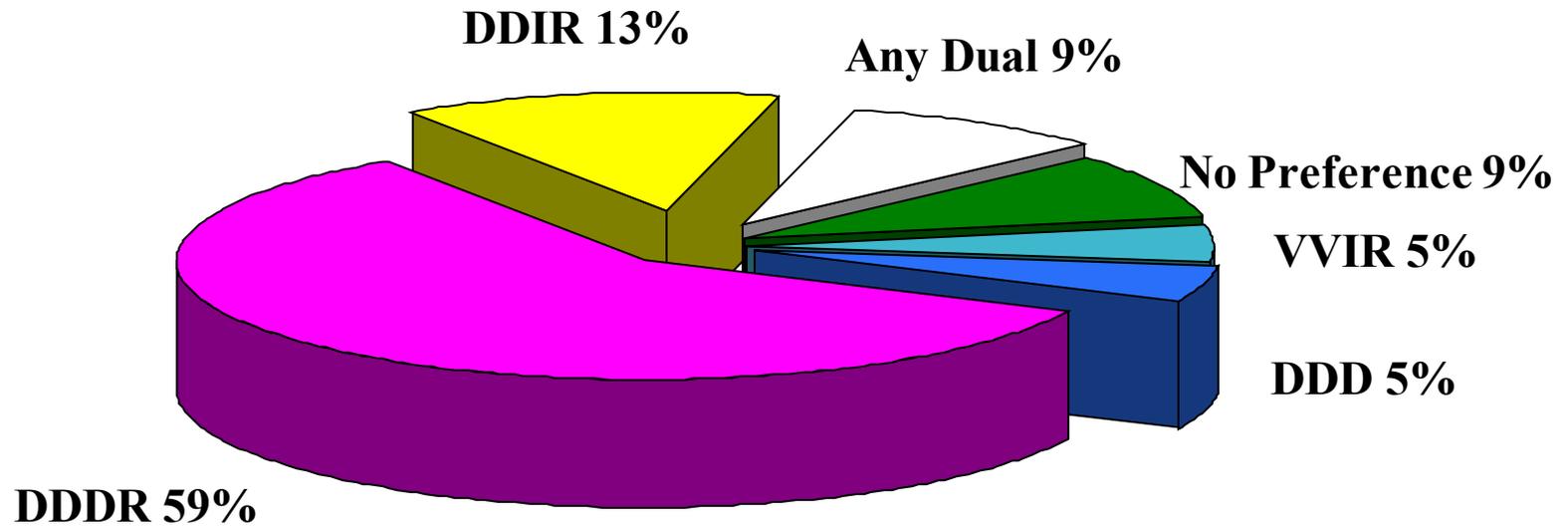
# Pacemaker Code

- Fourth letter
  - Many pacemakers have rate modulating features
  - Allows the HR to rise in response to physiologic demand
  - Designated by an “R”

# Pacemaker Code: Examples

- VVI
  - Ventricles paced, ventricles sensed, when it senses it stops from triggering a beat
- DDD
  - Both Chambers paced, both chambers sensed, inhibits if ventricular depolarization is sensed, triggers if only atrial depolarization is sensed
- VDD
  - Capable of pacing only the ventricle, senses both atrial and ventricular activity, responds by inhibition of ventricular pacing if ventricular depolarization is sensed, triggers a beat if only atrial depolarization is sensed

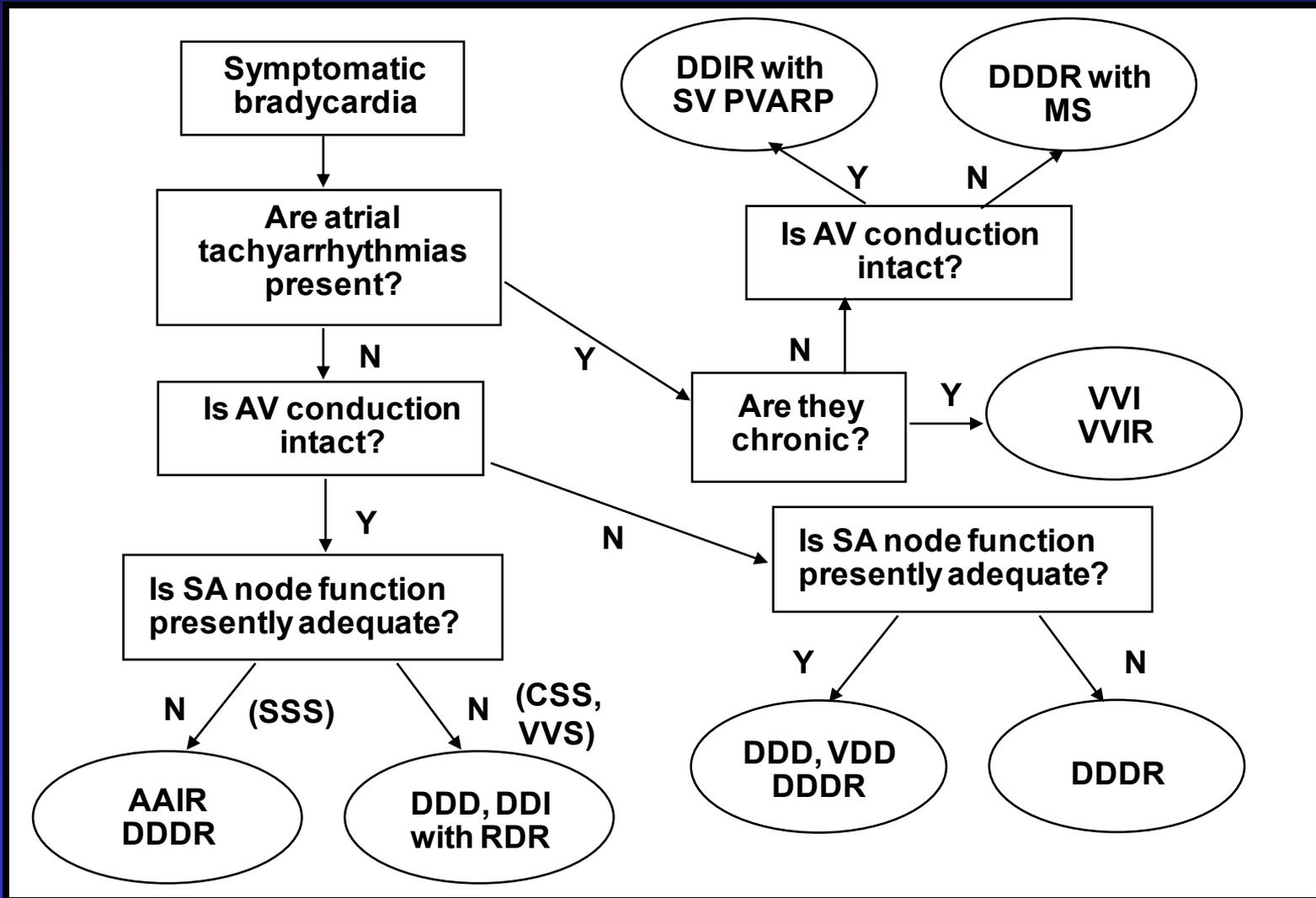
# Patient Mode Preference



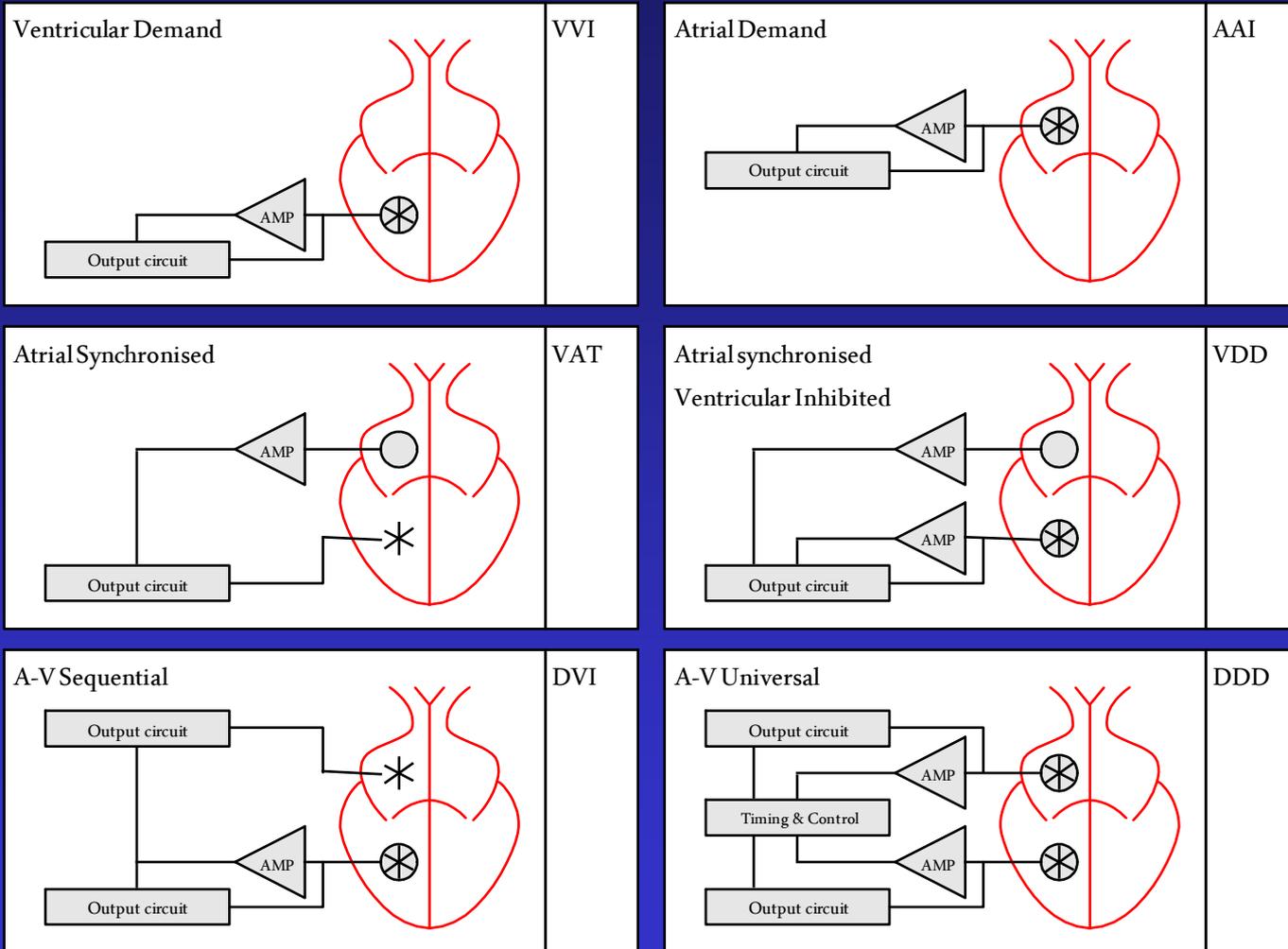
# Optimal Pacing Mode

- Sinus Node Disease - AAI (R)
- AVB - DDD
- SND + AVB - DDDR + DDIR
- Chronic AF + AVB - VVI (R)

# Mode Selection Decision Tree



# Pacing Modes



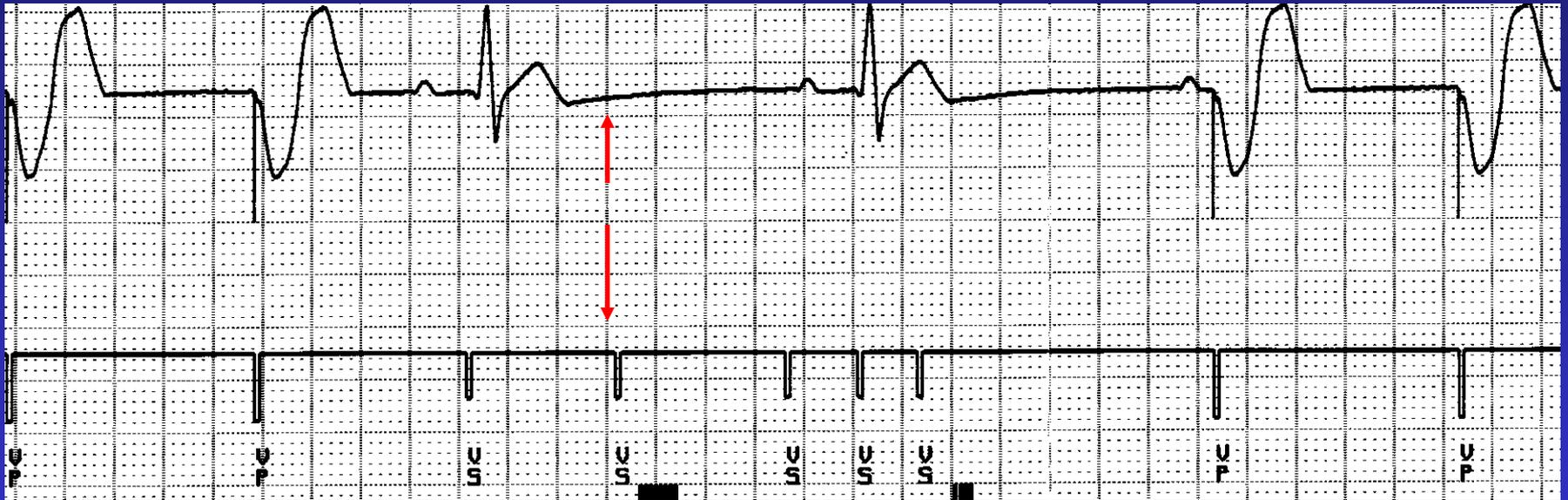
# Abnormal Pacemaker Function

- Investigations
  - Electrolytes (incl Ca, Mg, PO<sub>4</sub>)
  - Troponin (as indicated)
  - ECG
  - CXR
  - Application of magnet\*

# Pacemaker Complications

1. Pocket Complications
  - a) Infection
  - b) Thrombophlebitis
2. Pacemaker syndrome
3. Abnormal Pacemaker function
  - a) Failure to Pace
  - b) Failure to Sense
  - c) Failure to Capture
  - d) Oversensing

# Case



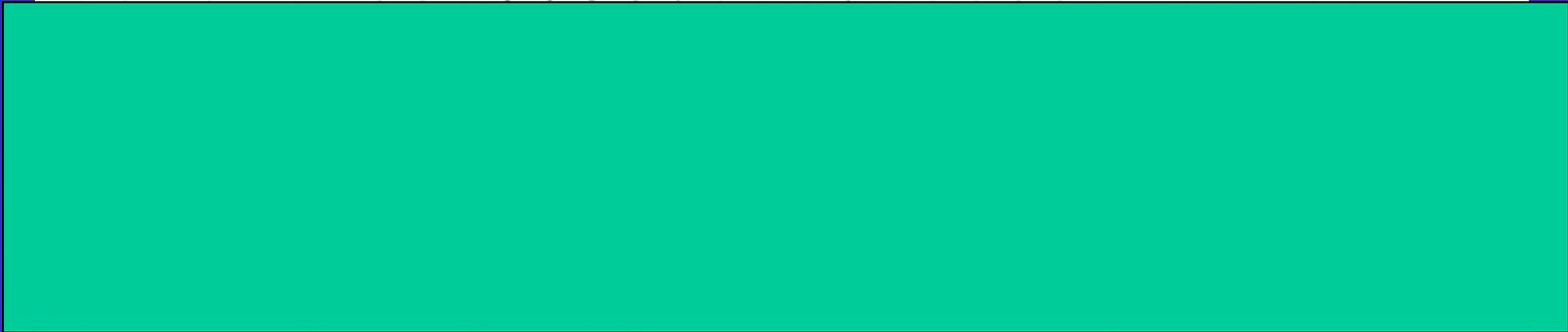
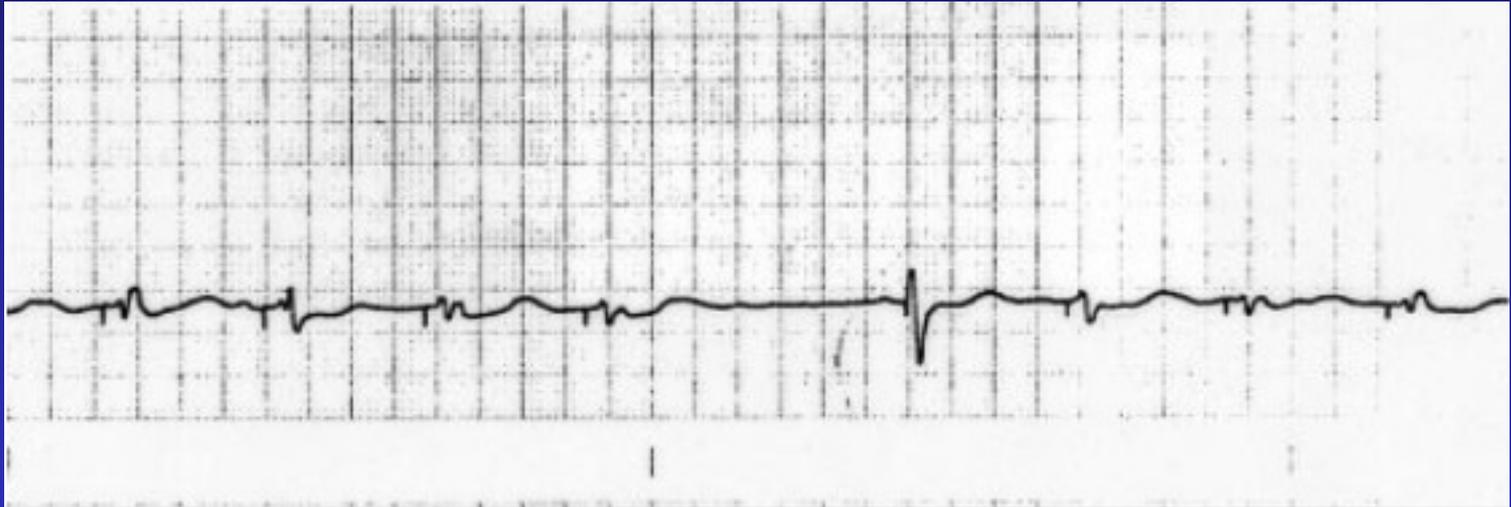
# Failure to Pace

- Diagnosis
  - Pacemaker does not fire when expected
  - There should be a pacemaker spike between two native complexes occurring at an interval longer than the LRLI
  - A complete absence of pacer spikes immediately after an exceeded LRLI indicates failure to generate output
  - Application of magnet yields no pacing spikes
  - What do you think is happening if you see intermittent pacemaker spikes on the ECG?
    - Suggests that pacemaker is oversensing and NOT failing to generate output

# Failure to Pace

- Etiology
  - Lead fracture
  - Loose connection
  - Insulation defect
  - Battery depletion
  - Oversensing

# Case



# Oversensing

- Diagnosis
  - Resulting rhythm is a bradycardia
  - May see intermittent or an absence of spikes
  - In absence of spikes it is difficult to tell between failure to generate output

# Oversensing

- Etiology
  - Extracardiac
    - Myopotentials (pectoralis)
    - Electrocautery
  - Intracardiac
    - Large T or U waves
    - Crosstalk (dual chamber pacemakers)

# Case



# Failure to Capture

- Diagnosis
  - Pacing spike is seen on the tracing; but there is no evidence of depolarization
  - Must differentiate between fusion and pseudo-fusion beats

# Failure to Capture

- Etiology
  - Lead Issues
    - Lead dislodgment (most common)
    - Perforation (rare)
  - Increased threshold for capture
    - Electrolytes (especially hyperK)
    - Ischemia
    - Scar tissue
    - Metabolic disturbances (acidosis, hypothyroidism, hypoxemia)
    - Drugs (antiarrhythmics)

# Case



# Failure to Sense

(AKA Undersensing)

- Diagnosis
  - Occurs when a previous electrical potential is not detected by the pacemaker
  - Detected by finding a pacemaker beat that is immediately followed by a native beat at an interval less than the LRLI\*
  - Pacemaker output competes with the intrinsic rhythm of the heart
  - Responsible for 1.3% of pacemaker replacements
  - Example
    - Pacemaker spike occurs between the QRS and the T wave

# Failure to Sense

- Etiology (anything that changes amplitude, vector, or frequency of electrical signals)
  - All causes of failure to capture
  - New BBBs
  - PVCs
  - Atrial or ventricular tachydysrhythmias
  - Functional undersensing\*
    - Complexes occur during the pacemaker's refractory period
  - Electrolyte abnormalities severe enough to widen the QRS

# Pacemaker Syndrome

- **Pathophysiology**

- Occurs in pacemakers that pace only the ventricle (e.g. VVI)
- AV synchrony is lost → retrograde VA conduction → atrial contraction against closed MV + TV valve → jugular venous distension + atrial dilation → sx of CHF and reflex vasodepressor effects

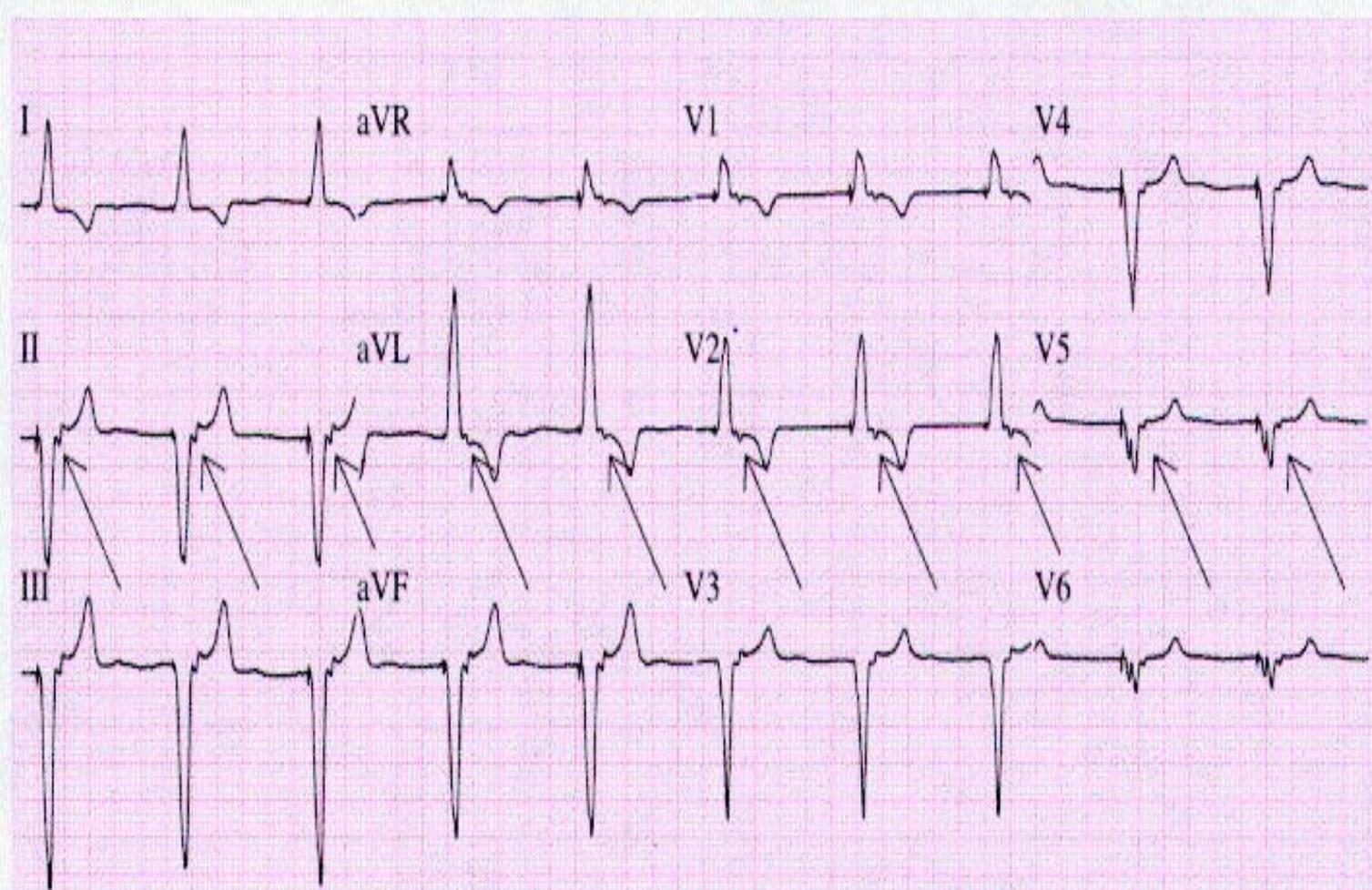
- **Symptoms**

- Pre/syncope
- Orthostatic dizziness
- Fatigue
- Exercise intolerance
- Weakness
- Lethargy
- Chest fullness or pain
- Cough
- Uncomfortable pulsations in neck or abdomen
- RUQ pain

# Pacemaker Syndrome

- Diagnosis
  - Difficult diagnosis
  - Suggested by lack of AV synchrony
  - Retrograde P waves suggest ventriculoatrial conduction which in the context of AV dyssynchrony may cause atrial overload
  - May also see SBP drop of  $> 20$  mmHg when a native rhythm converts to a paced rhythm

# Case



# Nursing Assessment and Preprocedure Care

- •Assess patient's knowledge level of procedure.
- •Instruct patient that he may have nothing by mouth before the procedure.
- •Facilitate I.V. line insertion.
- •Explain to patient that pacemaker insertion will be performed in an operating or special procedures room with fluoroscope and continuous ECG monitoring.
- •Describe local anesthetic that will be used to minimize discomfort; sedation.
- •Explain to patient that pacemaker (if permanent) will be placed under the skin in (usually) the left upper chest.
- •The incision will be closed with suture or staples.

# Nursing Diagnoses:

- Decreased Cardiac Output related to potential pacemaker malfunction and dysrhythmias
- •Risk for Injury related to pneumothorax, hemothorax, bleeding, microshock, and accidental malfunction
- •Risk for Infection related to surgical implantation of pacemaker generator and/or leads
- •Anxiety related to pacemaker insertion, fear of death, lack of knowledge, and role change
- •Impaired Physical Mobility related to imposed restrictions of arm movement and bed rest
- •Acute Pain related to surgical incision and transcutaneous external pacing stimuli
- •Disturbed Body Image related to pacemaker implantation

# PREOPERATIVE CARE

- Provide routine preoperative care and teaching
  - Assess knowledge and understanding of the procedure, clarifying and expanding on existing knowledge as needed.
  - *Clarifying knowledge, providing information, and conveying emotional support reduces anxiety and fear and allows the client to develop a realistic outlook regarding pacemaker therapy.*
  - Place ECG monitor electrodes away from potential incision sites. *This helps preserve skin integrity.*
  - Teach range-of-motion (ROM) exercises for the affected side.
  - *ROM exercises of the affected arm and shoulder prevent stiffness and impaired function following pacemaker insertion*

# POSTOPERATIVE CARE

- Provide postoperative monitoring, analgesia, and care
- Obtain a chest X-ray as ordered. *A postoperative chest X-ray is used to identify lead location and detect possible complications, such as pneumothorax or pleural effusion.*
- Position for comfort.

Minimize movement of the affected arm and shoulder during the initial postoperative period.

- *Restricting movement minimizes discomfort on the operative side and allows the leads to become anchored, reducing the risk of dislodging.*

- Assist with gentle ROM exercises at least three times daily, beginning 24 hours after pacemaker implantation. *ROM exercises help restore normal shoulder movement and prevent contractures on the affected side.*
- Monitor pacemaker function with cardiac monitoring or intermittent ECGs. Report pacemaker problems to the physician: Failure to pace. *This may indicate battery depletion, damage or dislodgement of pacer wires, or inappropriate sensing.*
- • Failure to capture (the pacemaker stimulus is not followed by ventricular depolarization). *The electrical output of the pacemaker may not be adequate, or the lead may be dislodged*

- Improper sensing (the pacemaker is firing or not firing, regardless of the intrinsic rate). *This increases the risk for decreased cardiac output and dysrhythmias.*
- Runaway pacemaker (a pacemaker firing at a rapid rate). *This may be due to generator malfunction or problems with sensing.*
- Hiccups. *A lead positioned near the diaphragm can stimulate it, causing hiccups. Hiccups may occur in extremely thin clients or may indicate a medical emergency with perforation of the right ventricle by the pacing electrode tip.*
- Assess for dysrhythmias and treat as indicated. *Until the catheter is “seated” or adheres to the myocardium, its movement may cause myocardial irritability and dysrhythmias. Fibrotic tissue develops within 2 to 3 days.*

- Document the date of pacemaker insertion, the model and type, and settings. *This information is important for future reference.*
- Immediately report signs of complications, including myocardial perforation, cardiac tamponade, pneumothorax or hemothorax, emboli, skin breakdown, bleeding, infection, endocarditis, or poor wound
- *Early identification of complications allows for aggressive intervention.*
- • Provide a pacemaker identification card including the manufacturer's name, model number, mode of operation, rate parameters, and expected battery life. *This card provides a reference for the client and future health care providers.*

# HOME CARE

- Provide appropriate teaching for the client and family about: Placement of the pacemaker generator and leads in relation to the heart.
- How the pacemaker works and the rate at which it is set. Battery replacement. Most pacemaker batteries last 6 to 12 years.
- Replacement requires an outpatient surgery to open the subcutaneous pocket and replace the battery.
- How to take and record the pulse rate. Instruct to assess pulse daily before arising and notify the physician if 5 or more BPM slower than the preset pacemaker rate.
- Incision care and signs of infection. Bruising may be present following surgery.
- • Signs of pacemaker malfunction to report, including dizziness, fainting, fatigue, weakness, chest pain, or palpitations

- Activity restrictions as ordered. This usually is limited to contact sports (which may damage the generator) and avoiding heavy lifting for 2 months after surgery.
- Resume sexual activity as recommended by the physician.
- Avoid positions that cause pressure on the site.
- Avoid tight-fitting clothing over the pacemaker site to reduce irritation and avoid skin breakdown.
- Carry the pacemaker identification card at all times, and wear a MedicAlert bracelet or tag.
- Notify all care providers of the pacemaker.
- • Do not hold or use certain electrical devices over the pacemaker site, including household appliances or tools, garage door openers, antitheft devices, or burglar alarms. Pacemakers will set off airport security detectors; notify security officials of its presence.
- • Maintain follow-up care with the physician as recommended