Cardiac Arrhythmias

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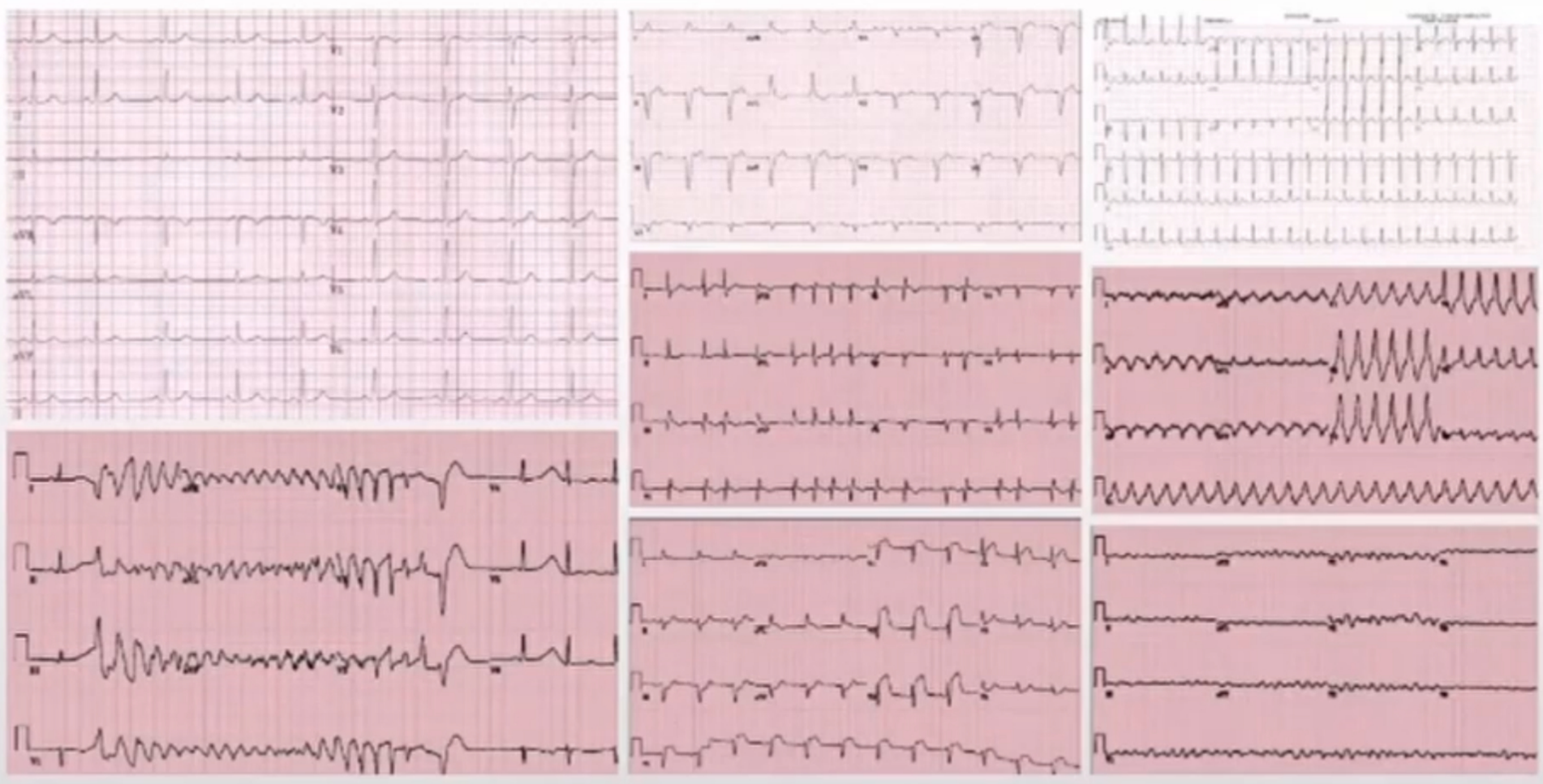
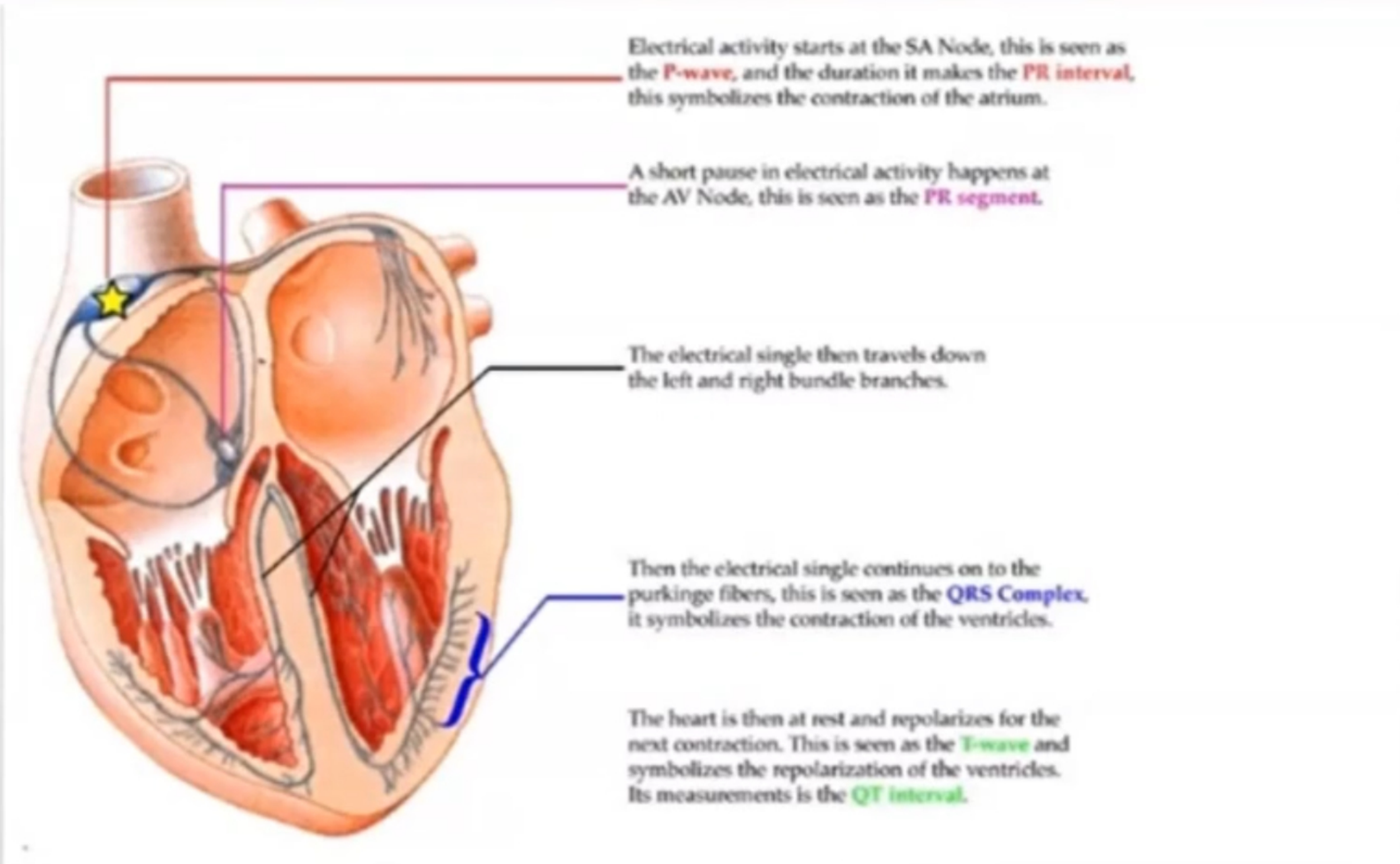
Cardiac Arrhythmias

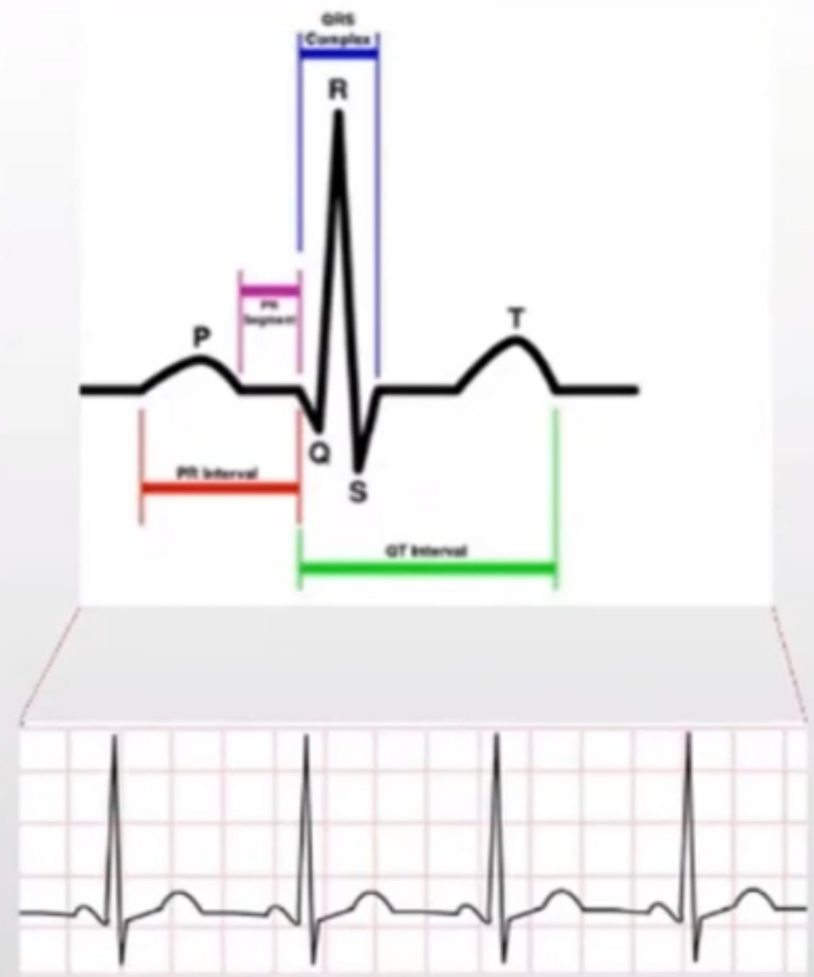


Cardiac Arrhythmias

- ECG Basics
- Approach to Rhythm
- Brady-Arrhythmias
  - Sinus Bradycardia
- Arrhythmias
  - Premature Atrial Contraction
  - Premature Ventricular Contraction
- Tachy-Arrhythmias
  - Sinus Tachycardia
  - Atrial Fibrillation
  - Atrial Flutter
  - Multifocal Atrial Tachycardia
  - Supraventricular Tachycardias
  - Ventricular Tachyarrhythmias

ECG Basics



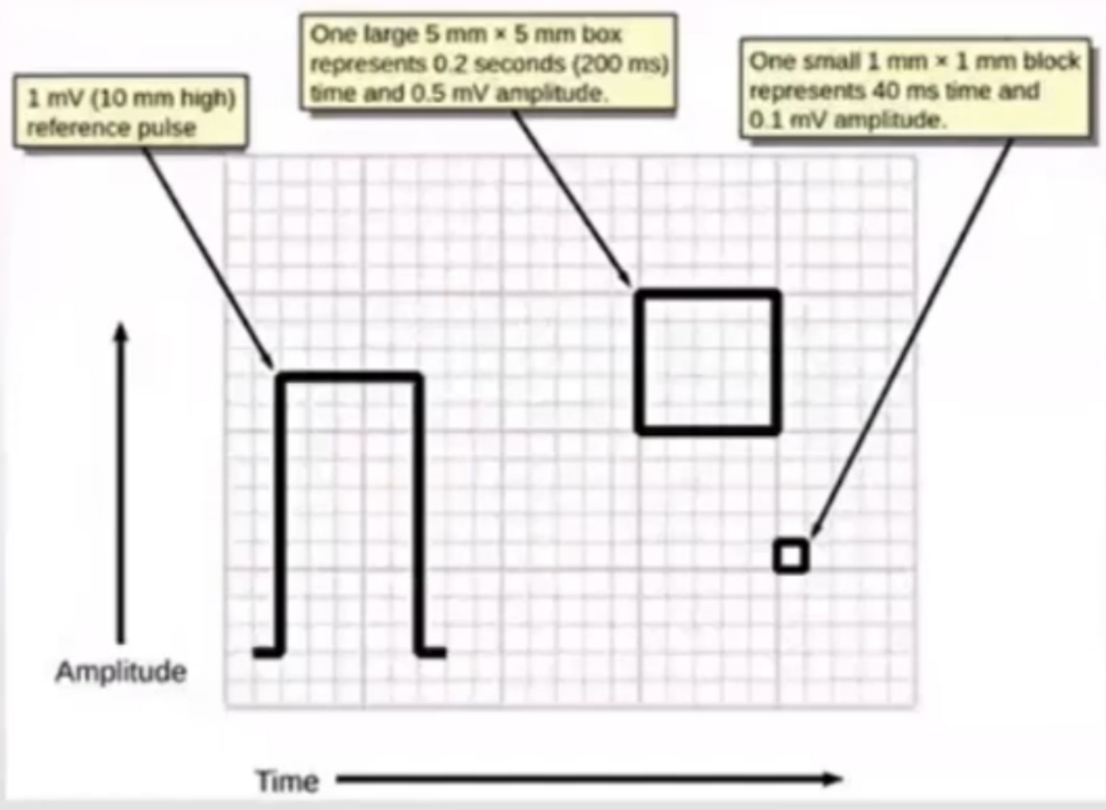


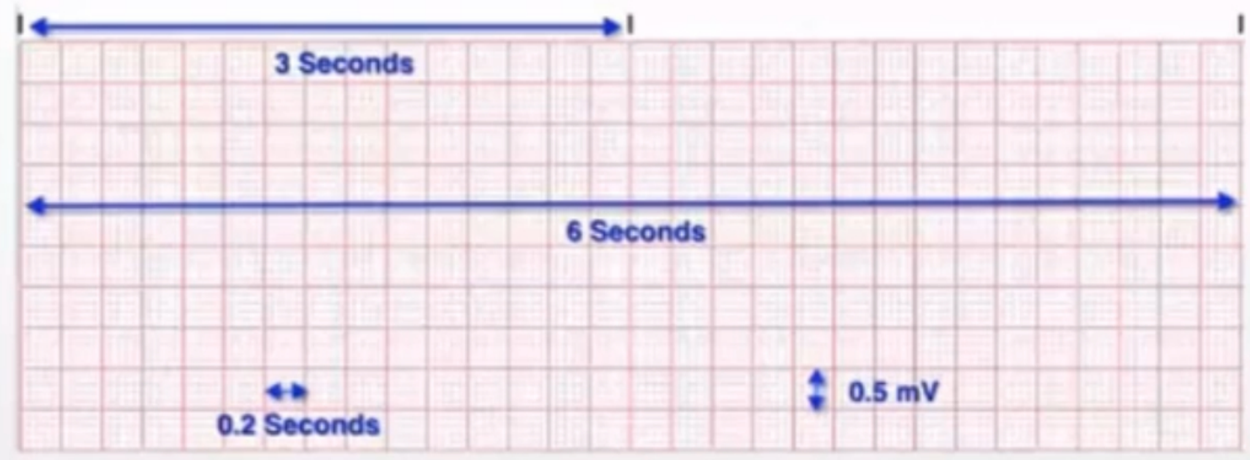
Internet Source: Amurecek.divinetart.com

ECG Basics

- **Approach to Reading ECG:**
  - Verify
  - Rate
  - Rhythm
  - Axis
  - Amplitude
  - Intervals
  - Ischemia

ECG Basics





The whole ECG Strip is 10 seconds

Internet Source: practicalclinical skills.com

ECG Basics - Rate

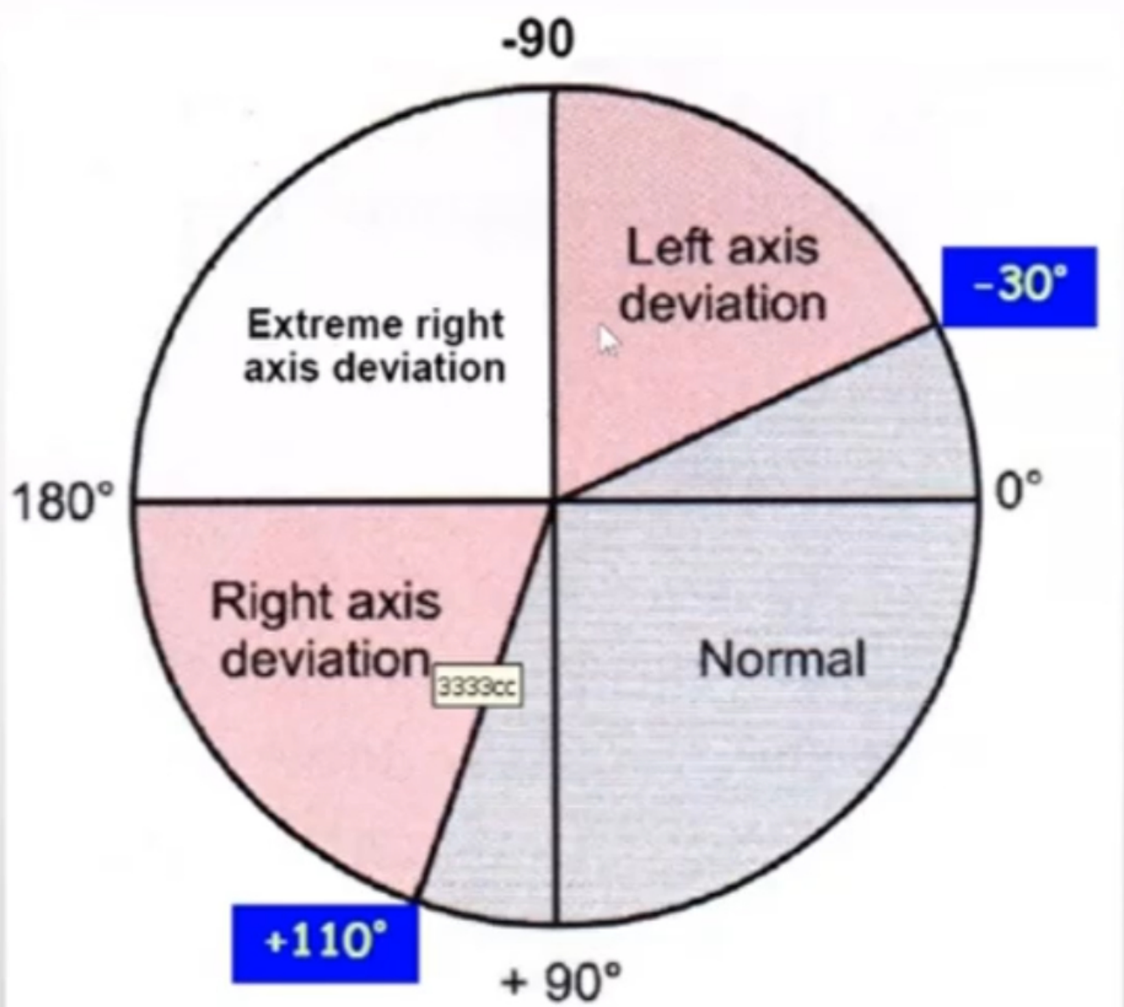
- Heart Rate Calculation Methods:
  - Counts QRS complexes
    - 6 second interval X 10
    - All strip (10 seconds) X 6
  - Distance between QRS-QRS complex
    - Rate = 300 / Large Boxes
    - Rate = 1500 / Small Boxes

# Large Boxes	HR (BPM)
1	300
2	150
3	100
4	75
5	60
6	50

ECG Basics - Rhythm

Approach to Rhythm Questions:	Clinical Significance
1. Is it Tachycardia / Normal Rate / Bradycardia?	Rate
2. QRS is it Narrow or Wide?	Narrow: Rhythm from AVN and above & conduction through normal system Wide: Rhythm below AVN OR Abnormal conduction
3a. Narrow QRS – Is it Regular or Irregular	
3b. Wide QRS – What is Morphology?	Pathophysiology of Wide QRS: Vent. Origin or Aberrant conduction?
4. Look for P-wave (Best place in Lead II and V1)	What is the atria doing?
5. Relationship between the P wave and QRS ?	What is the underlying circuit?

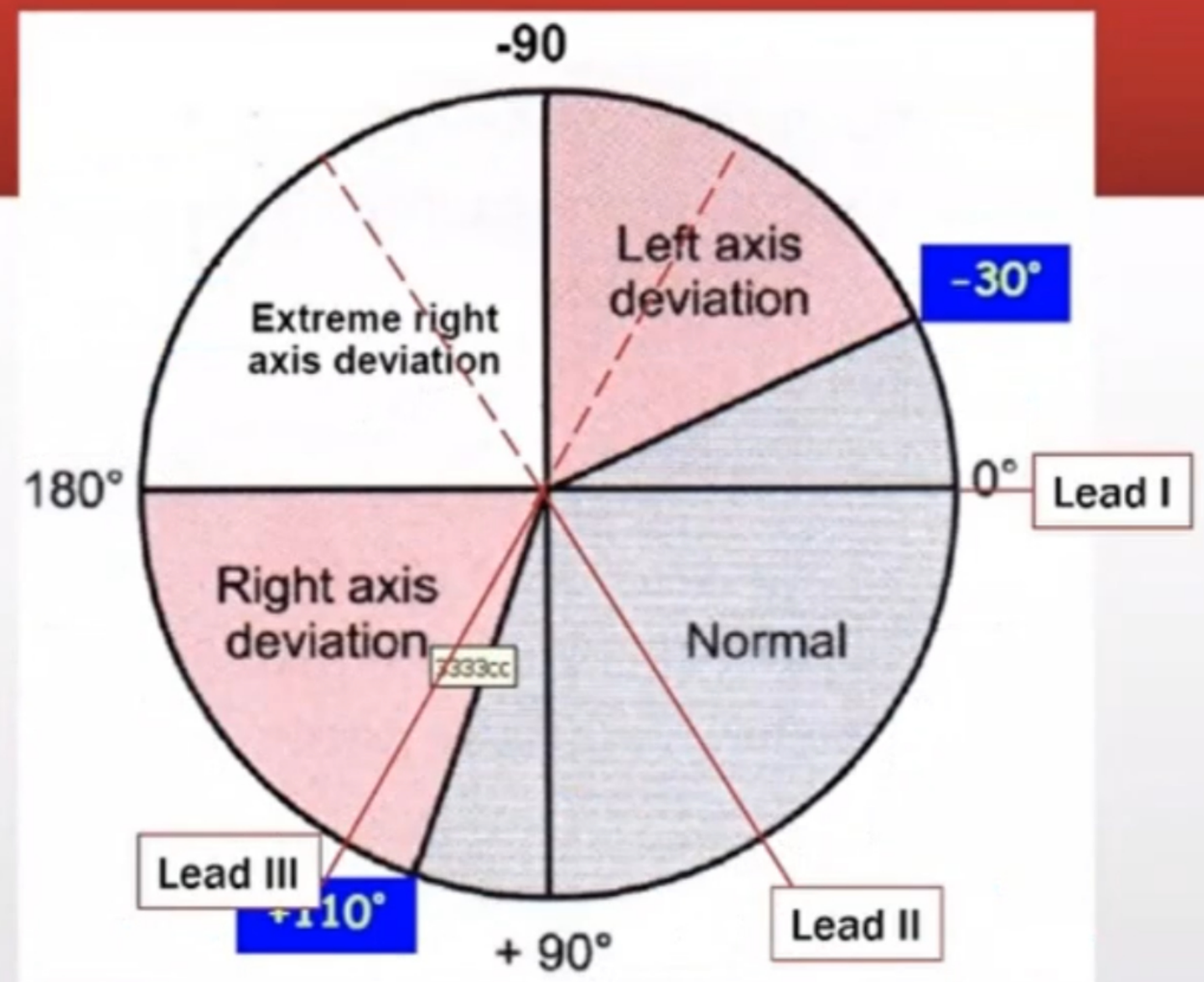
ECG Basics - Axis



ECG Basics - Axis

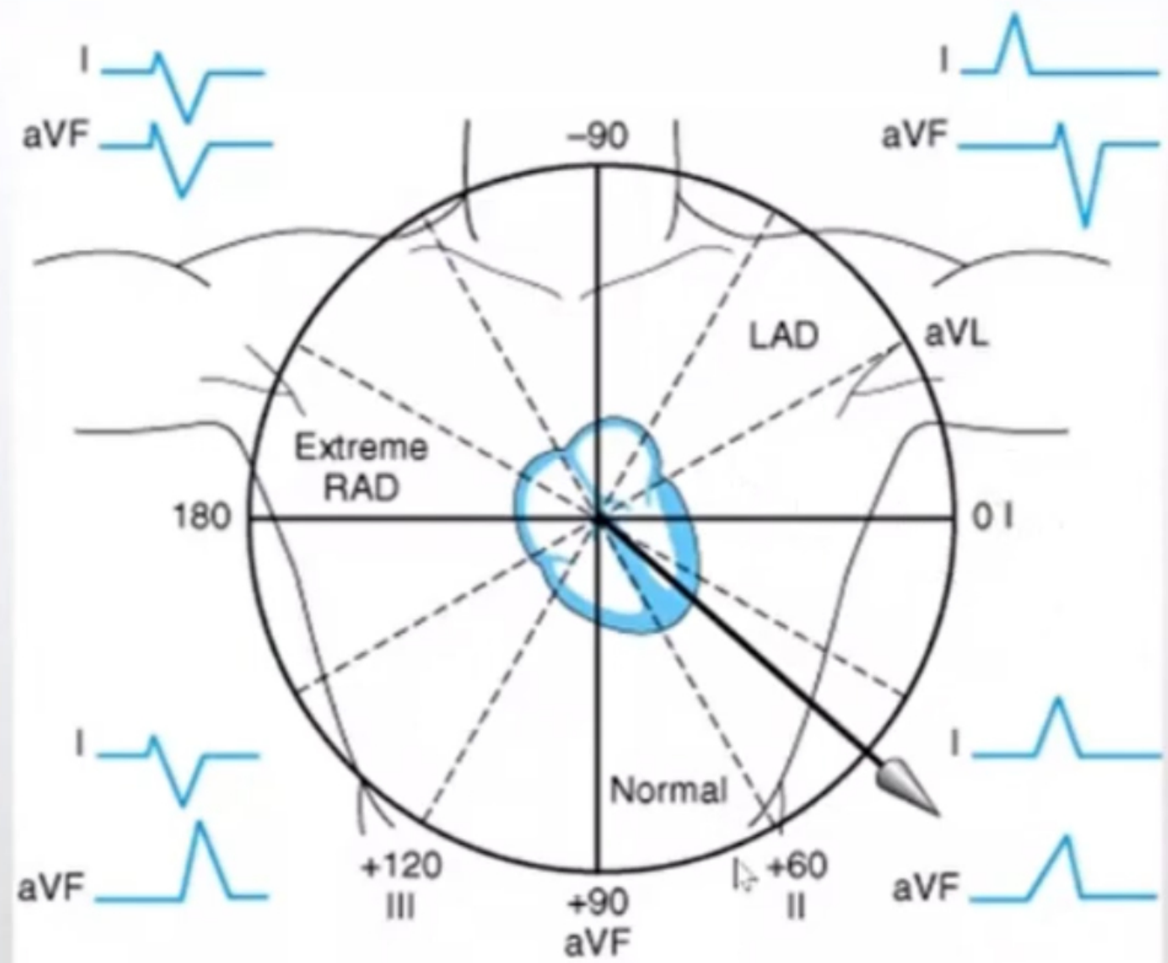
- Heart Axis Calculation Methods:
  - Lead I, II & III

Axis	Lead I	Lead II	Lead III
Normal	Positive	Positive	Positive
LAD	Positive	Negative	Negative
RAD	Negative	Positive	Positive
Extreme Axis	Negative	Negative	Negative



ECG Basics - Axis

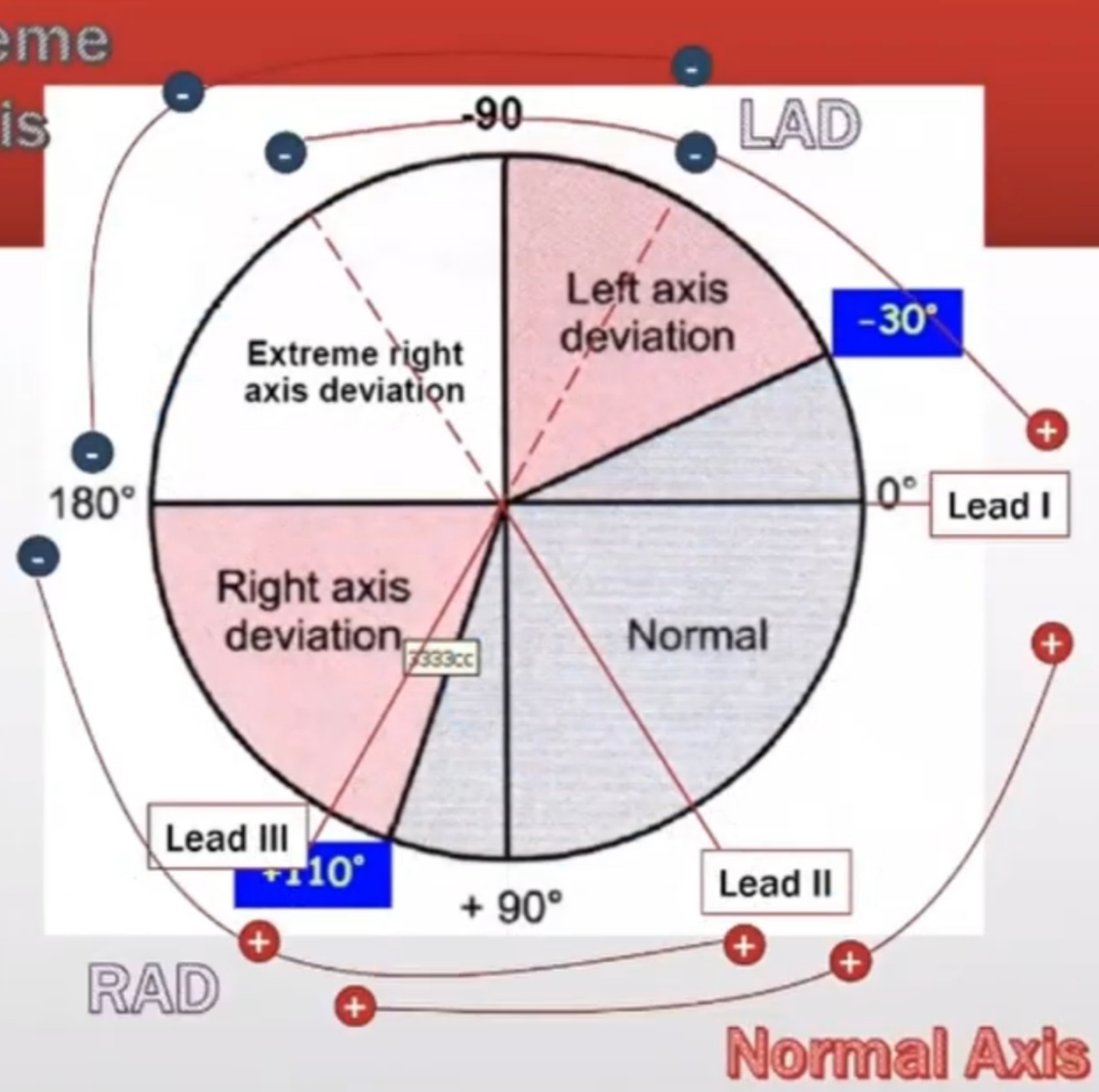
- Heart Axis Calculation Methods:
  - Lead I & Lead AVF



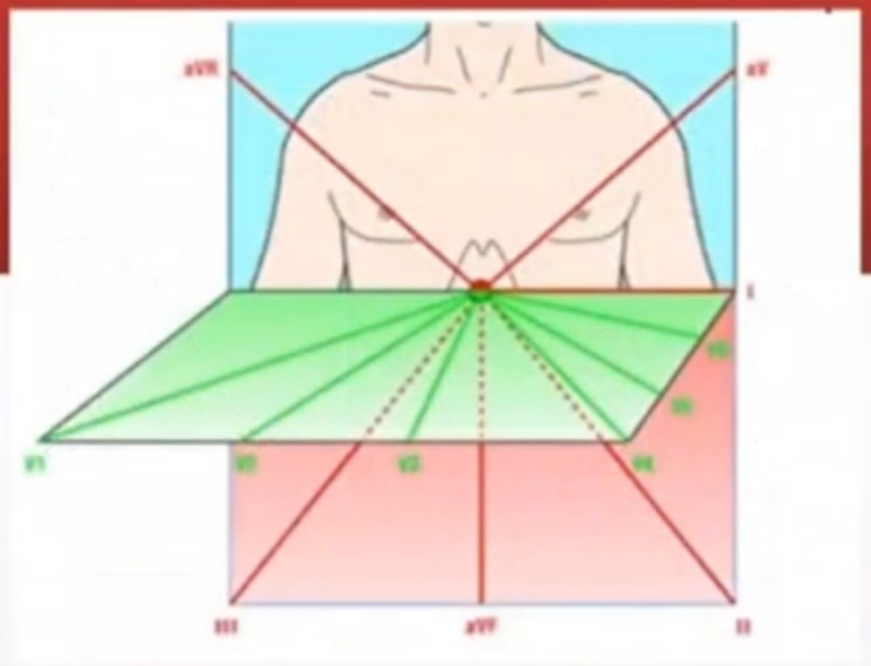
ECG Basics - Axis

- Heart Axis Calculation Methods:
  - Lead I, II & III

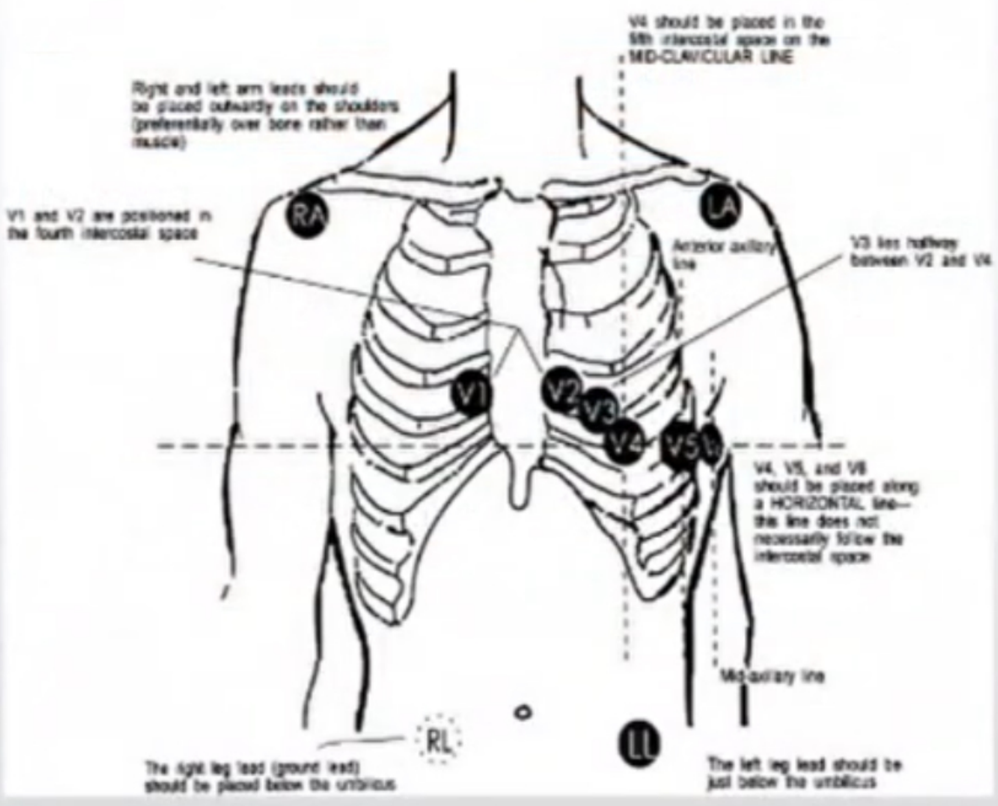
Axis	Lead I	Lead II	Lead III
Normal	Positive	Positive	Positive
LAD	Positive	Negative	Negative
RAD	Negative	Positive	Positive
Extreme Axis	Negative	Negative	Negative

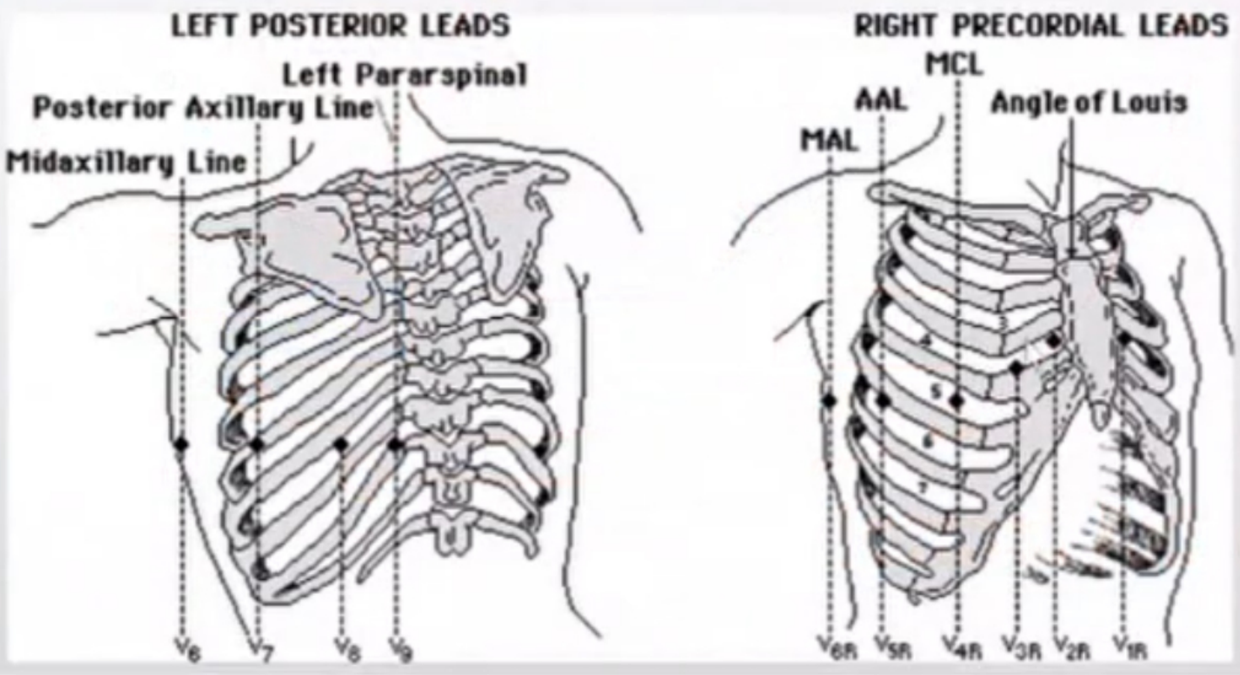


ECG Basics - Axis



12-lead ECG Electrode Placement





Internet Source: circ.ahajournal.org

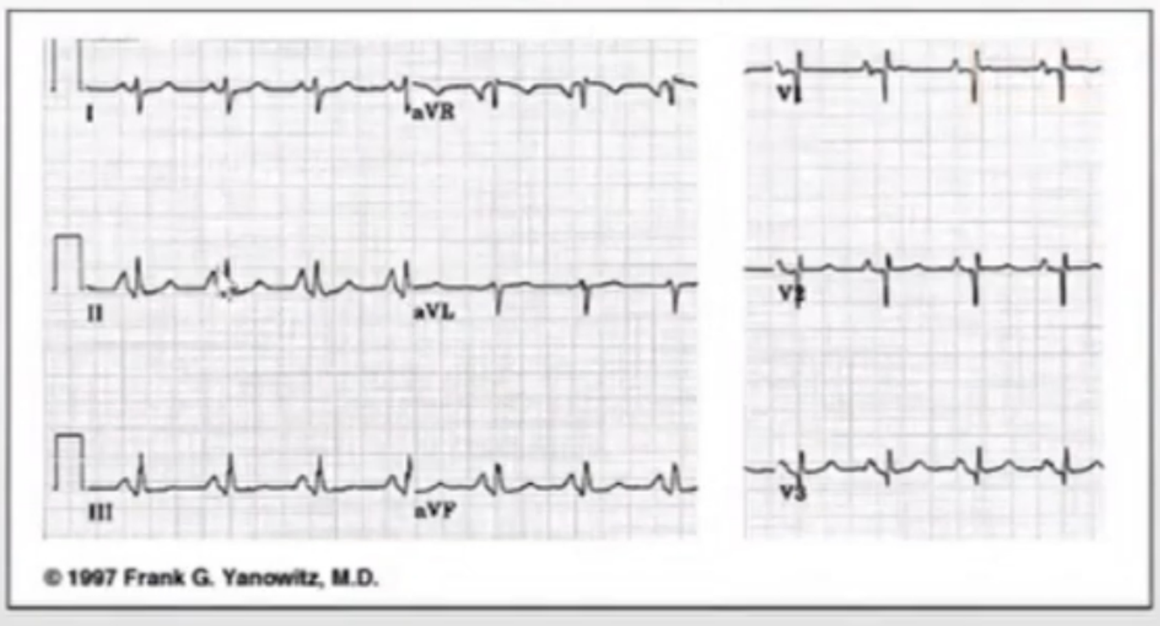
ECG Basics – Amplitude / Hypertrophy

- Low Amplitude
  - Limb leads < 0.5 mV
  - Precordial leads < 1.0 mV

Component	Amplitude (mV)
P wave	0.2
QRS	1.0
T-wave	0.2 – 0.3

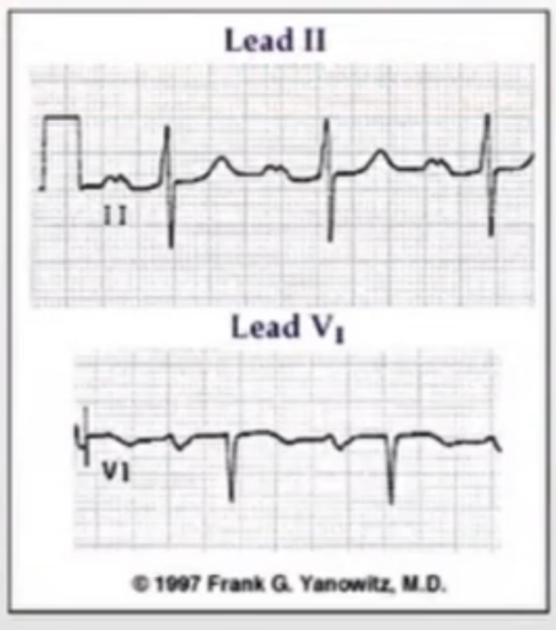
ECG Basics – Amplitude / Hypertrophy

RAE



P wave amplitude > 2.5 mm in II and/or > 1.5 mm in V1

LAE



P wave duration ≥ 0.12s in frontal plane (usually lead II)
Notched P wave in limb leads with the inter-peak duration ≥ 0.04s
Terminal P negativity in lead V1 (i.e., "P-terminal force") duration ≥ 0.04s & depth ≥ 1 mm.

ECG Basics – Amplitude / Hypertrophy

LVH

ESTES Criteria	Points
•Voltage Criteria (any of): R or S in limb leads ≥ 20 mm •S in V1 or V2 ≥ 30 mm •R in V5 or V6 ≥ 30 mm	3 points
•ST-T Abnormalities: Without digitalis •With digitalis	3 points 1 point
Left Atrial Enlargement in V1	3 points
Left axis deviation	2 points
QRS duration 0.09 sec	1 point
Delayed intrinsicoid deflection in V5 or V6 (>0.05 sec)	1 point

("diagnostic", ≥ 5 points; "probable", 4 points)

CORNELL Voltage Criteria

- S in V3 + R in aVL > 24 mm (men)
- S in V3 + R in aVL > 20 mm (women)

(sensitivity = 22%, specificity = 95%)

Limb-lead voltage criteria:

- R in aVL ≥ 11 mm
- R in aVL ≥ 13 mm + S in III ≥ 15 mm (if LAD)
- R in I + S in III > 25 mm

Chest-lead voltage criteria:

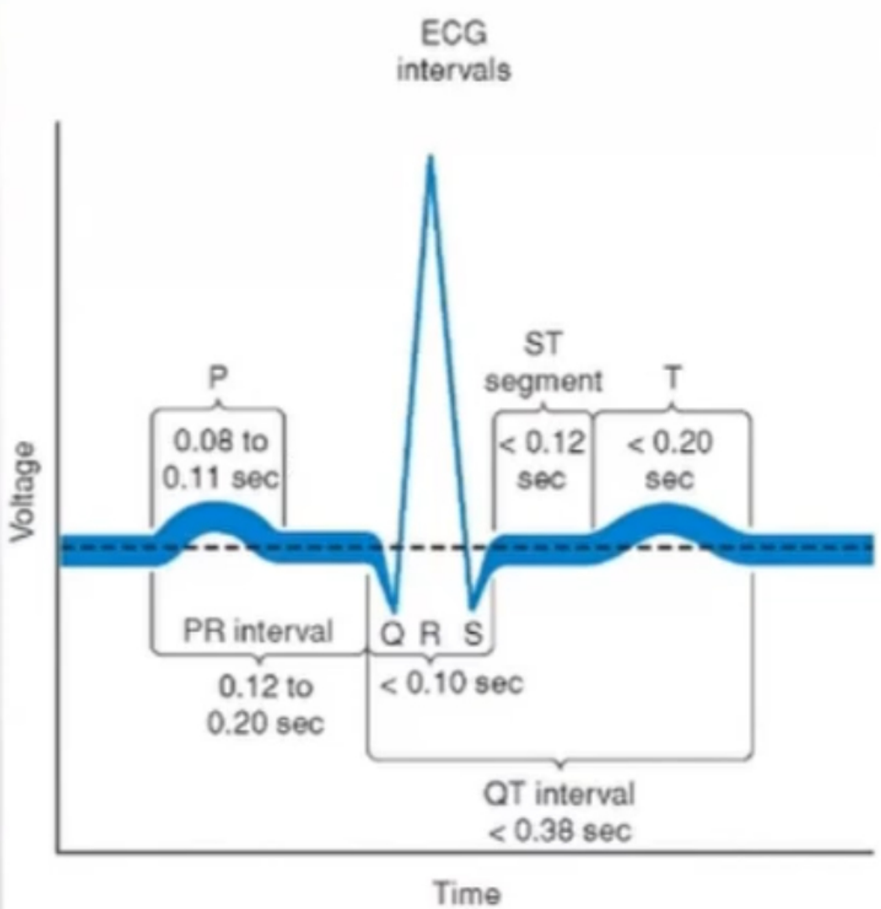
- S in V1 + R in V5 or V6 ≥ 35 mm

ECG Basics – Amplitude / Hypertrophy

RVH

- Any one or more of the following (if QRS duration < 0.12 sec):
  - Right axis deviation (> 90 degrees) in presence of disease capable of causing RVH
  - R in aVR ≥ 5 mm, or
  - R in aVR > Q in aVR
- Any one of the following in lead V1:
  - R/S ratio > 1 *and* negative T wave
  - qR pattern
  - R > 6 mm, *or* S < 2mm, or rSR' with R' > 10 mm
- Other chest lead criteria:
  - R in V1 + S in V5 (or V6) 10 mm
  - R/S ratio in V5 or V6 < 1
  - R in V5 or V6 < 5 mm
  - S in V5 or V6 > 7 mm

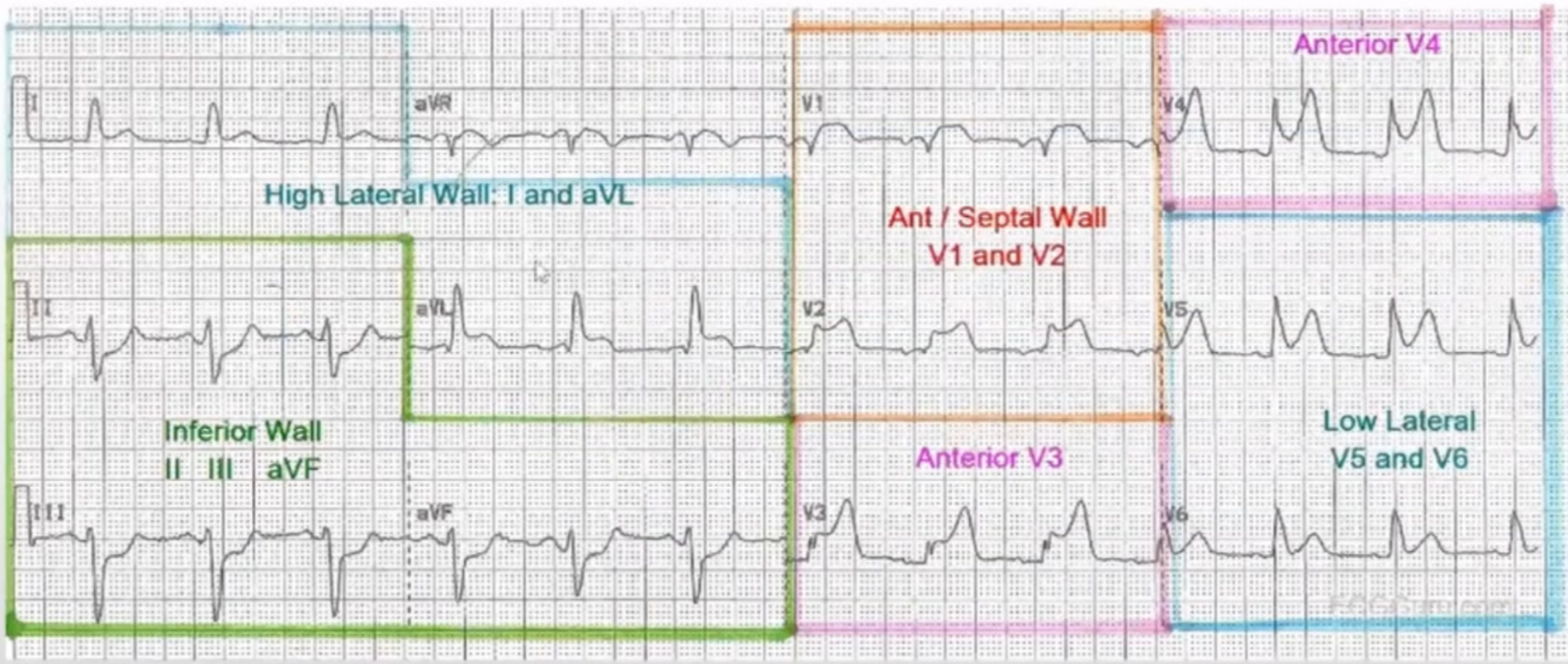
ECG Basics - Intervals



$$QTc = QT\ Interval / \sqrt{RR\ Interval}$$

Upper Limit of Normal QTc	ms
Male	> 460 – 470
Female	> 470 – 480

ECG Basics - Ischemia



Internet Source: ECGguru.com

ECG Basics - Ischemia

ST segment depression	Horizontal ST despression	Downsloping ST depression
T-wave inversion		
Horizontal ST with ST–T angulation		
Tall, wide based T waves		
U-wave inversion		

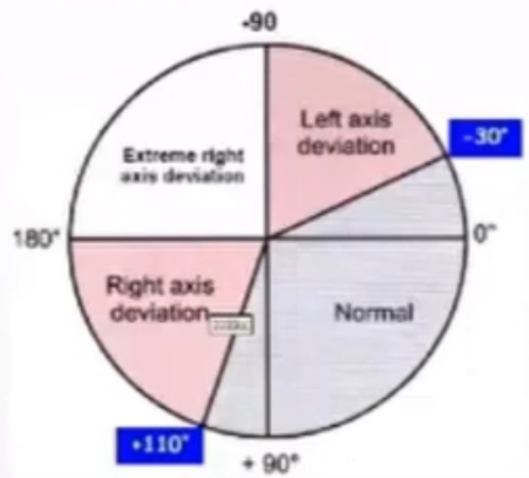
Approach to ECG

- **Rate**
  - Regular: Rate = 300 / Large Boxes
  - Irregular: Rate = # R in ECG X 6

- **Rhythm**

Approach to Rhythm Questions:
1. Is it Tachycardia / Normal Rate / Bradycardia?
2. QRS is it Narrow or Wide?
3a. Narrow QRS – Is it Regular or Irregular
3b. Wide QRS – What is Morphology?
4. Look for P-wave (Best place in Lead II and V1)
5. Relationship between the P wave and QRS ?

- **Axis**



- **Amplitude**

Low:
Limb <0.5 mm
Chest < 1.0 mm

LAE:
P Width >120ms
RAE:
P Ht. > 2.5 mm

LVH : Cornell's Criteria
- S in V3 + R in aVL > 24 mm (men)
- S in V3 + R in aVL > 20 mm (women)

LVH: Lead AVL > 11 mm

RVH : Lead V1
- R/S ratio > 1 *and* negative T wave
- R > 6 mm / S < 2mm
- rSR' with R' > 10 mm

- **Intervals**

Intervals		# Small sq.
PR	120-200 ms	3-5
QRS	< 110-120 ms	< 3
QT	< 480-500 ms	< ½ RR Interval < 12

- **Ischemia**

STEMI

Non – ST ACS

Approach to Rhythm

Approach to Rhythm – Normal Rate

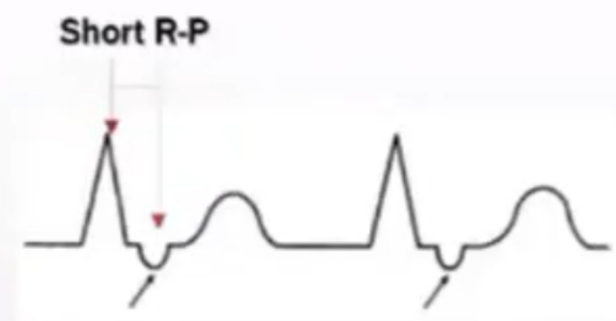
Question	Answer							
1. Rate	Normal Rate							
2. QRS	Narrow						Wide	
3. QRS	Regular				Irregular			
							Morphology	
							Ventricular	Aberrancy
4. P wave	Present			Absent	Present	Absent	Absent	Present
5. P-QRS Relation	Single	Multiple	Retrograde					
DDx	**NSR**	A.Flutter	Junctional Rhythm	Junctional Rhythm	SR with PAC	A.Fib	AIVR	Conduction Abnormality
	Atrial Rhythm	2:1 AV Block			Wandering Pacemaker			
	1st degree AV Block				A.Fl with Variable Conduction			

Approach to Rhythm - Bradycardia

Question	Answer									
1. Rate	Bradycardia									
2. QRS	Narrow							Wide		
3. QRS	Regular						Irregular			
								Morphology		
								Ventricular	Aberrancy	
4. P wave	Present					Absent	Present	Absent	Absent	Present
5. P-QRS Relation	Single	Multiple	Group Beating	Retrograde	AV Dissociation					
DDx	SB	A.Flutter with SVR	2nd degree AV Block	Junctional Escape Rhythm	Complete AV Block (3rd degree)	Junctional Escape Rhythm	SB with PAC	A.Fib with SVR	Ventricular Escape Rhythm	Conduction Abnormality
	1st degree AV Block	2:1 AV Block					A.Fl with Slow & Variable Conduction			

Approach to Rhythm - Tachycardia

- **DDx of SVT**
  - *Short RP Tachycardias (RP<PR):*
    - Typical AV Nodal Re-entry Tachycardia (AVNRT)
    - Junctional Tachycardia
    - **Orthodromic Atrioventricular Tachycardia (OD – AVRT)**
    - *Atrial Tachycardia*



  - *Long RP Tachycardias (RP>PR):*
    - Sinus Tachycardia (ST)
    - Atrial Tachycardia (AT)
    - *Atypical Orthodromic Atrioventricular Tachycardia (OD – AVRT)*
    - *Atypical AV Nodal Re-entry Tachycardia (AVNRT)*
    - *Junctional Tachycardia*

  - *Mimickers:*
    - Atrial Flutter with rapid conduction
    - A. Fibrillation with very rapid conduction

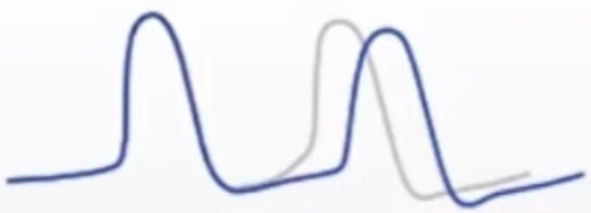
Approach to Rhythm - Tachycardia

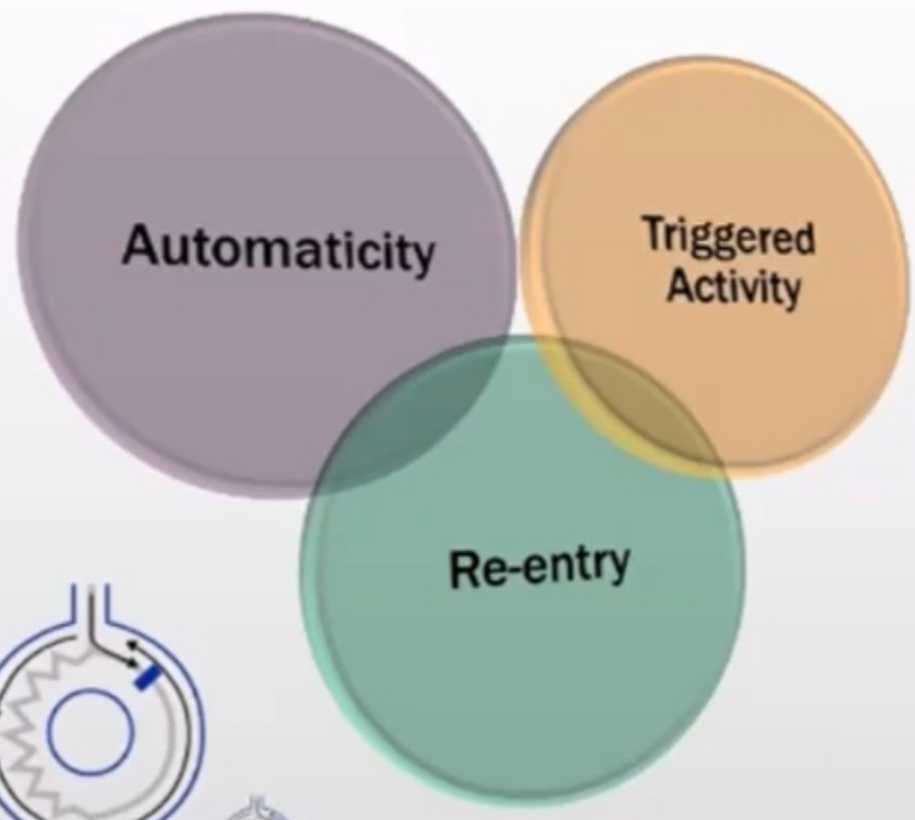
Tachyarrhythmia Framework

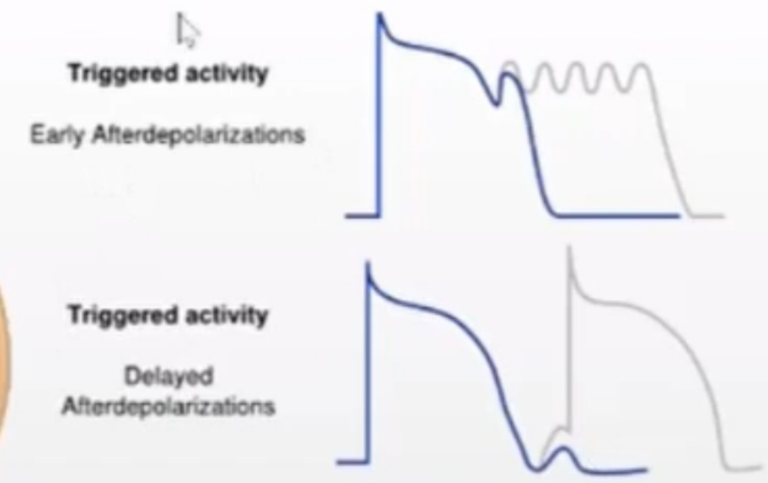
	REGULAR RHYTHM	IRREGULAR RHYTHM
NARROW QRS	• Sinus tachycardia • AVNRT • Orthodromic AVRT • Atrial Tachycardia • Atrial flutter • Junctional tachycardia	• Atrial fibrillation • Atrial flutter w/ variable AV block • Multifocal atrial tachycardia
WIDE QRS	• Ventricular tachycardia • SVT with bundle branch block • Antidromic AVRT • Pre-excited SVT	• Polymorphic ventricular tachycardia • Atrial fibrillation with bundle branch block • Atrial flutter with variable AV block & bundle branch block

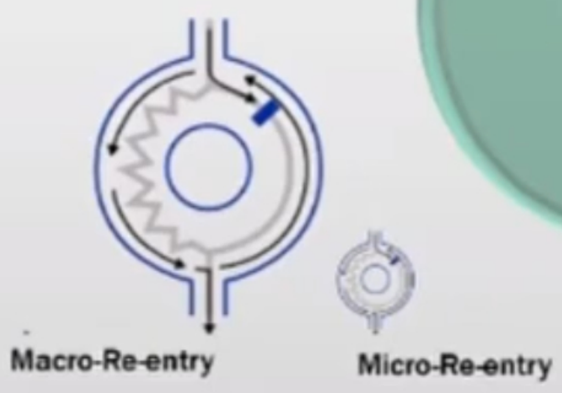
Arrhythmias

Mechanisms of Arrhythmias







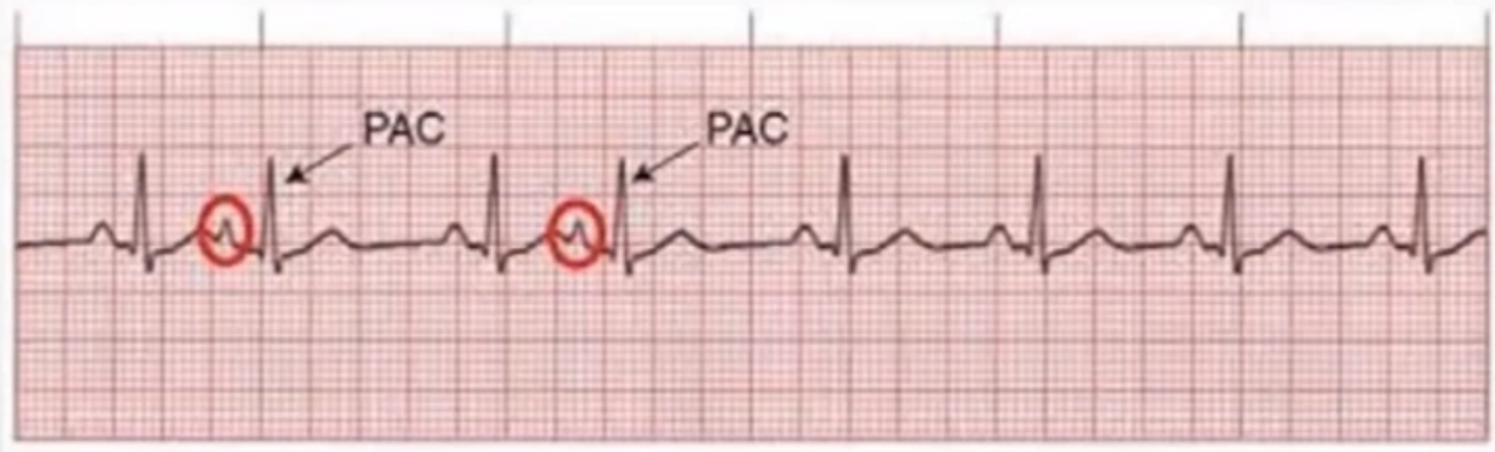


Arrhythmias

- Premature Atrial Contraction / Complex
- Premature Ventricular Contraction / Complex

Premature Atrial Contractions / Complexes (PAC)

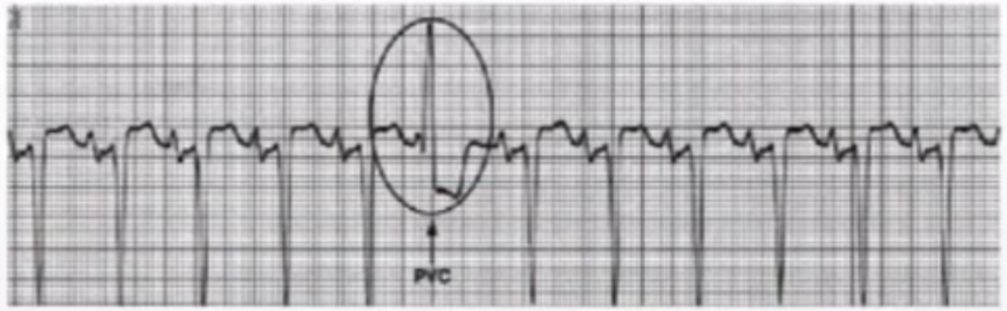
- Very common. May cause Palpitations
- Causes:
  - Adrenergic excess
  - Pharmacological
  - Electrolyte imbalances
  - Ischemia
  - Hypoxia
  - Infection.

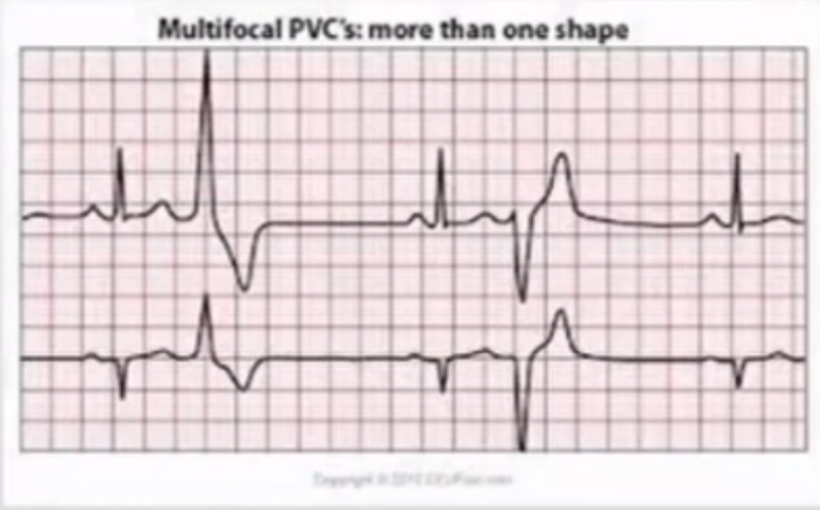


Clinical Status	Management
Asymptomatic	Observation
Symptomatic (Palpitations, Fatigue, Exercise Intolerance, Angina, Dizziness, Syncope)	Rx Cause B-Blockers

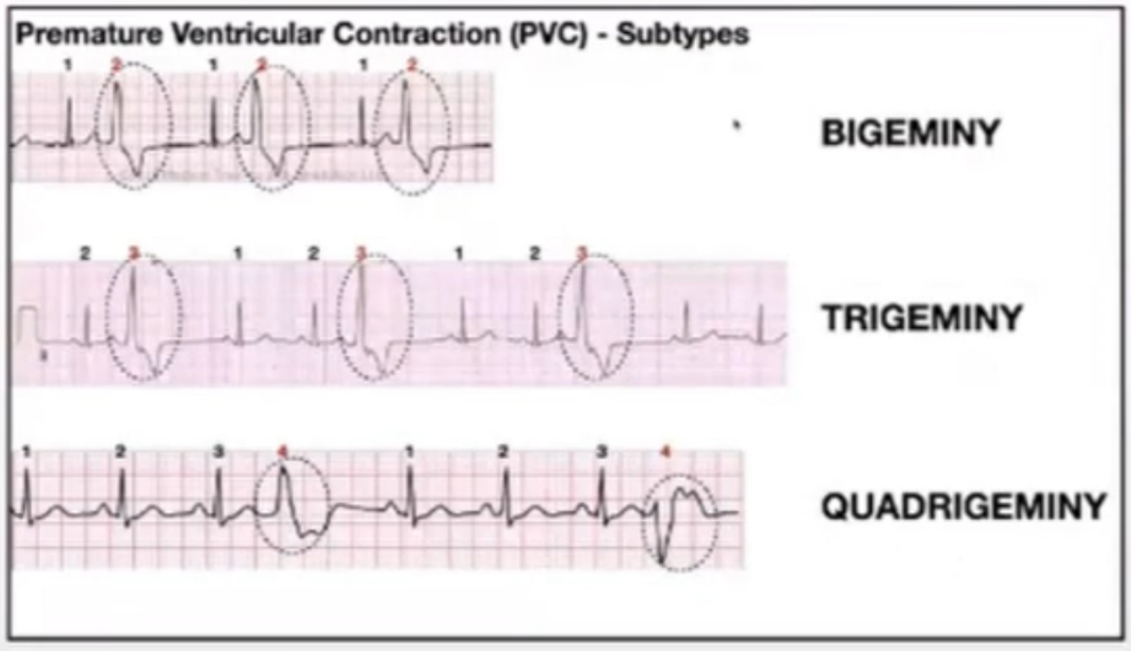
Premature Ventricular Contractions / Complexes (PVC)

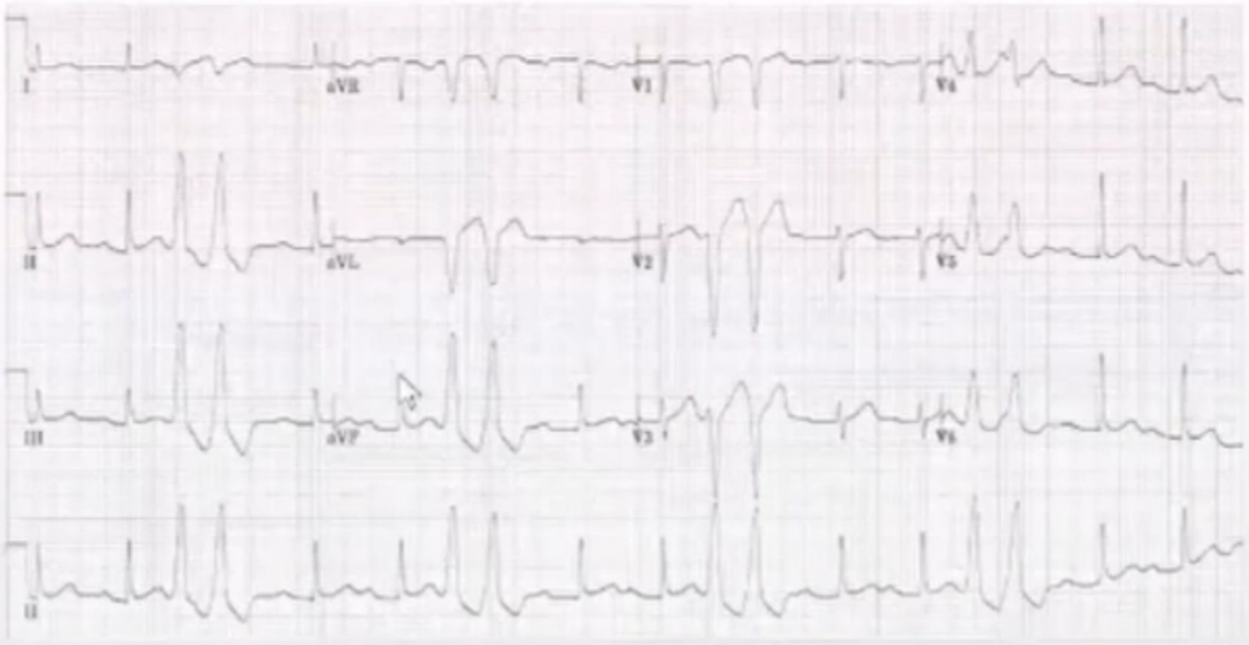
- Common. May cause Palpitations.
- Causes:
  - Hypoxia
  - Electrolyte abnormalities
  - Pharmacological
  - **Structural heart disease**

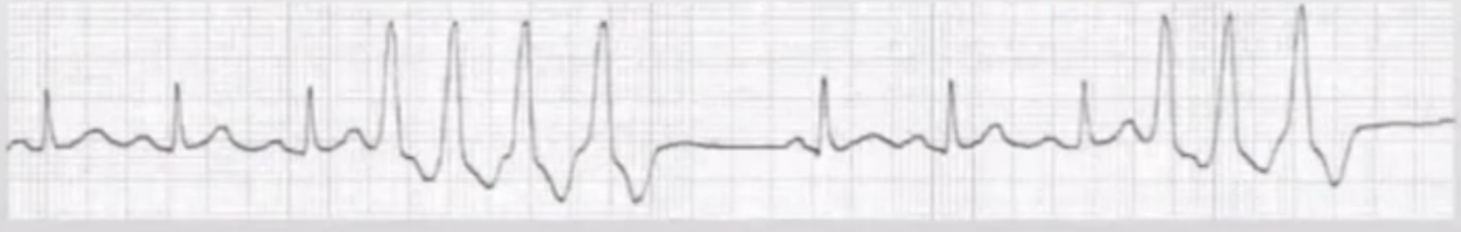




Premature Ventricular Contractions / Complexes (PVC)







NSVT

Premature Ventricular Contractions / Complexes (PVC)

Clinical Status	Management
Asymptomatic - Infrequent	Observation
Asymptomatic – Frequent / Repetitive	R/o Heart Disease B-Blockers EPS +/- ICD/Ablation
Symptomatic (Palpitations, Fatigue, Exercise Intolerance, Angina, Dizziness, Syncope)	Rx Cause B-Blockers

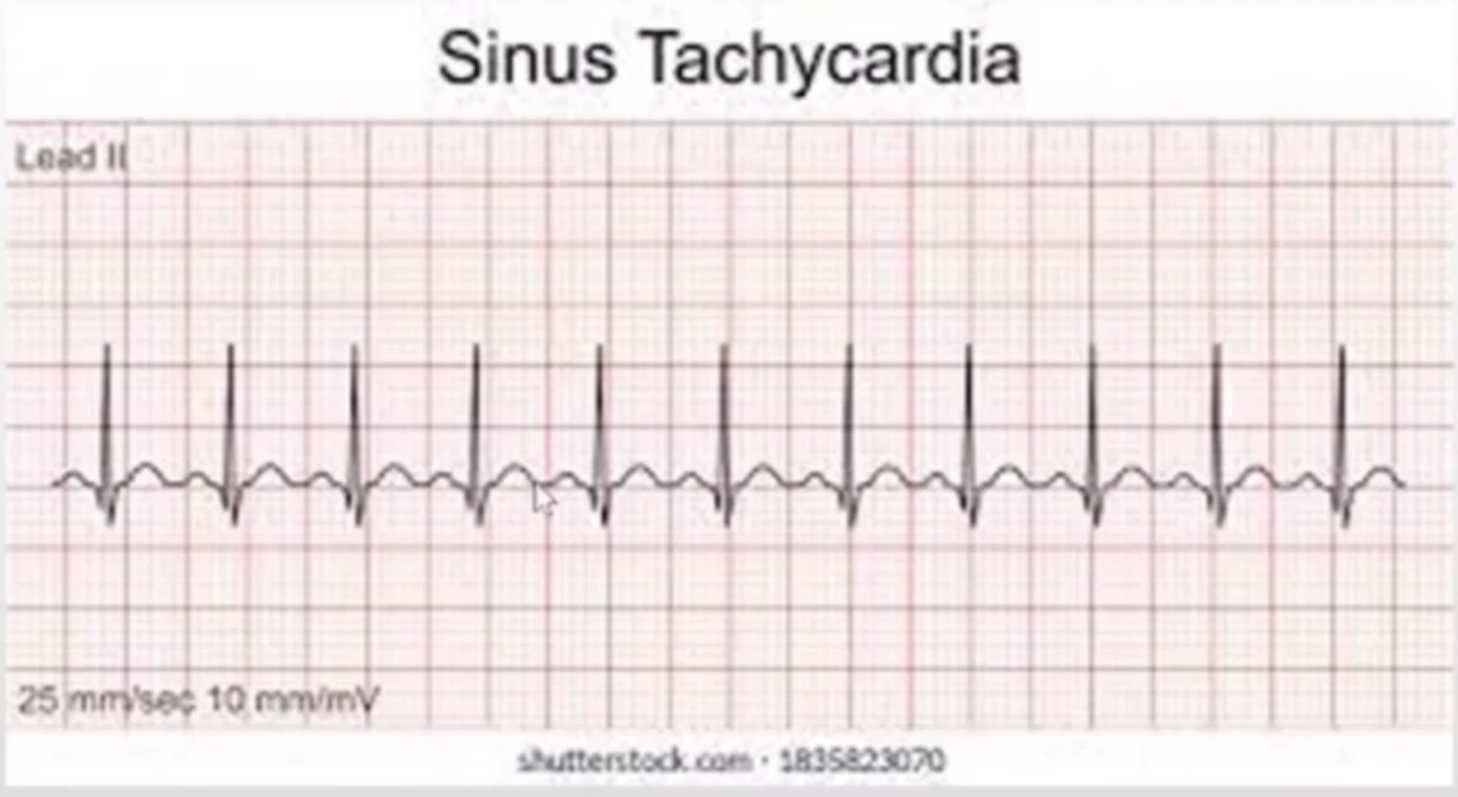
Tachyarrhythmias

Tachyarrhythmias

- Sinus Tachycardia
  - Inappropriate Sinus Tachycardia
- Atrial Fibrillation
- Atrial Flutter
- Multifocal Atrial Tachycardia
- Supraventricular Tachycardia
- Ventricular Tachycardia
- Ventricular Fibrillation

Sinus Tachycardia

- Rate >100 bpm



Sinus Tachycardia

- Causes:

Physiological	Cardiac Conditions	Medical Condition	Pharmacological
• Exercise • Emotion • Anxiety • Pain • Fever • Pregnancy • *Volume Depletion*	• MI • Cardiomyopathy / HF • Acute Valve Disease • Pericarditis • *Postural*	• Shock • Hypoxia • Respiratory Distress • P.E. • Anemia • Infection • *Dehydration* • Hyperthyroidism • Pheochromocytoma • Cushing's • Hypoglycemia • Panic Attack	• Caffeine • Alcohol • Tobacco • Catecholamines • B agonist • BB Withdrawal • Vasodilators • Atropine • Theophylline • Decongestants • Cocaine • Amphetamines • Thyroid Hormones

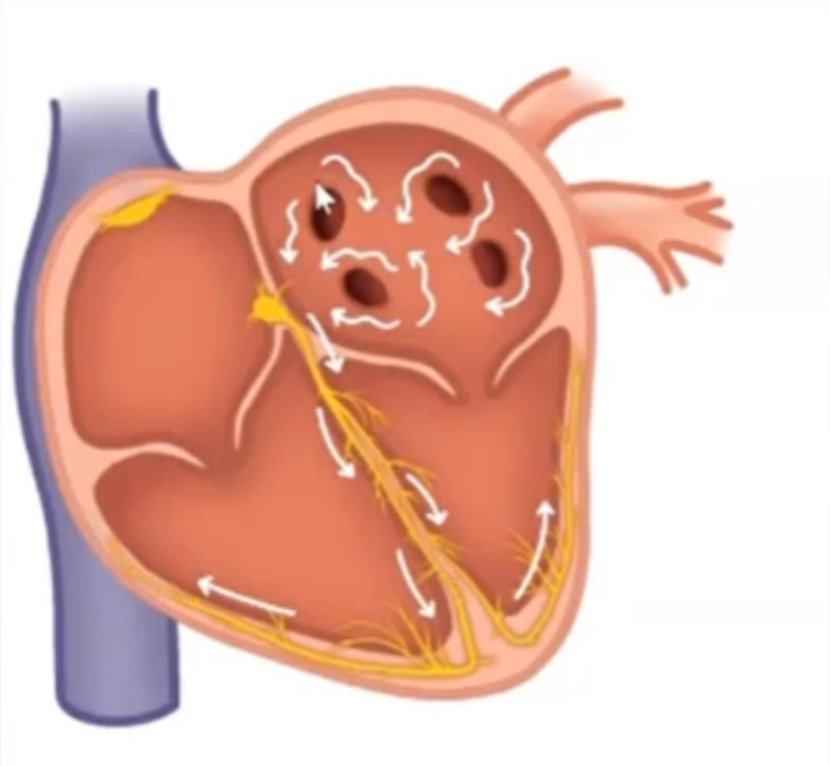
Sinus Tachycardia

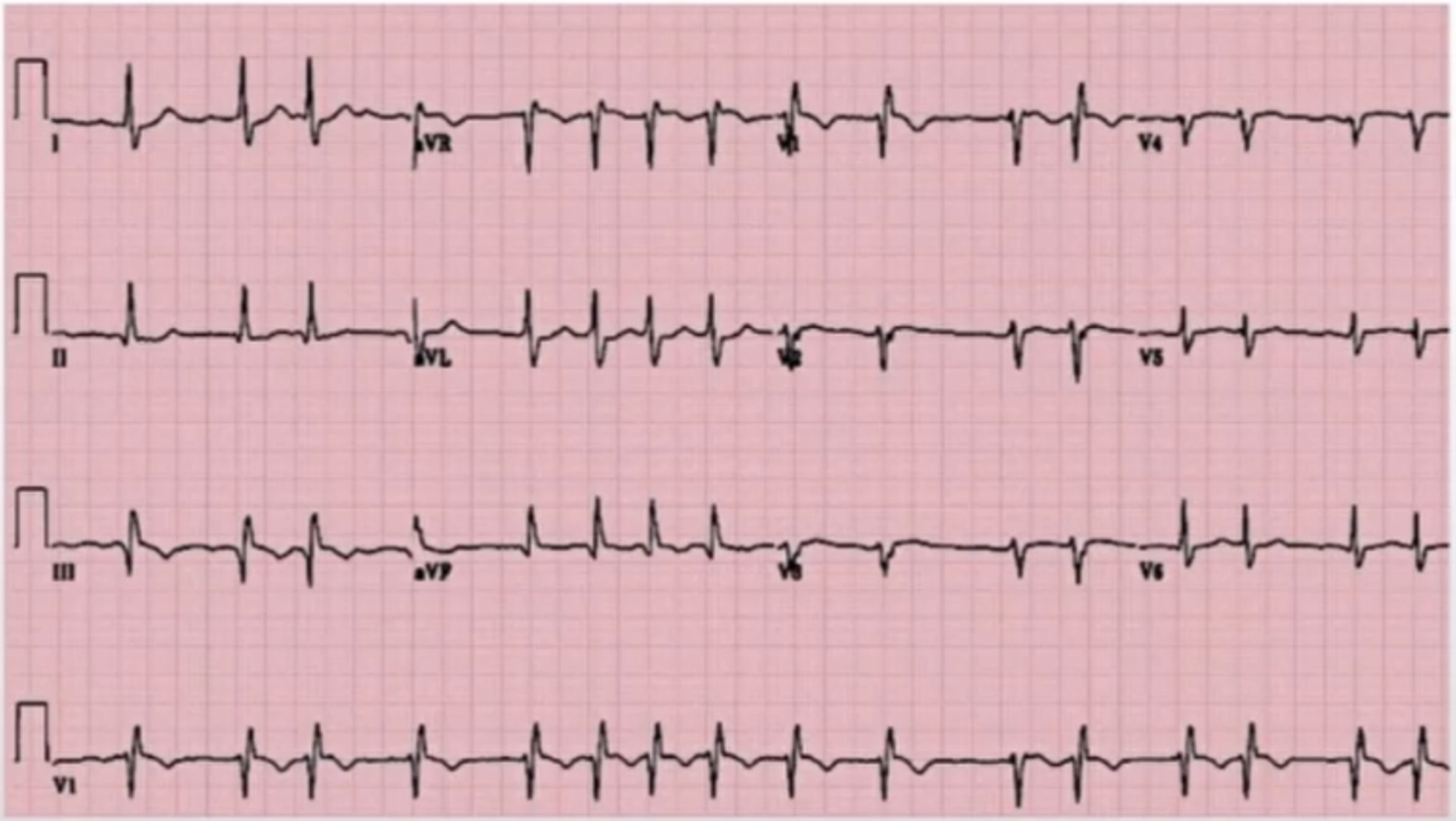
- Management:
  - Treat the underlying cause
  - Treat the underlying cause
  - Treat the underlying cause

- Inappropriate Sinus Tachycardia
  - B-Blockers
  - Ivabradine
  - RFA

Atrial Fibrillation

- Very common





Atrial Fibrillation

- Causes:
  - Heart disease: CAD, MI, HTN, mitral valve disease
  - History of cardiac surgery
  - Pericarditis
  - Pulmonary disease (PE, COPD, Hypoxia)
  - Thyroid disease
  - Pheochromocytoma
  - Systemic illness (e.g. Infection,)
  - Stress (postoperative, pain, anxiety)
  - Hyperadrenergic states
  - Cocaine or methamphetamine use
  - Extremes of activity (sedentary lifestyle, excess exercise such as marathon running)
  - Excessive alcohol intake ("holiday heart syndrome")

Atrial Fibrillation - Management

- **Rate Control**
  - B-Blockers
  - CCB
  - Digoxin
- **Anticoagulation**
  - Warfarin
  - DOACS

CHA2DS2-VASc Score	
CHF or LVEF ≤ 40%	1
HTN	1
Age ≥ 75	2
DM	1
CVA/TIA/TE	2
Vascular	1
Age 65-74	1
Female	1

HAS-BLED score

Condition	Points
H - Hypertension	1
A - Abnormal renal or liver function (1 point each)	1 or 2
S - Stroke	1
B - Bleeding	1
L - Labile INRs	1
E - Elderly (> 65 years)	1
D - Drugs or alcohol (1 point each)	1 or 2

Atrial Fibrillation - Management

- **Rate Control**
  - B-Blockers
  - CCB
  - Digoxin
- **Anticoagulation**
  - Warfarin
  - DOACS

CHA2DS2-VASc Score

CHF or LVEF ≤ 40%	1
HTN	1
A	2
D	1
C	2
V	1
A	1
F	1

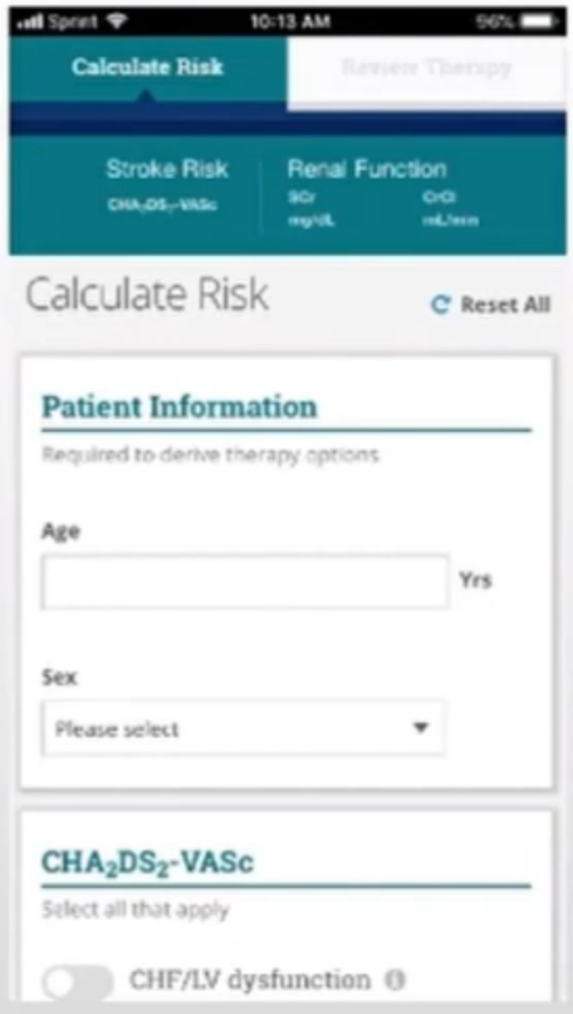
CVA Risk	
0	0
1	1.3
2	2.2
3	3.2
4	4
5	6.7
6	9.8
7	9.6
8	6.7
9	15.2

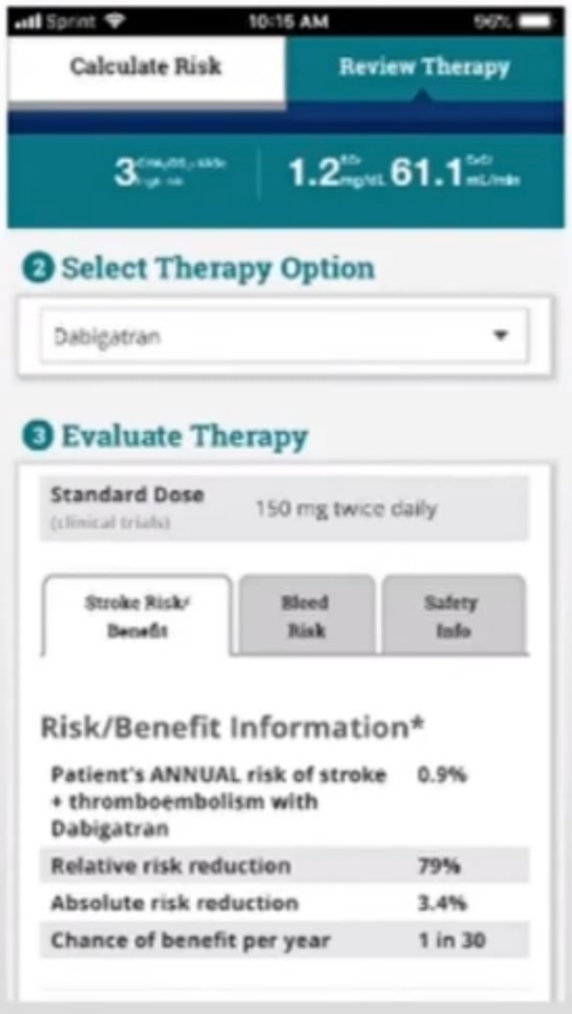
HAS-BLED score

Condition	Points
H - Hypertension	1
A - Abnormal renal or liver function (1 point each)	1 or 2
S - Strok	
B - Blee	
L - Labil	
E - Elde	
D - Drug	r 2

HAS-BLED score	Bleeds per 100 patient-years
0	1.13
1	1.02
2	1.88
3	3.74
4	8.70
5	12.5

Atrial Fibrillation - Pearls





Atrial Fibrillation - Management

Rate Control

- B-Blockers
- CCB
- Digoxin

Anticoagulation

- Warfarin
- DOACS

CHA2DS2-VASc Score	
CHF or LVEF ≤ 40%	1
HTN	1
Age ≥ 75	2
DM	1
CVA/TIA/TE	2
Vascular	1
Age 65-74	1
Female	1

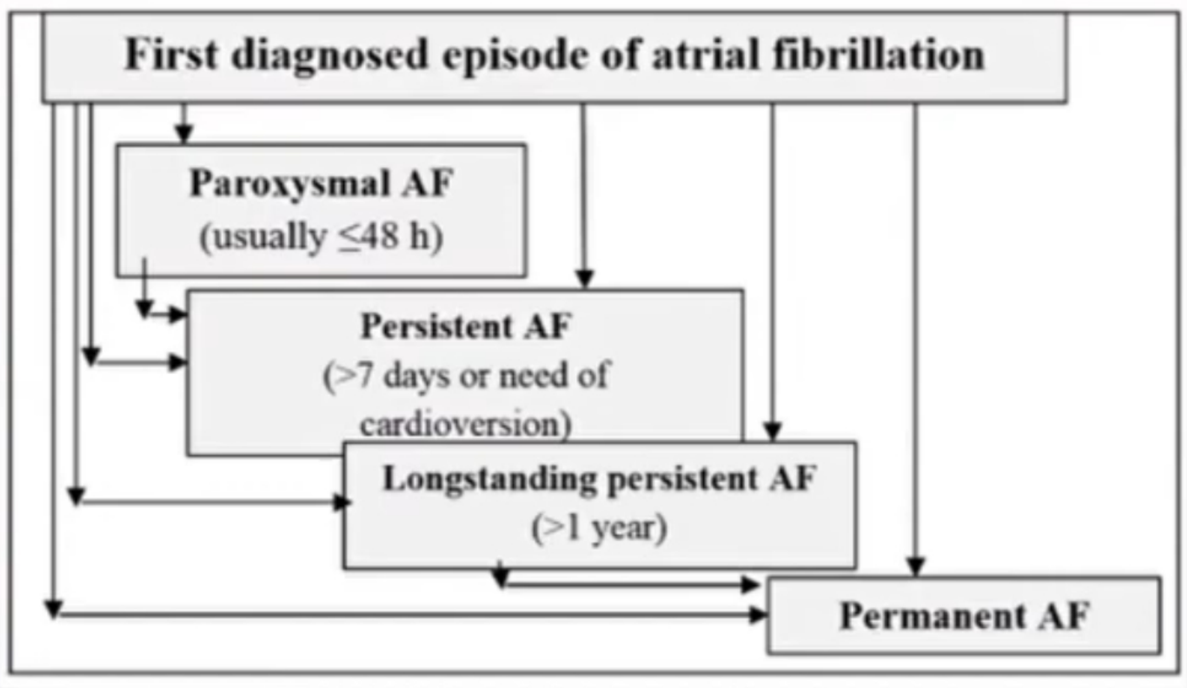
If

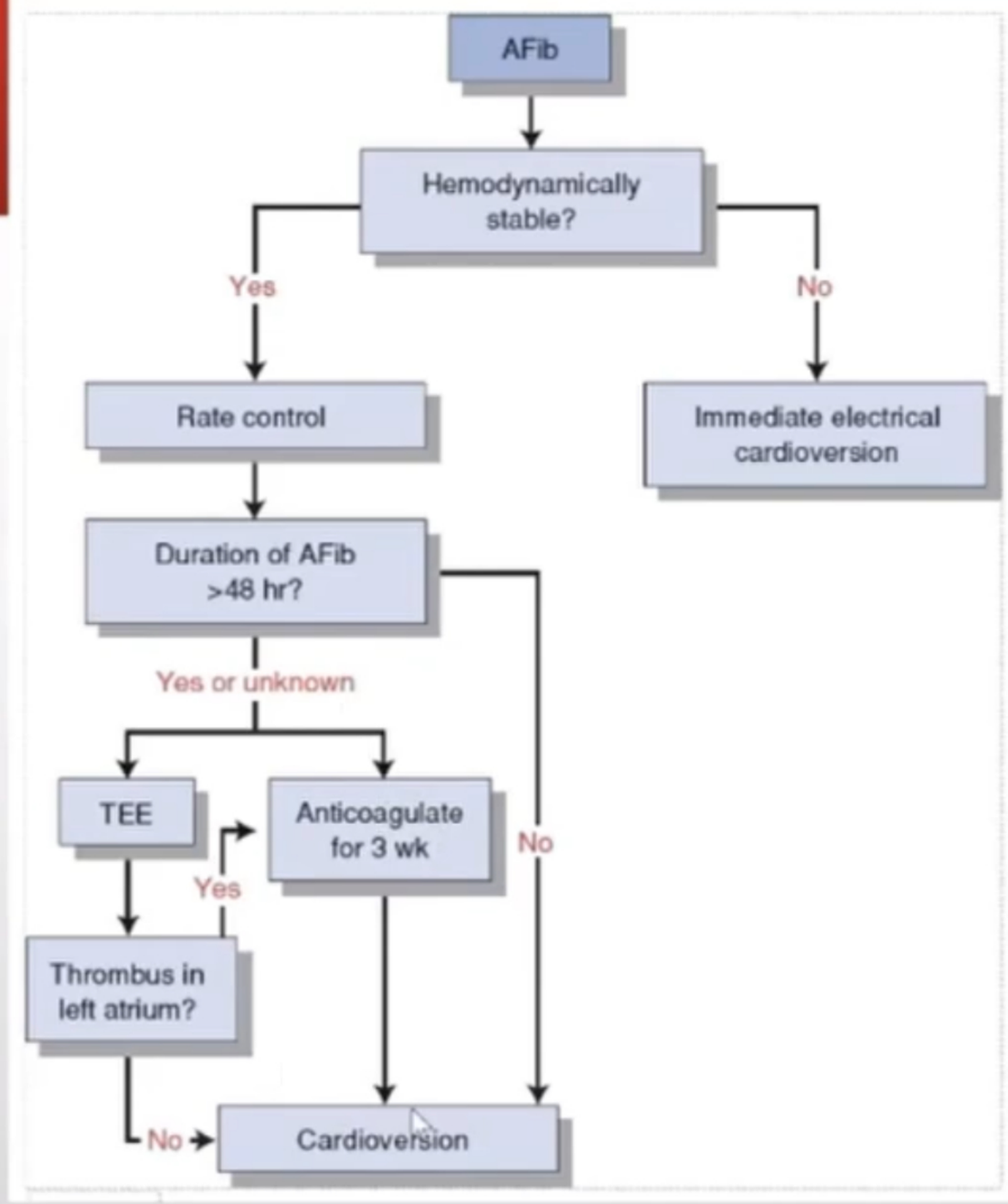
- Unstable
- Symptomatic
- Rate not controlled
- Young / New Onset

Rhythm Control

- Electrical
- Pharmacological
- Ablation

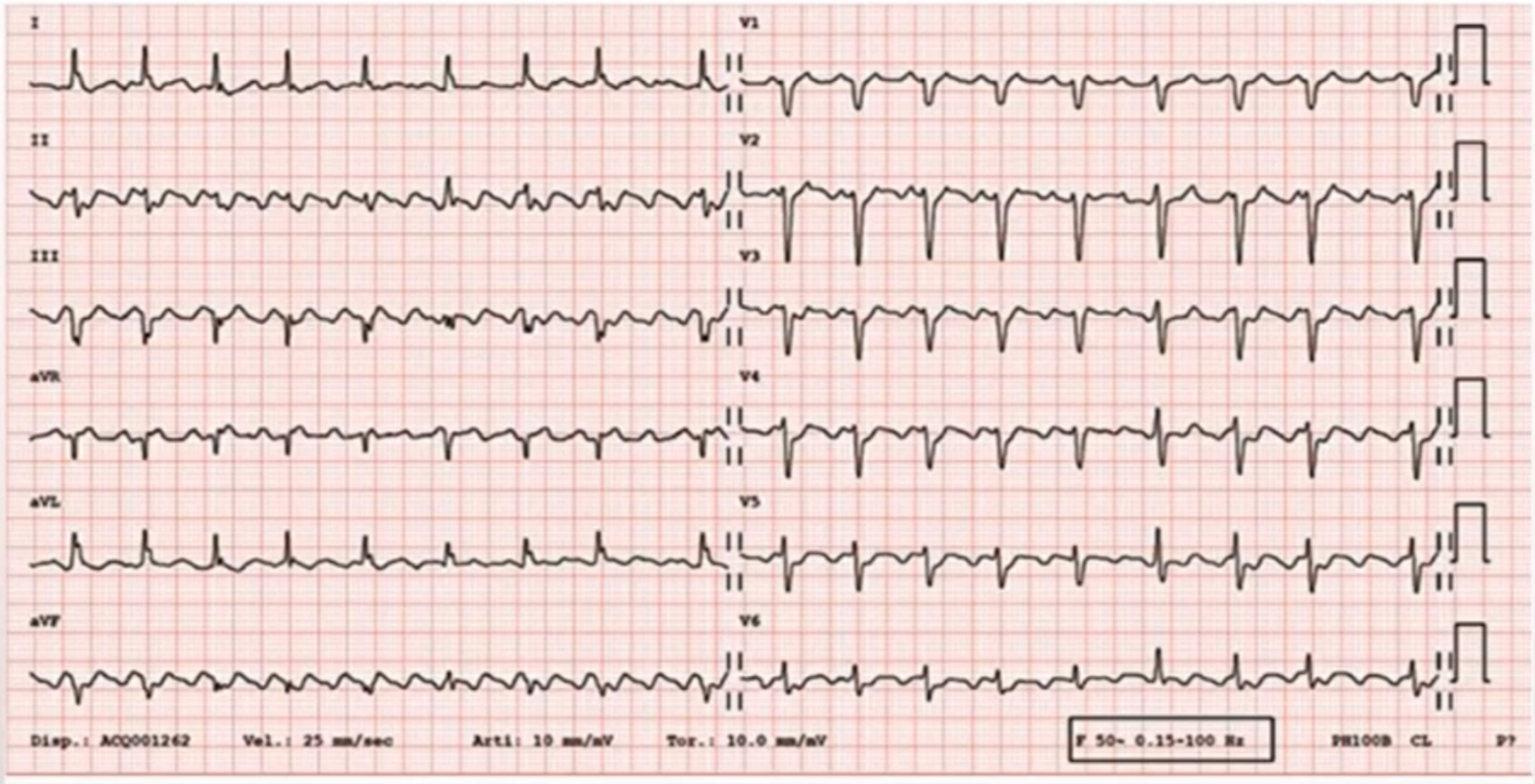
Atrial Fibrillation - Pearls





Atrial Flutter

- Common



Atrial Flutter - Management

Rate Control

- B-Blockers
- CCB
- Digoxin

Anticoagulation

- Warfarin
- DOACS

CHA2DS2-VASc Score	
CHF or LVEF ≤ 40%	1
HTN	1
Age ≥ 75	2
DM	1
CVA/TIA/TE	2
Vascular	1
Age 65-74	1
Female	1

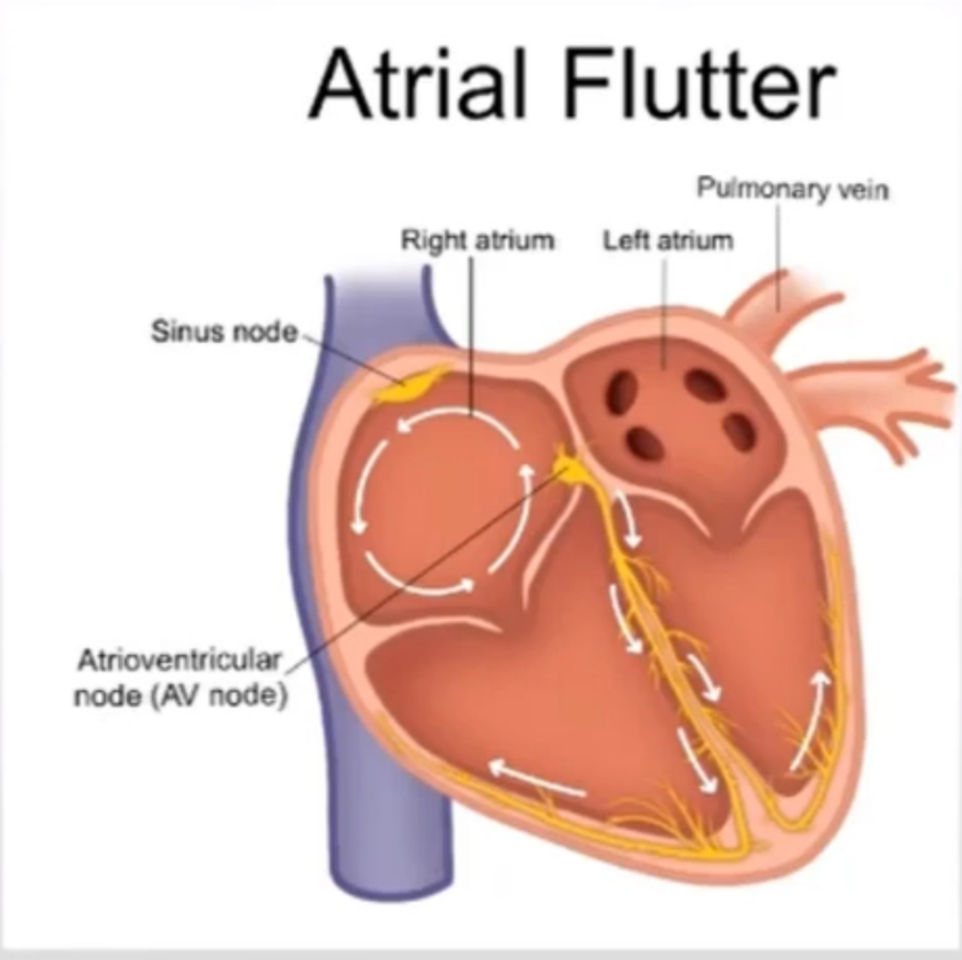
If

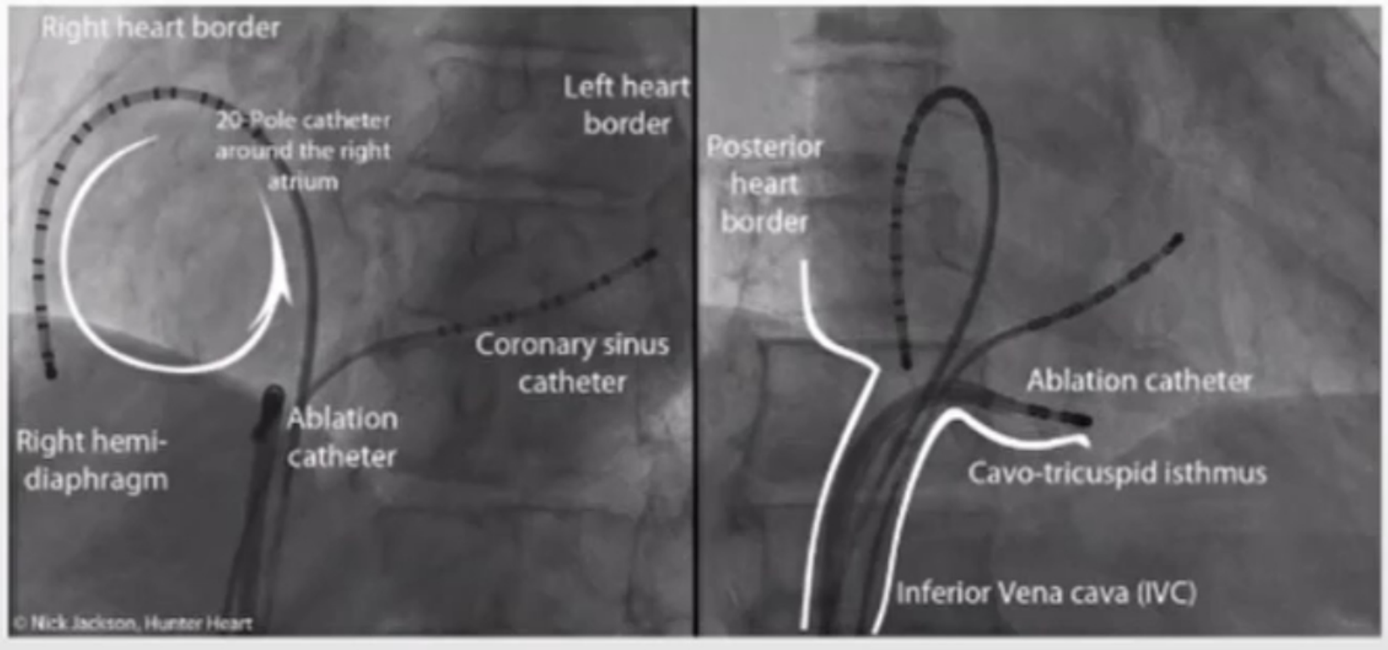
- Unstable
- Symptomatic
- Rate not controlled
- Young / New Onset

Rhythm Control

- Electrical
- Pharmacological
- Ablation

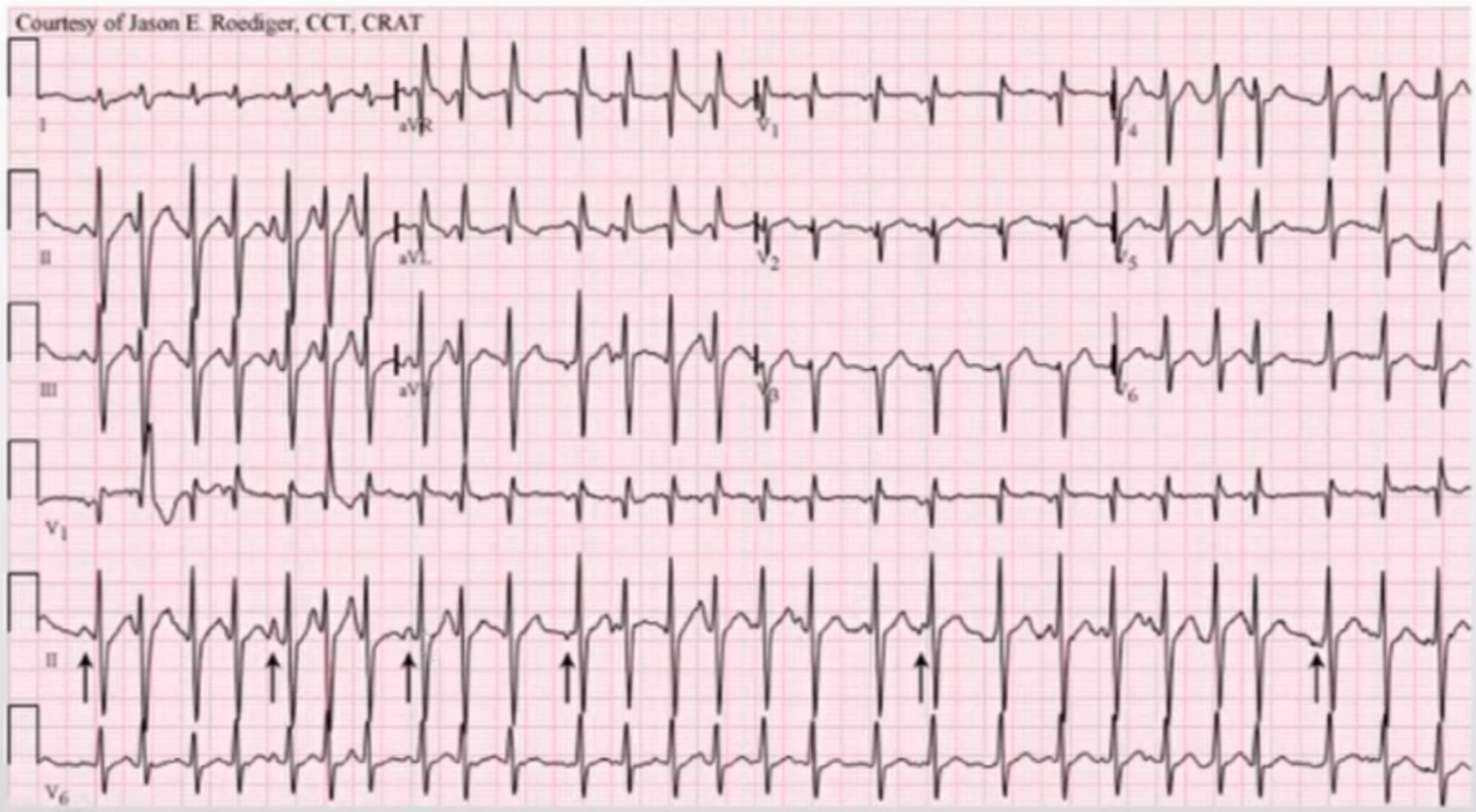
Atrial Flutter - Pearls





Multifocal Atrial Tachycardia (MAT)

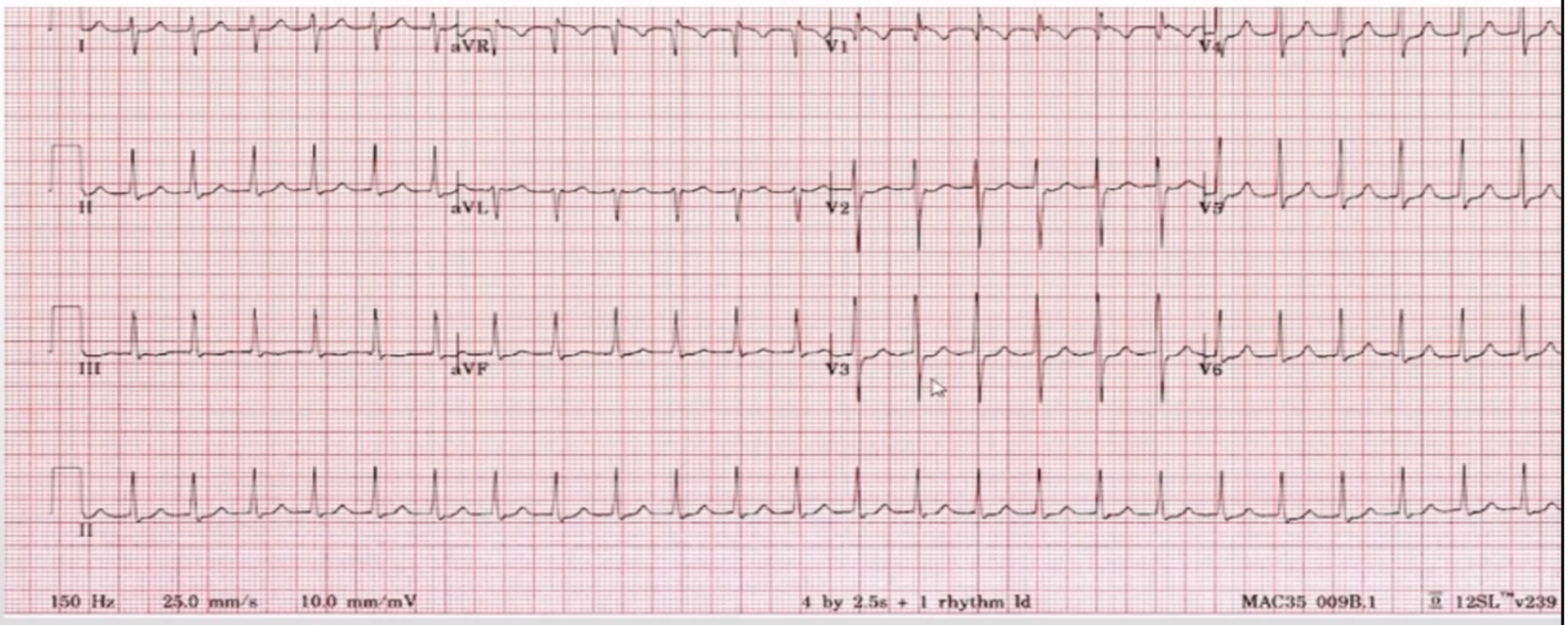
- Common in patients with severe pulmonary disease (e.g., COPD)



Multifocal Atrial Tachycardia (MAT)

- Treatment:
  - **Improve oxygenation and ventilation**
  - Medications: CCBs, β-blockers, digoxin, amiodarone
  - Electrical cardioversion is ineffective and should not be used

Supraventricular Tachycardia (SVT)



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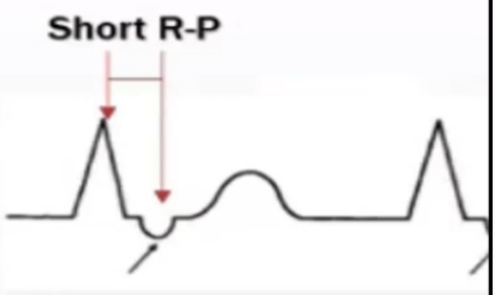
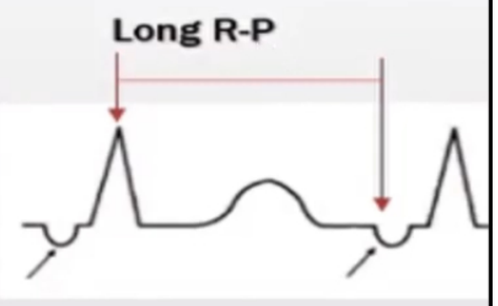
Supraventricular Tachycardia (SVT)

- **DDx of SVT**
  - *Short RP Tachycardias (RP<PR):*
    - **Typical AV Nodal Re-entry Tachycardia (AVNRT)**
    - **Junctional Tachycardia**
    - **Orthodromic Atrioventricular Tachycardia (OD – AVRT)**
    - *Atrial Tachycardia*

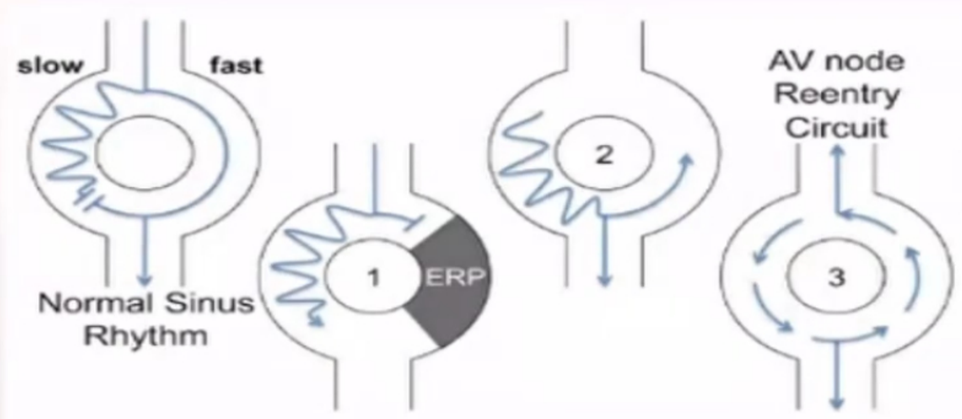


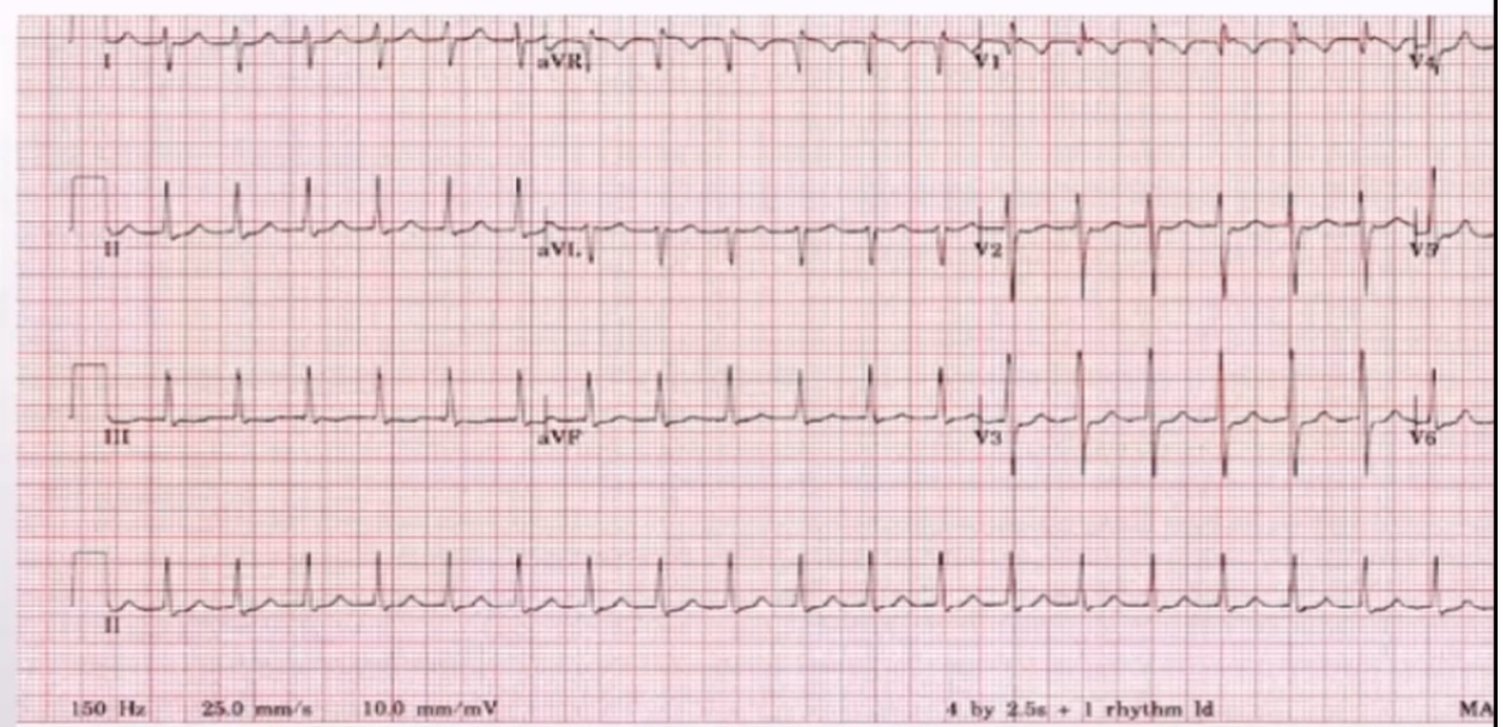
  - *Long RP Tachycardias (RP>PR):*
    - **Sinus Tachycardia (ST)**
    - **Atrial Tachycardia (AT)**
    - *Atypical Orthodromic Atrioventricular Tachycardia (OD – AVRT)*
    - *Atypical AV Nodal Re-entry Tachycardia (AVNRT)*
    - *Junctional Tachycardia*



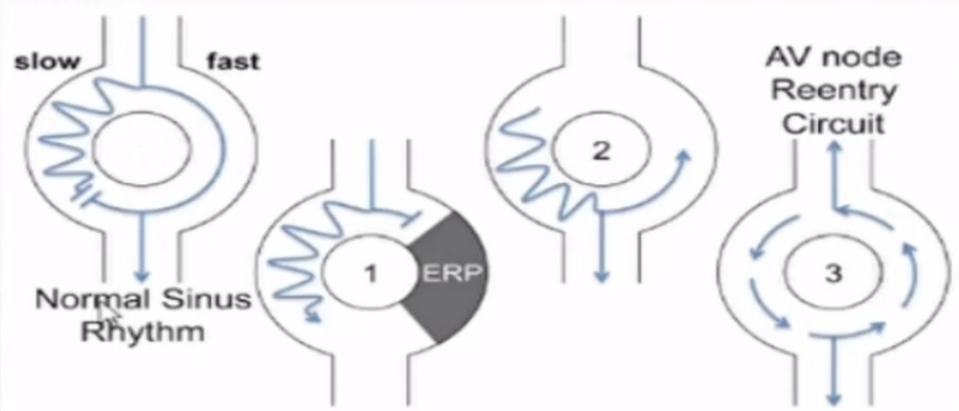
  - *Mimickers:*
    - Atrial Flutter with rapid conduction
    - A. Fibrillation with very rapid conduction

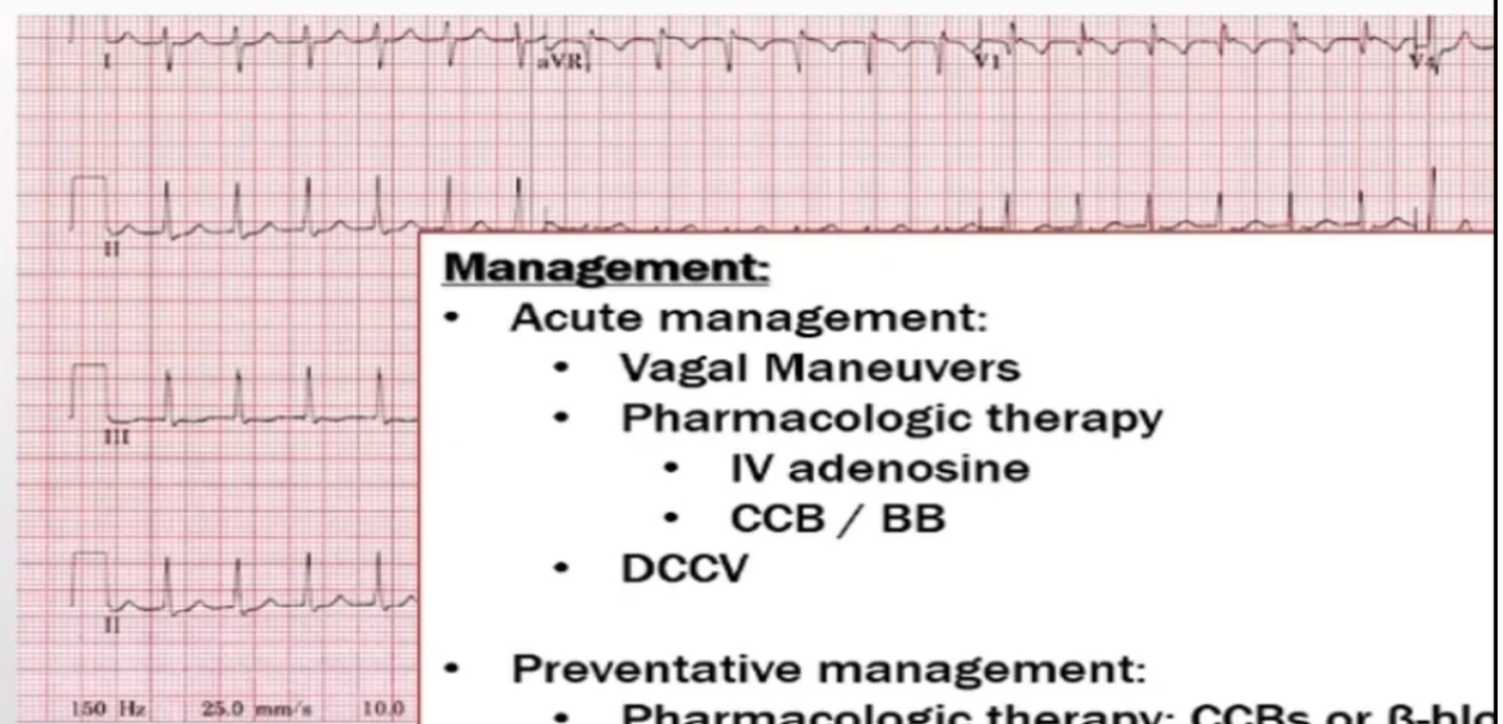
SVT: AV Nodal Re-entrant Tachycardia (AVNRT)





SVT: AV Nodal Re-entrant Tachycardia (AVNRT)

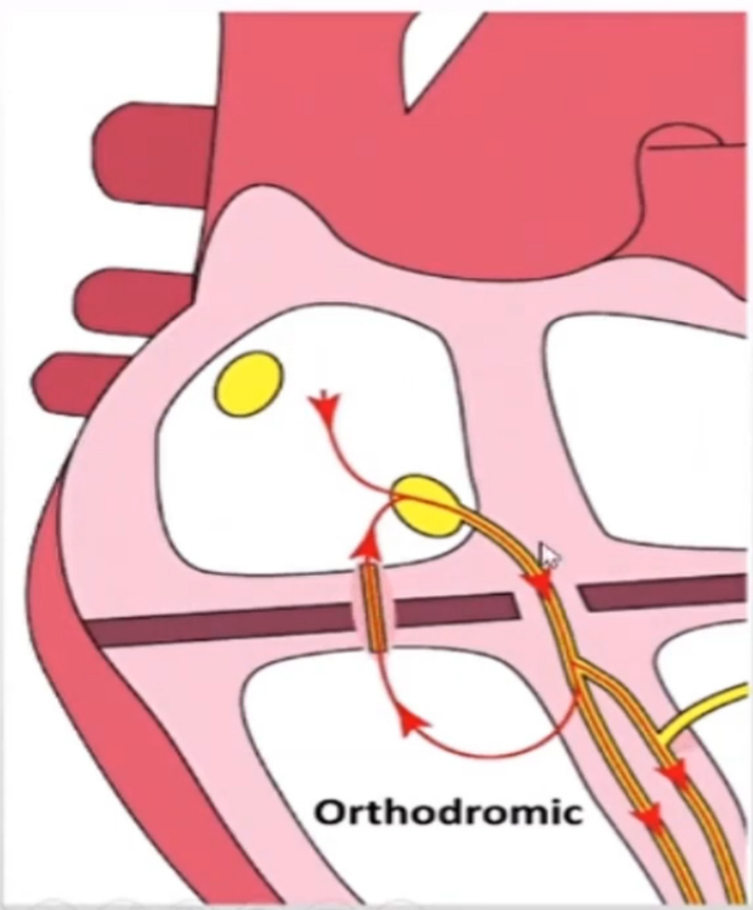


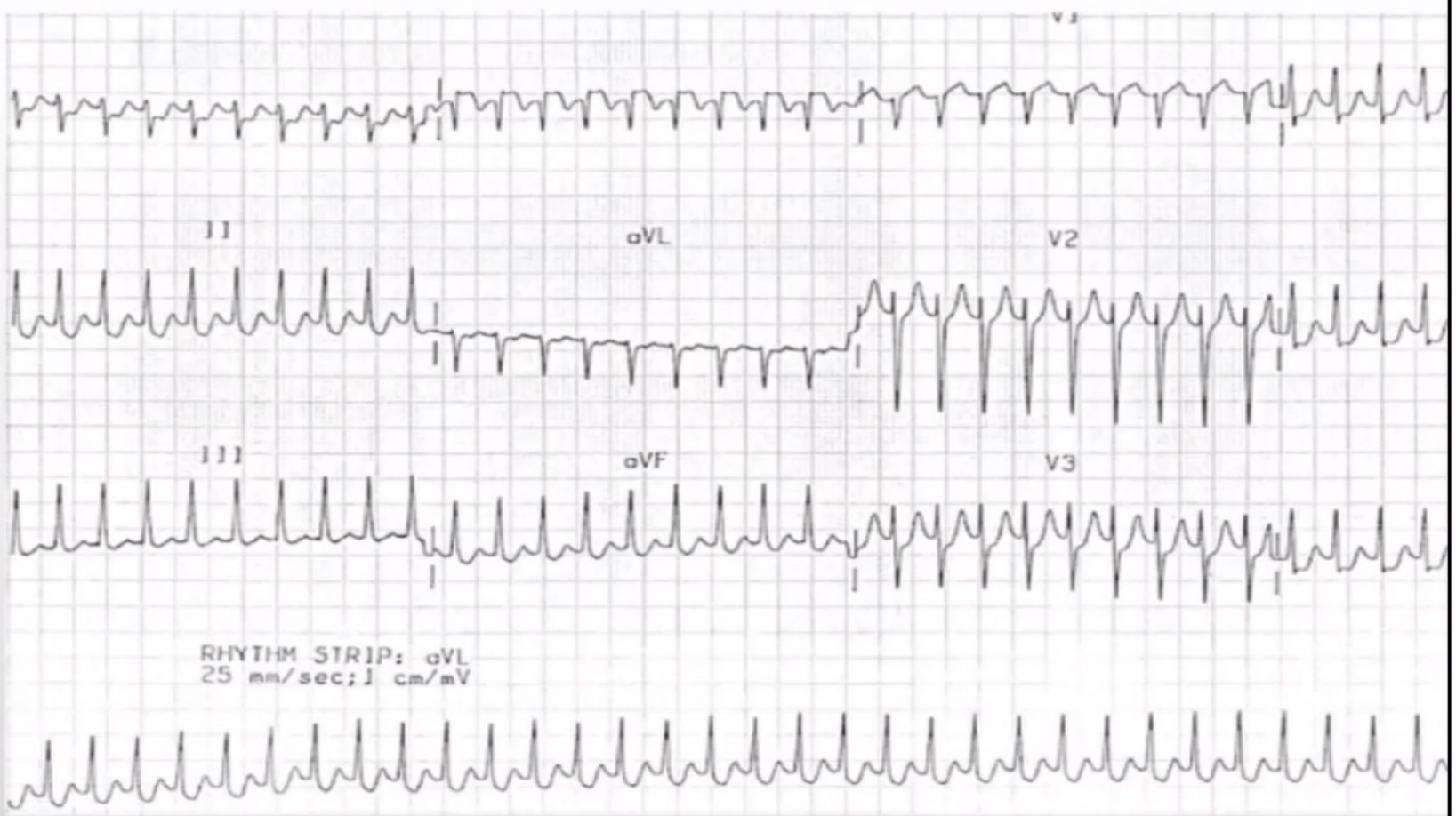


Management:

- Acute management:
  - Vagal Maneuvers
  - Pharmacologic therapy
    - IV adenosine
    - CCB / BB
  - DCCV
- Preventative management:
  - Pharmacologic therapy: CCBs or β-blc
  - Ablation

SVT: Orthodromic AV Re-entrant Tachycardia (AV





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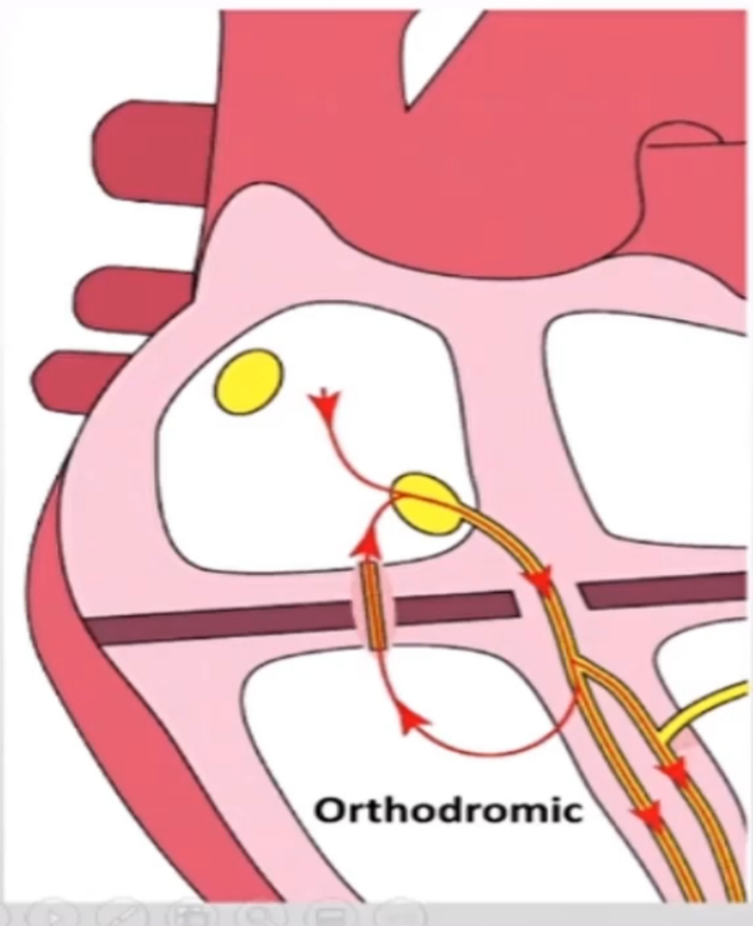
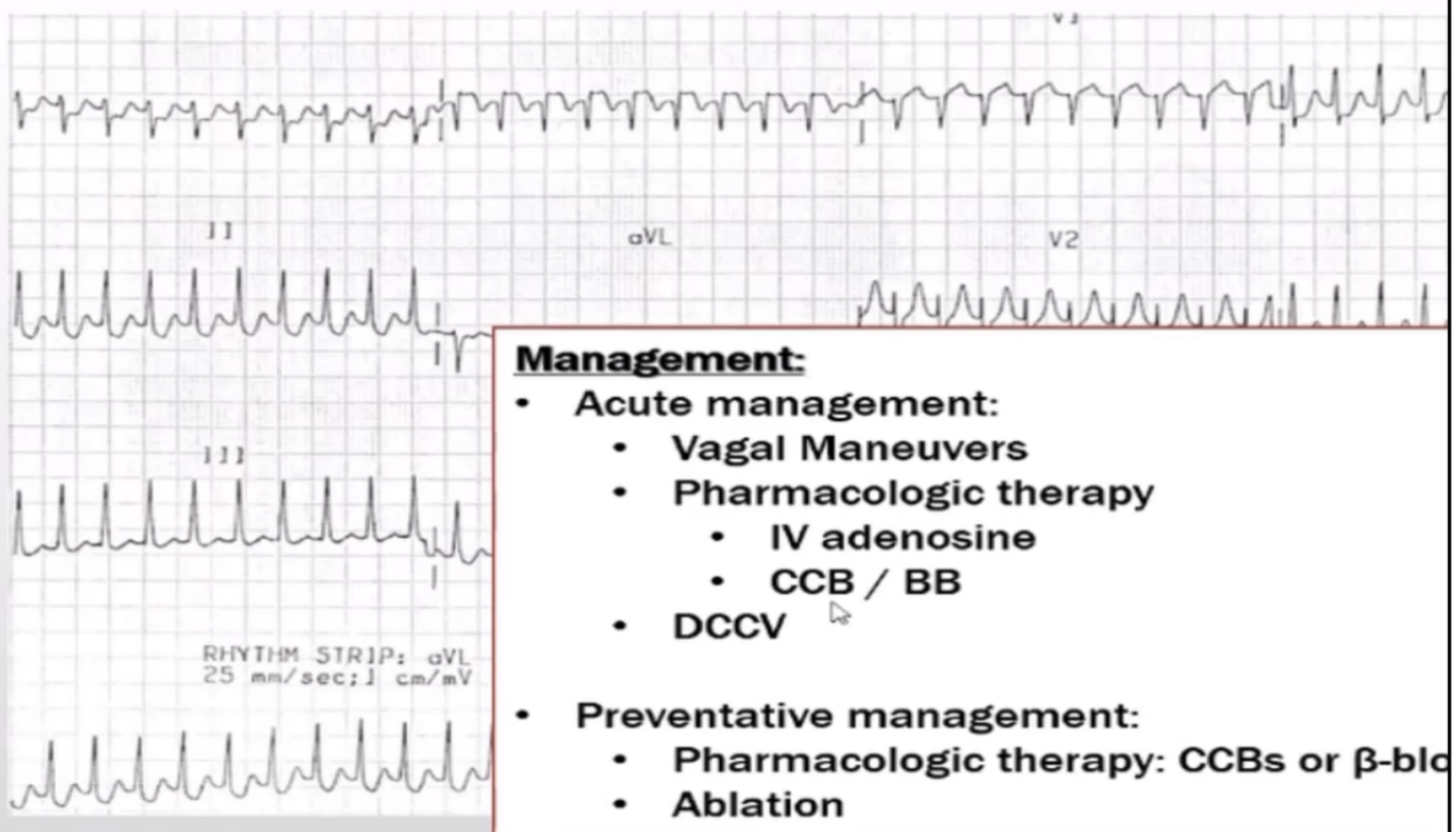
SVT: Orthodromic AV Re-entrant Tachycardia (AV





Management:

- Acute management:
  - Vagal Maneuvers
  - Pharmacologic therapy
    - IV adenosine
    - CCB / BB
  - DCCV
- Preventative management:
  - Pharmacologic therapy: CCBs or β-blc
  - Ablation

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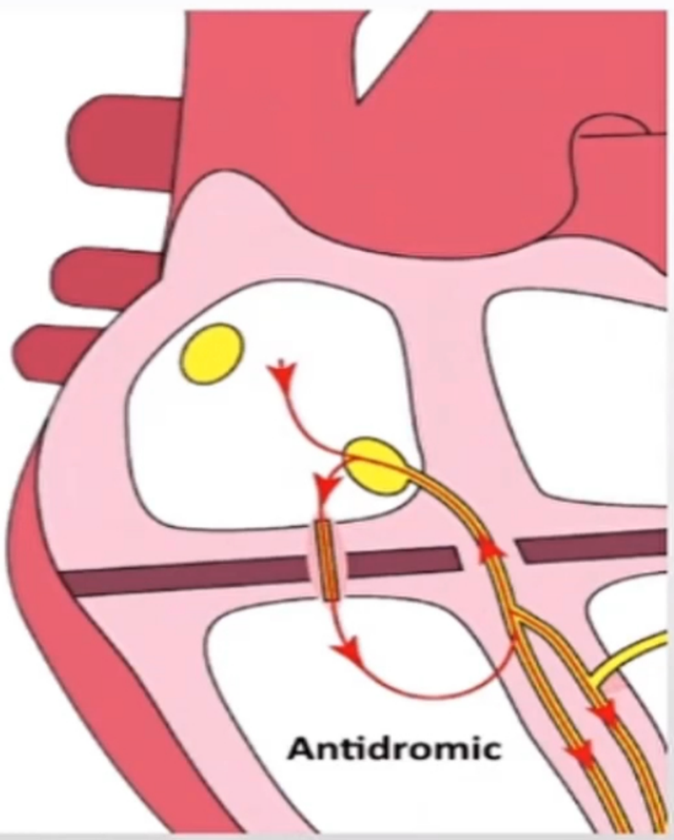
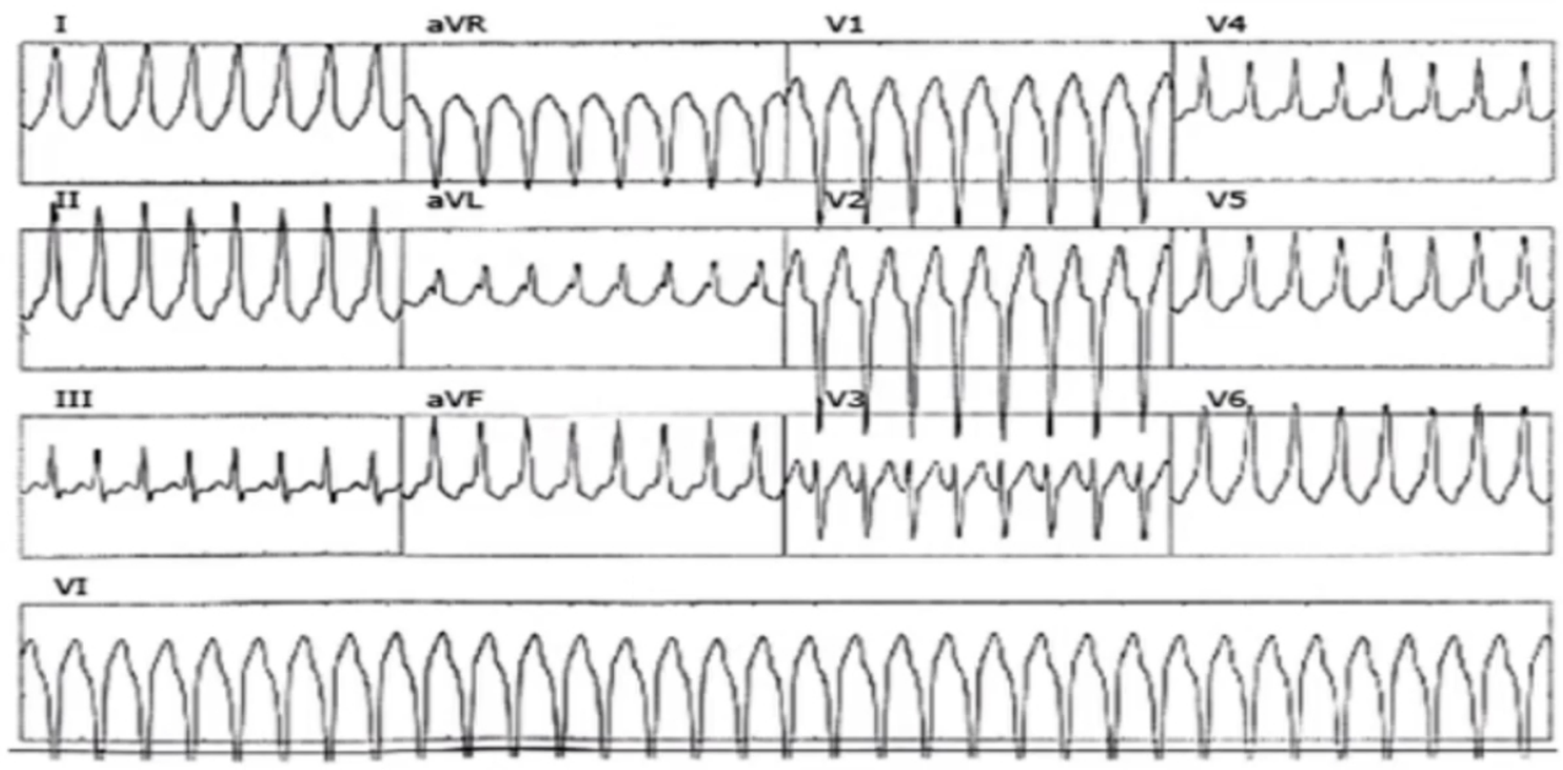
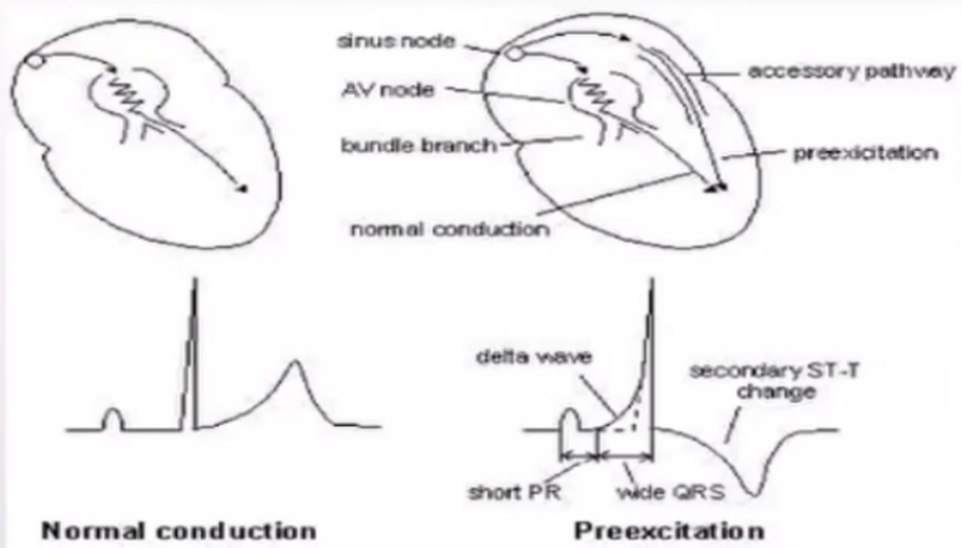
SVT: Antidromic AV Re-entrant Tachycardia (AVR

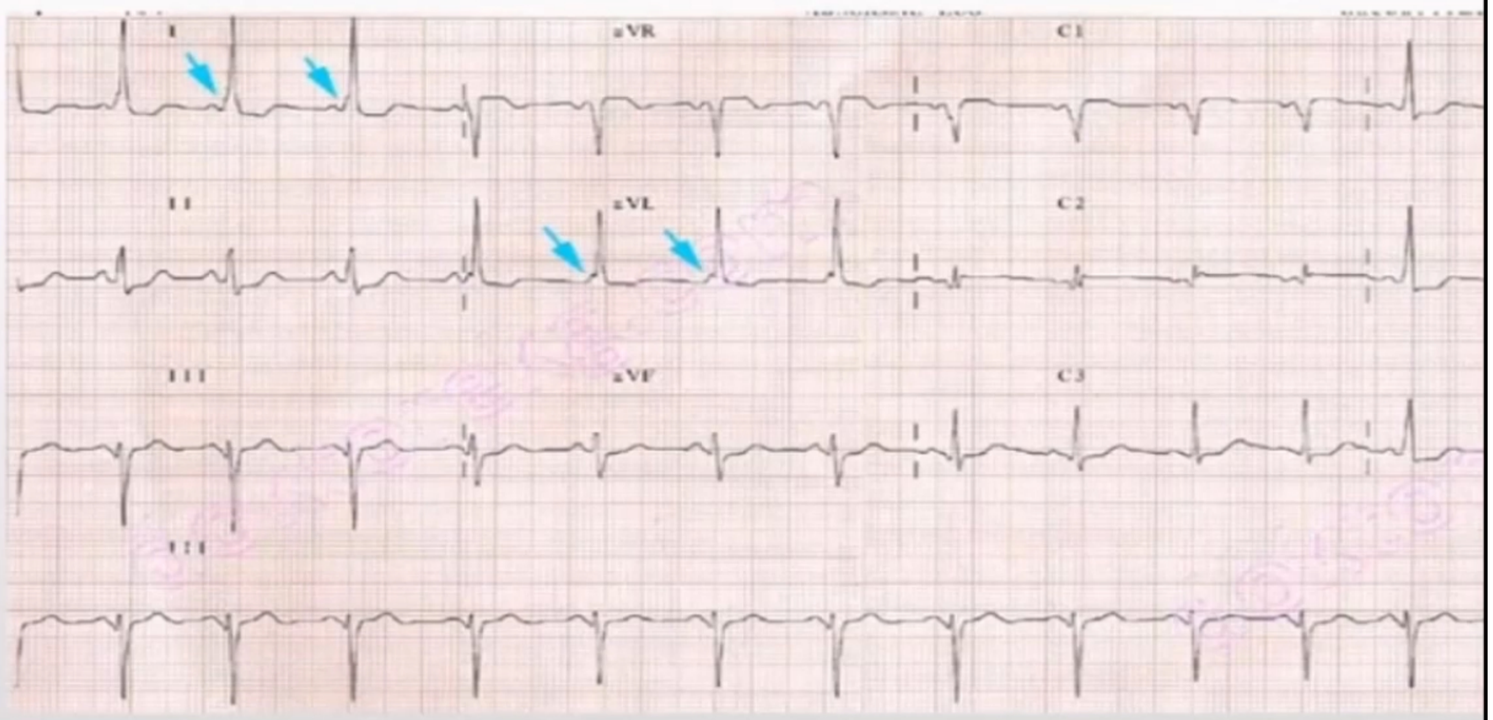




SVT: Wolf Parkinson White Syndrome (WPW)

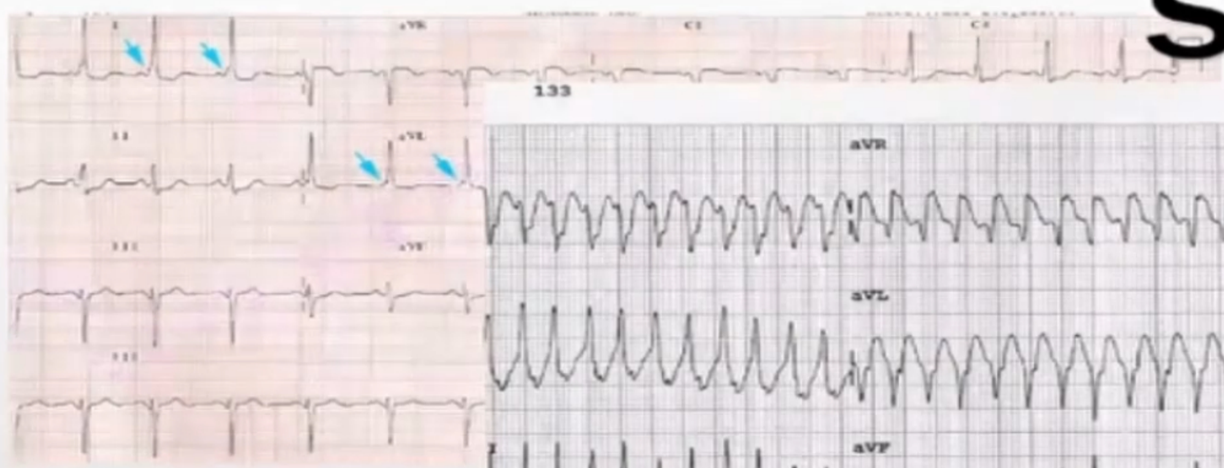
Pre-excitation

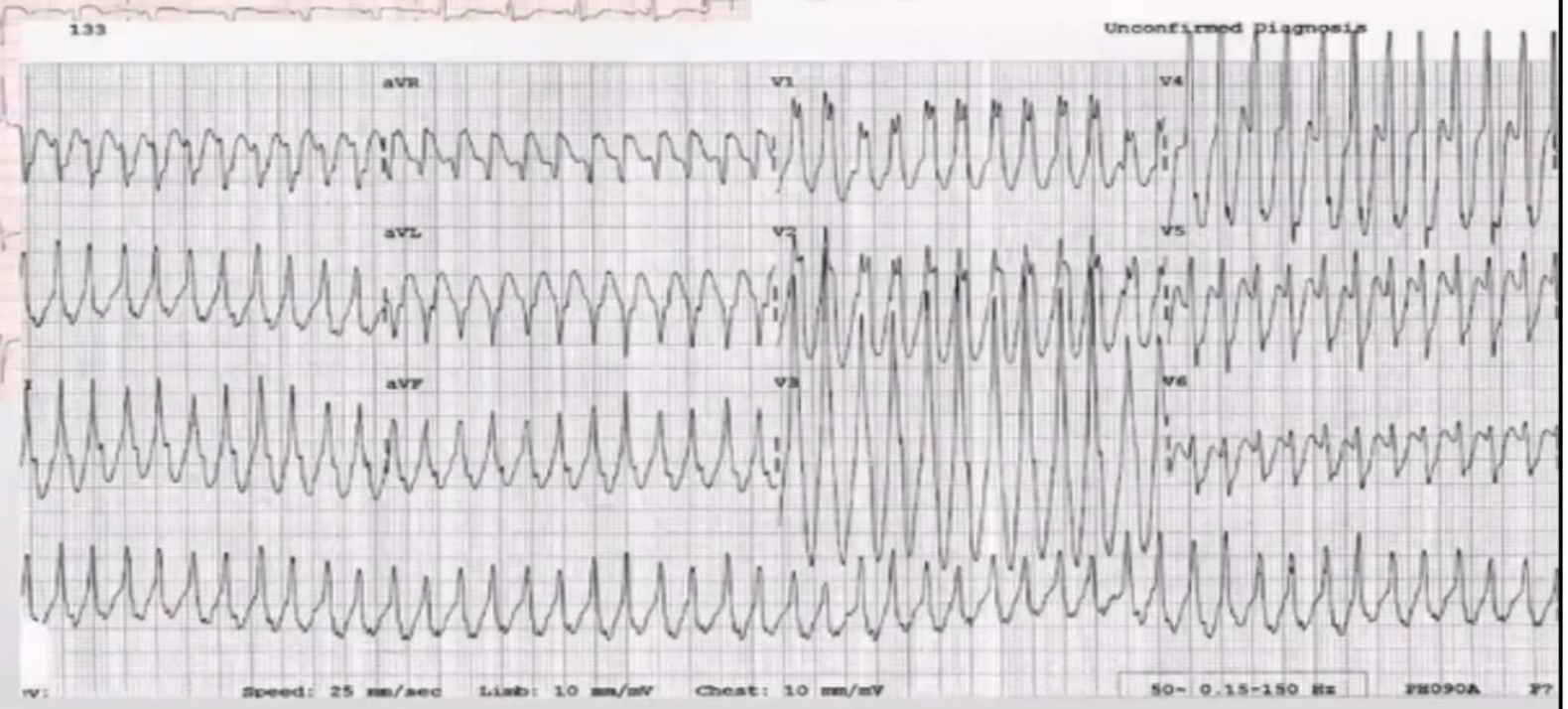




SVT: Wolf Parkinson White Syndrome (WPW)

Pre-excitation + SVT = WP





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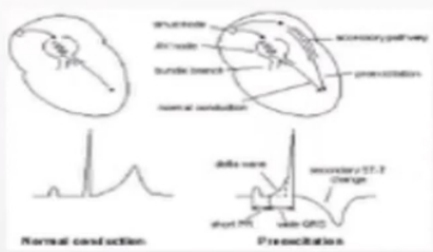
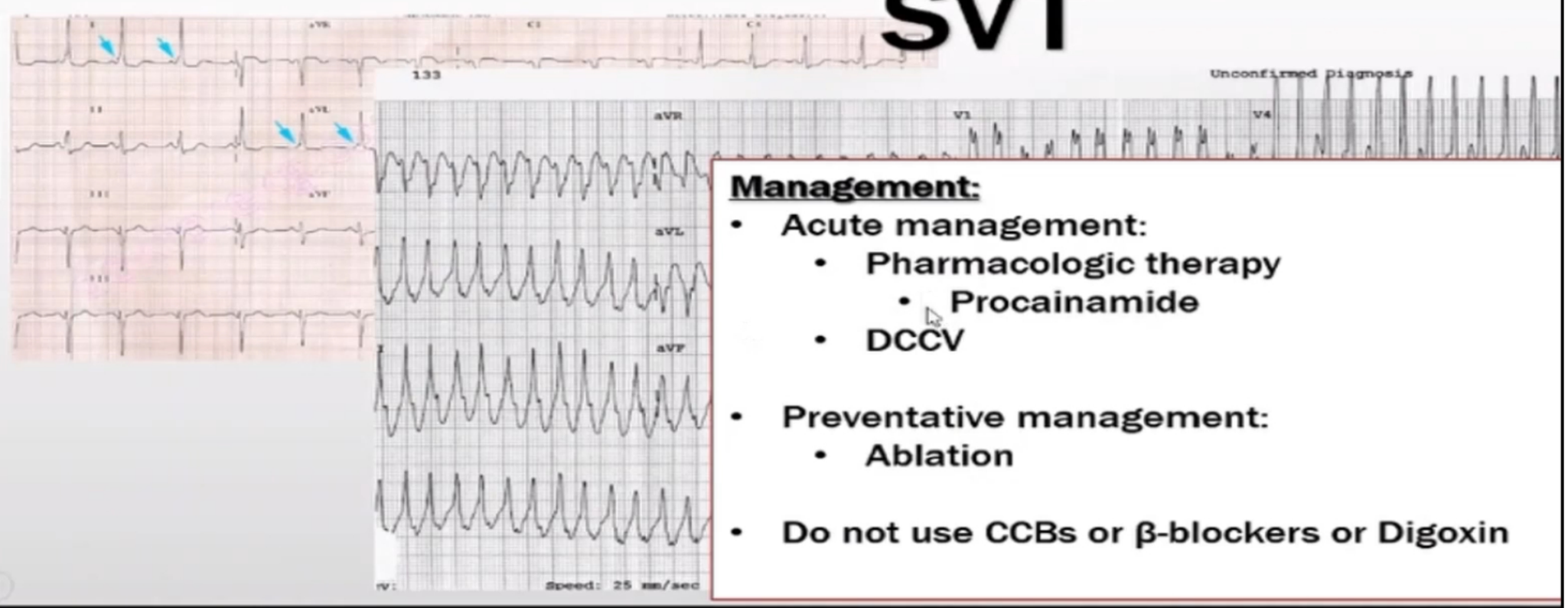
SVT: Wolf Parkinson White Syndrome (WPW)

Pre-excitation + SVT = WPW





Management:

- Acute management:
  - Pharmacologic therapy
    - Procainamide
  - DCCV
- Preventative management:
  - Ablation
- Do not use CCBs or β-blockers or Digoxin

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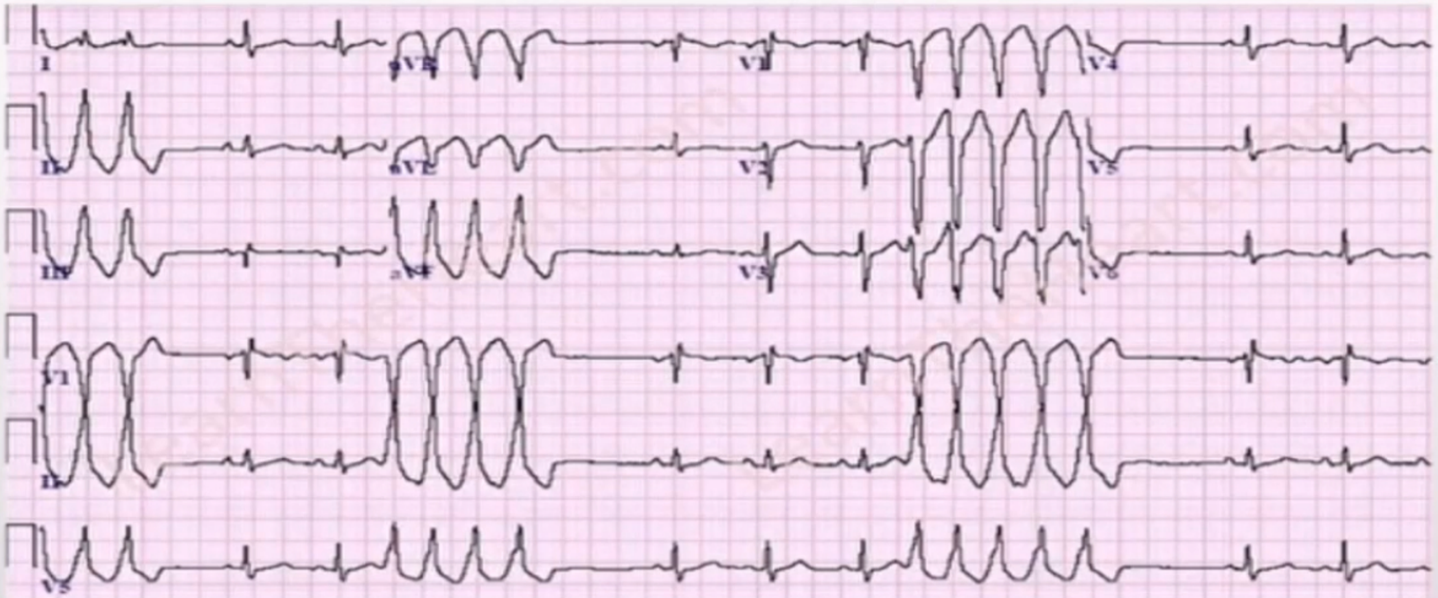
Ventricular Tachycardia (VT)

- Causes:
  - Ischemia
  - CAD with prior MI is the most common cause
  - Cardiomyopathies
  - Ventricular scar tissue
  - Congenital defects
  - Long QT syndrome
  - Electrolyte Abnormalities
  - Drug toxicity (antiemetics, antipsychotics, SSRIs, TCAs, macrolide and fluoroquinolone antibiotics)

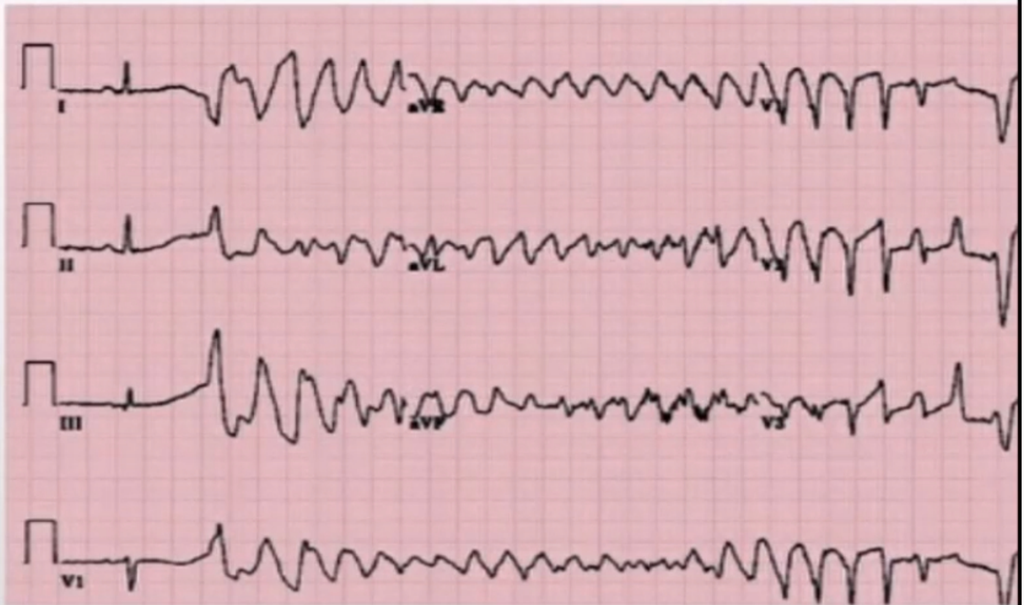
Ventricular Tachycardia (VT)

- Non-Sustained Ventricular Tachycardia (NSVT): < 30 seconds

Monomorphic



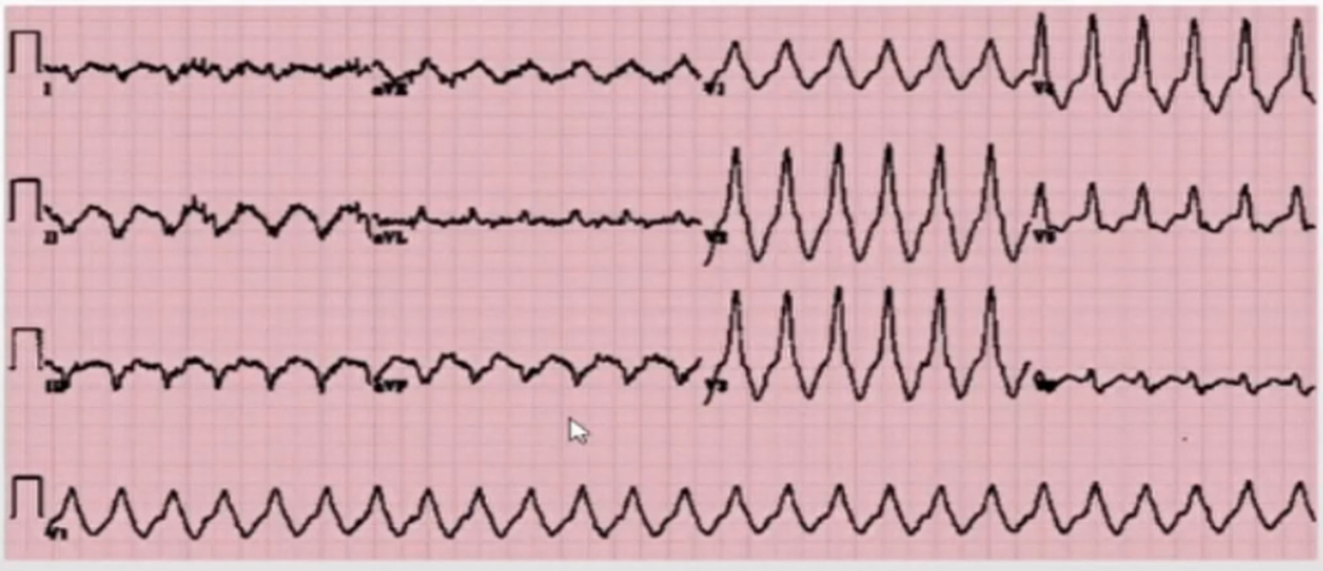
Polymorphic



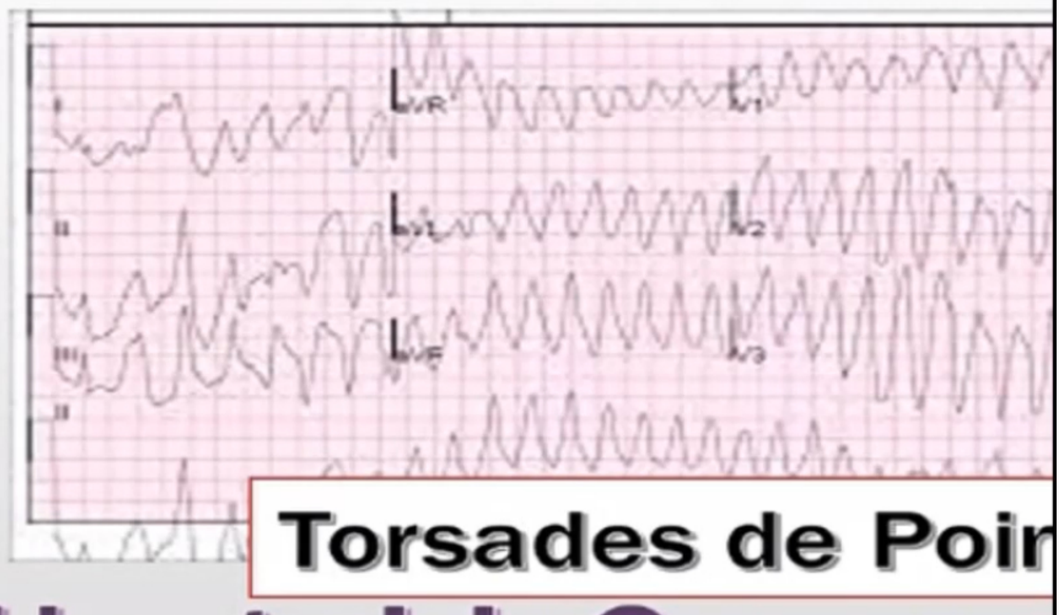
Ventricular Tachycardia (VT)

- Sustained Ventricular Tachycardia (NSVT): > 30 seconds

Monomorphic



Polymorphic



Stable vs. Unstable?

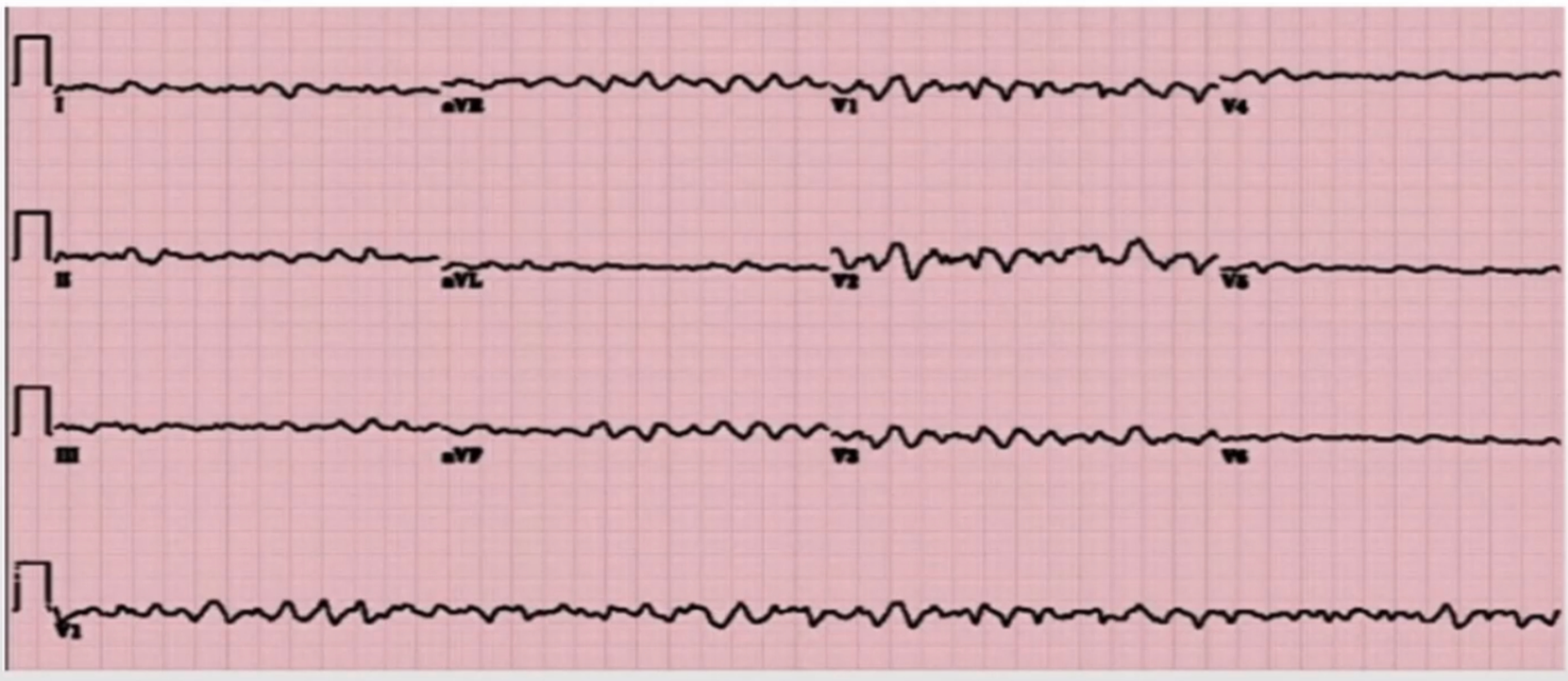
Ventricular Tachycardia (VT) - Stable

Management:

- Acute management:
  - Treat the underlying cause:
    - Ischemia
    - Correct Electrolyte Abnormalities
    - Remove Drug +/- Antidote
  - Pharmacological Therapy:
    - IV Amiodarone
  - DCCV

- Preventative management:
  - Consider ICD
  - Consider EPS

Ventricular Vibrilation (VF)

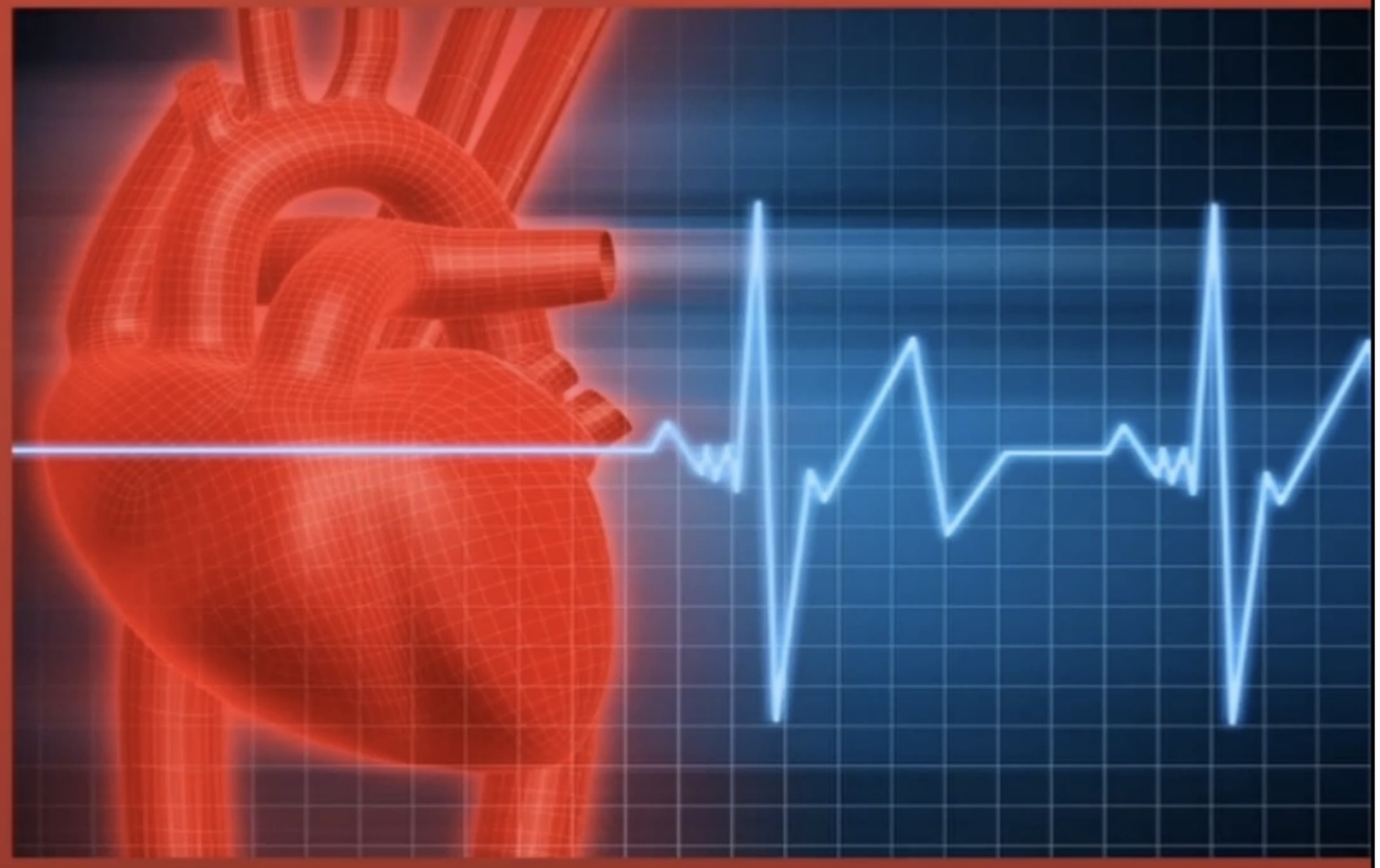


Code

Defibrill

& Unstable Sustained V

Bradyarrhythmias



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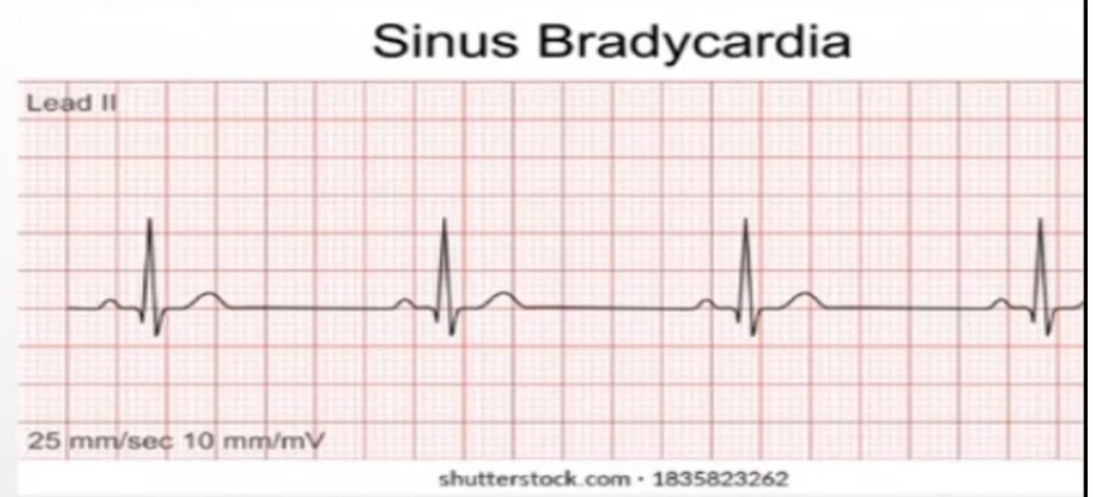
Bradycardia

- Sinus Bradycardia
- Sick Sinus Syndrome (SSS)
- Atrio-Ventricular (AV) Block
  - 1st Degree
  - 2nd Degree
    - Mobitz Type I (Wenckebach)
    - Mobitz Type II
    - 2:1 Block
  - 3rd Degree (Complete)
- Pacemakers & Cardiac Devices

Sinus Bradycardia

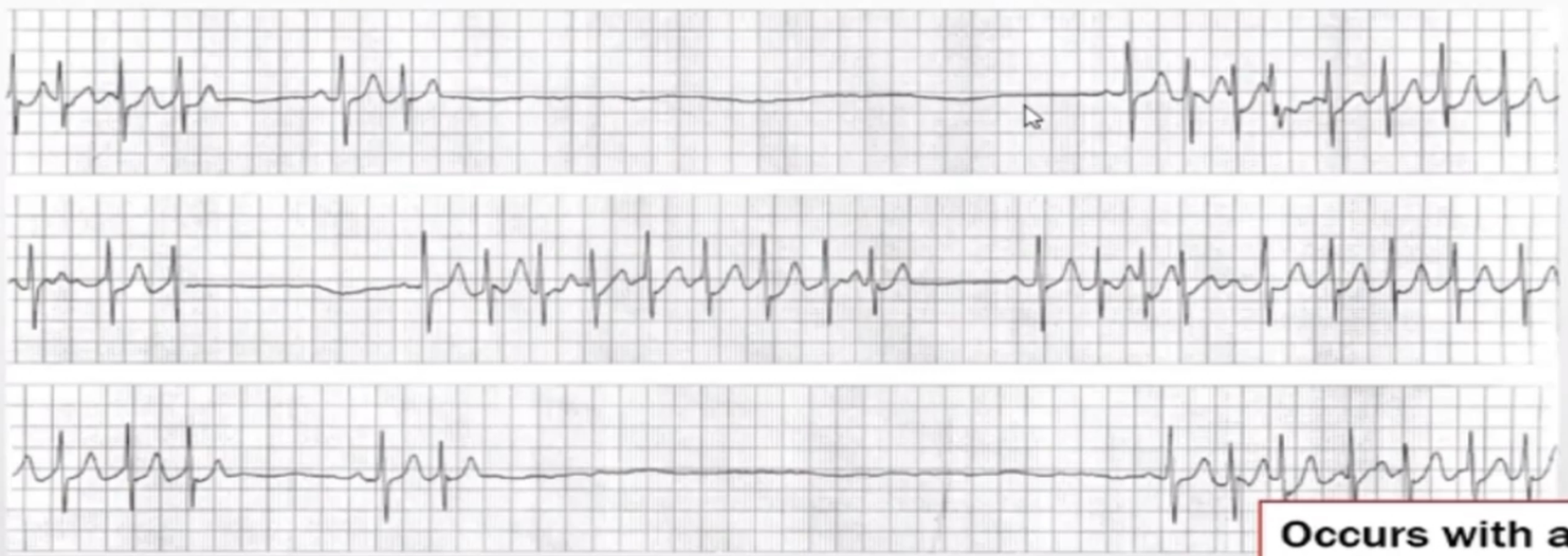
- Rate < 60 bpm
- Causes:
  - Ischemia
  - Increased Vagal tone
  - Structural Heart Disease (Infiltrative, IE, ACHD)
  - Medications
  - Athletes



Clinical Status	Management
Asymptomatic	Observation
Symptomatic (Fatigue, Exercise Intolerance, Angina, Dizziness, Syncope)	Rx Cause Atropine / B Agonist (Acute Pacemaker

Sick Sinus Syndrome (SSS)

- SA Dysfunction



Occurs with advanced age
Marked Persistent Sinus Bradycardia
SA Pauses and Blocks
Frequently associated with Tachy-Bra
Usually co-exists with AV nodal disea

- Management:
  - Pacemaker placement

Atrio-Ventricular (AV) Block

- 2nd Degree AV Block – Mobitz Type I (Wenckebach)
  - Progressive PR Prolongation followed by a dropped QRS

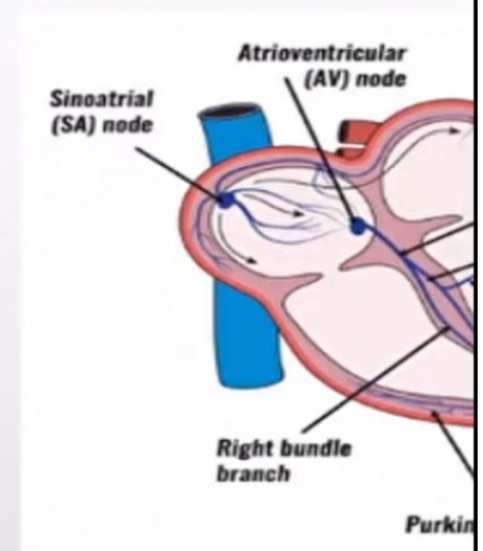
Causes:
- Ischemia
- Increased
- Structural
- Medicatio

- Management:

Clinical Status	Management
Asymptomatic	Observation
Symptomatic (Fatigue, Exercise Intolerance, Angina, Dizziness, Syncope)	Rx Cause Atropine / B Agonist (Acu Pacemaker

Atrio-Ventricular (AV) Block

- 2nd Degree AV Block – Mobitz Type II
  - Progressive PR Prolongation followed by a dropped QRS



- Management:
  - Pacemaker placement indicated

Atrio-Ventricular (AV) Block

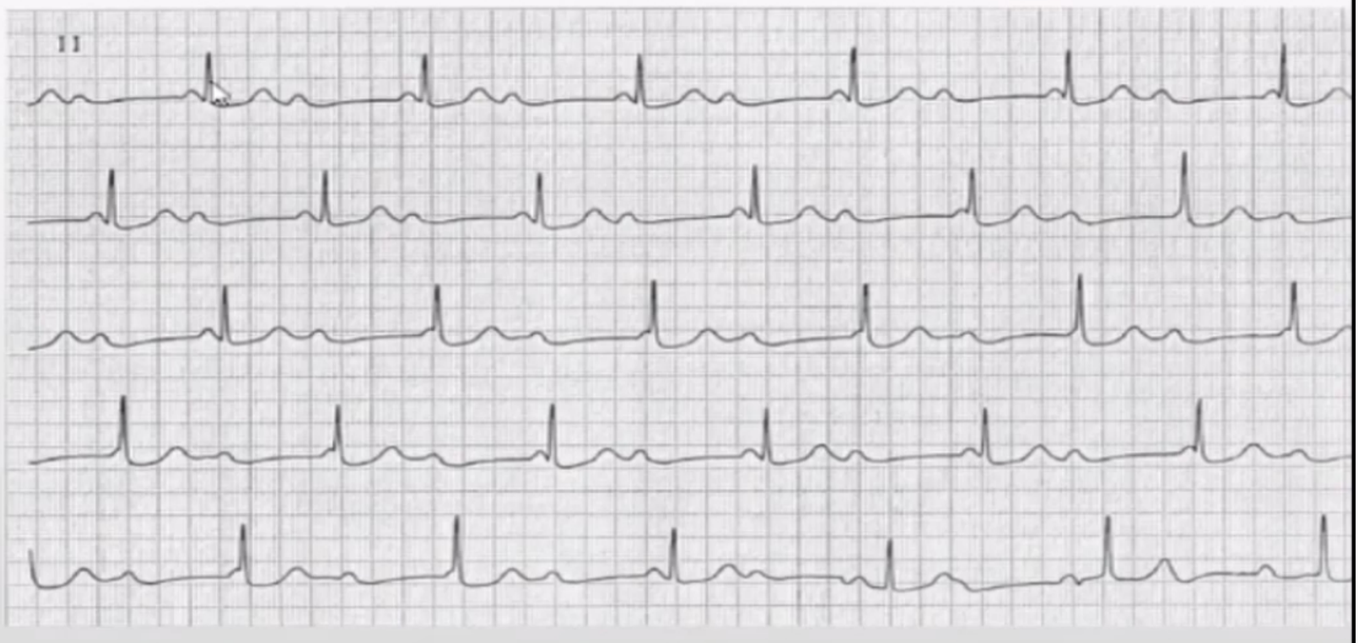
- 2nd Degree AV Block (2:1 Block)
  - Alternating conducted QRS followed by a dropped QRS

- Management:
  - Needs further evaluation

Atrio-Ventricular (AV) Block

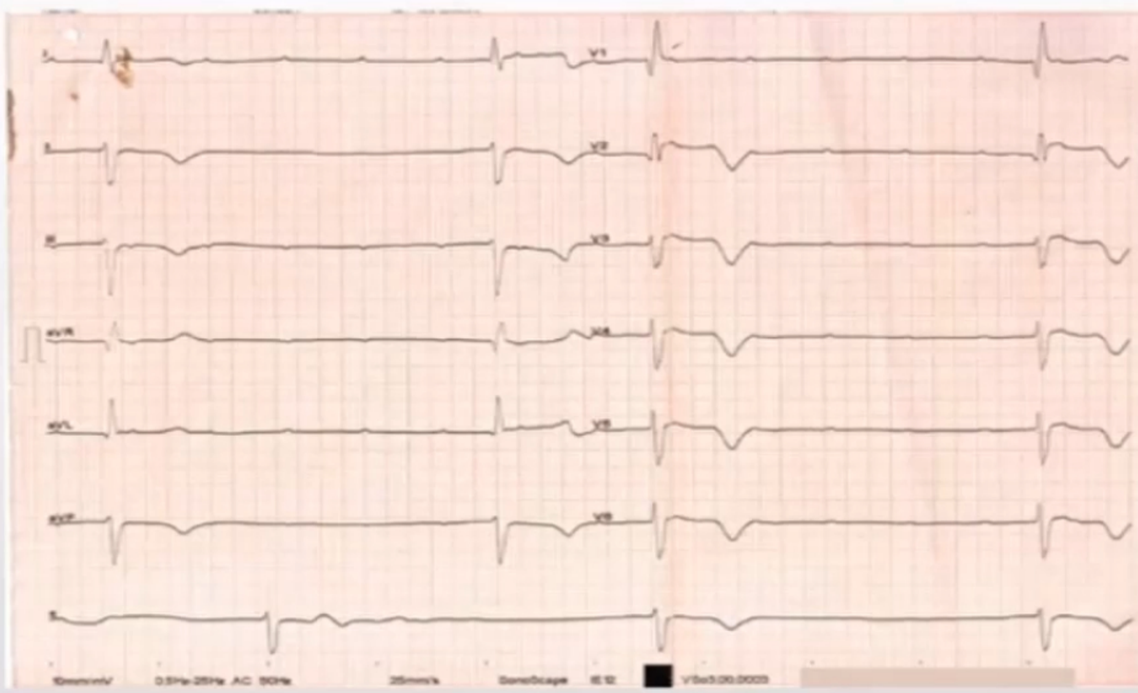
- 3rd Degree AV Block
  - P > QRS
  - AV Dissociation

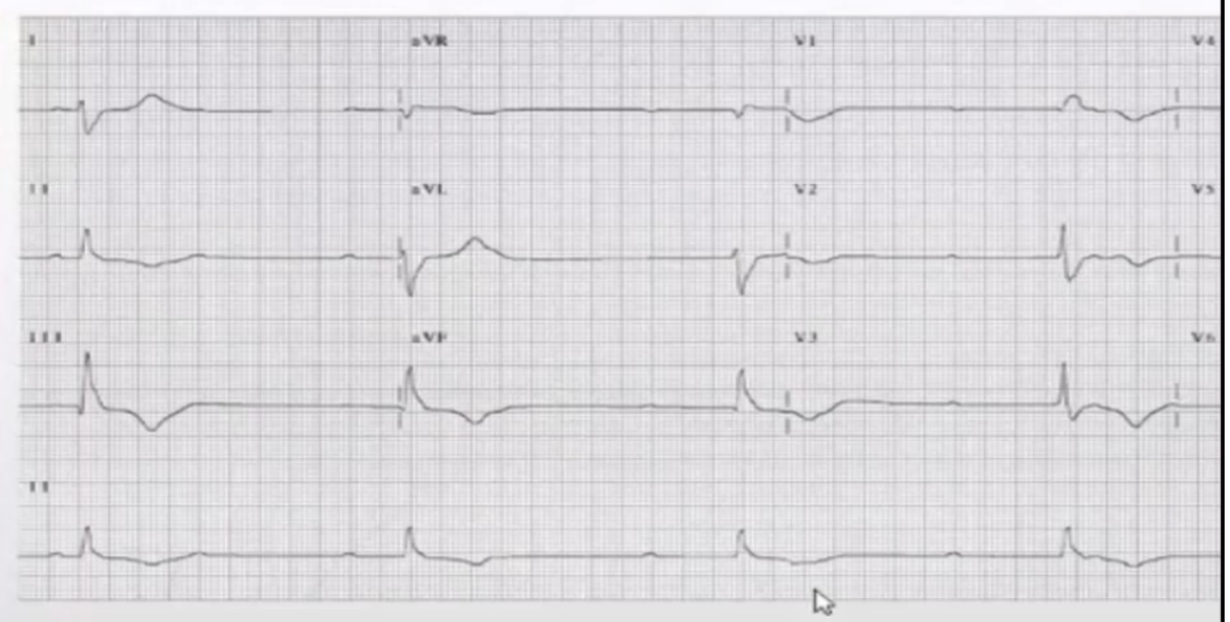
- Management:
  - Medical Emergency
  - Emergent Pacer placement



Atrio-Ventricular (AV) Block

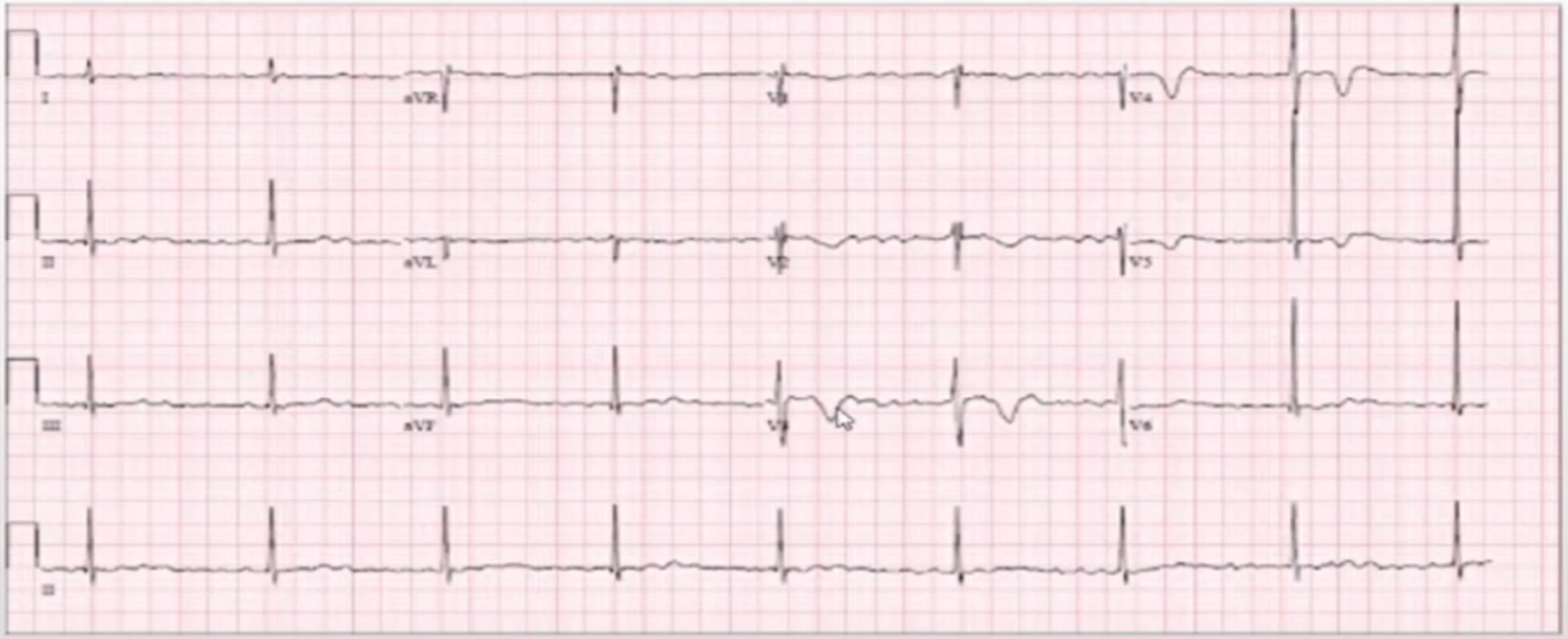
- 3rd Degree AV Block





Atrio-Ventricular (AV) Block

- 3rd Degree AV Block



Pacemakers & Cardiac Device

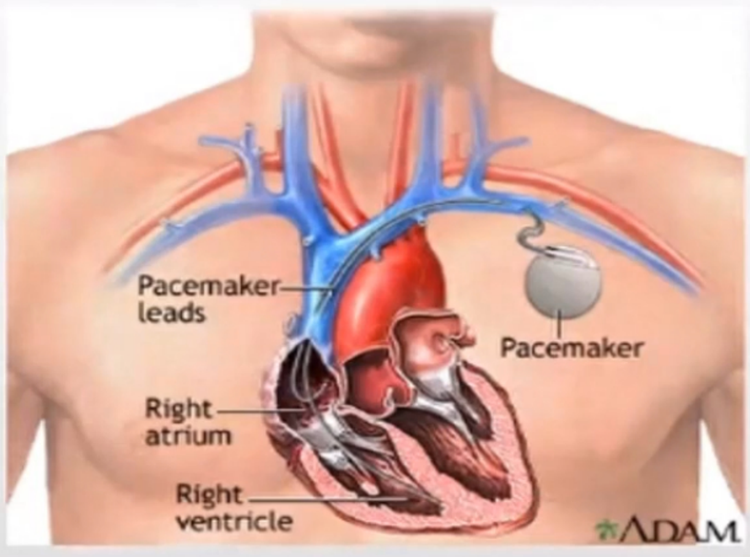
Temporary

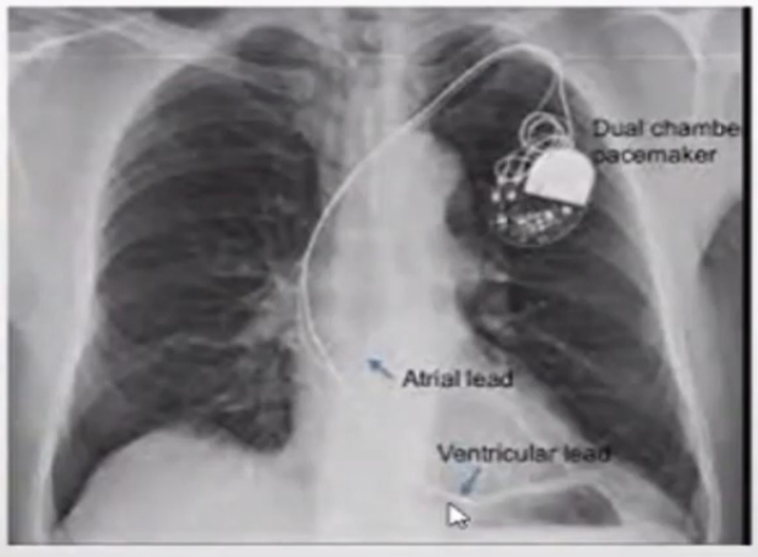
Transcutaneous

Transvenous (TVP)

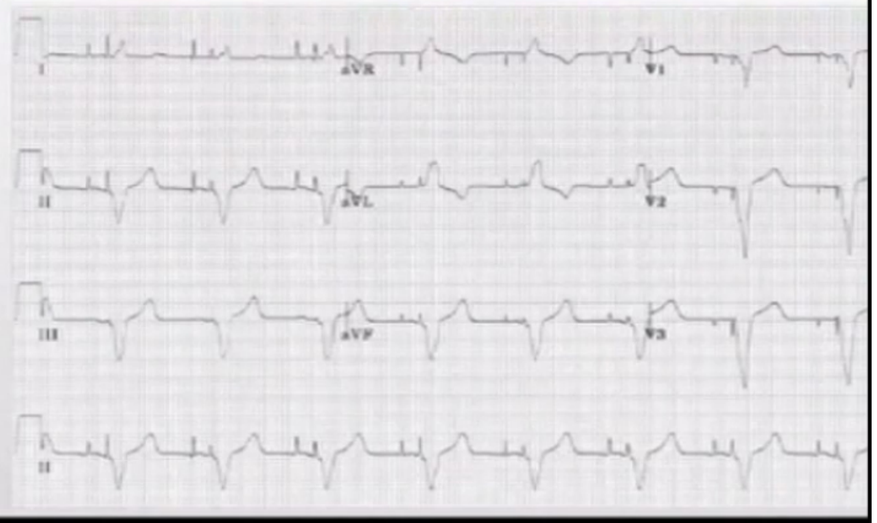
Pacemakers & Cardiac Devices

Permanent Pacemaker (PPM)



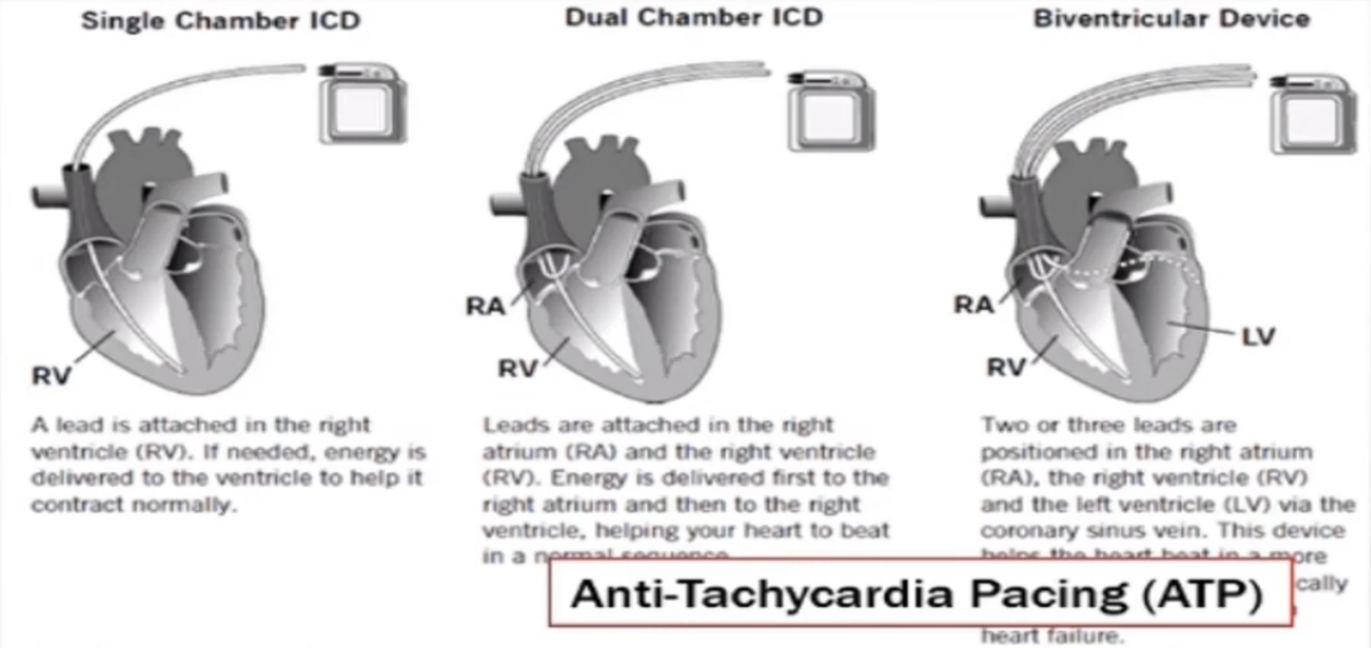


Letter 1	Letter 2	Letter 3	Letter
Chamber Paced	Chamber Sensed	Sensing Response	Programm
A = Atrium	A = Atrium	T = Triggered	P = Sim
V = Ventricle	V = Ventricle	I = Inhibited	M = Multiprogra
D = Dual	D = Dual	D = Dual (Inhibits Both the Atrium & Ventricle)	R = Rate Ad
O = None	O = None	O = None	O = No



Pacemakers & Cardiac Devices

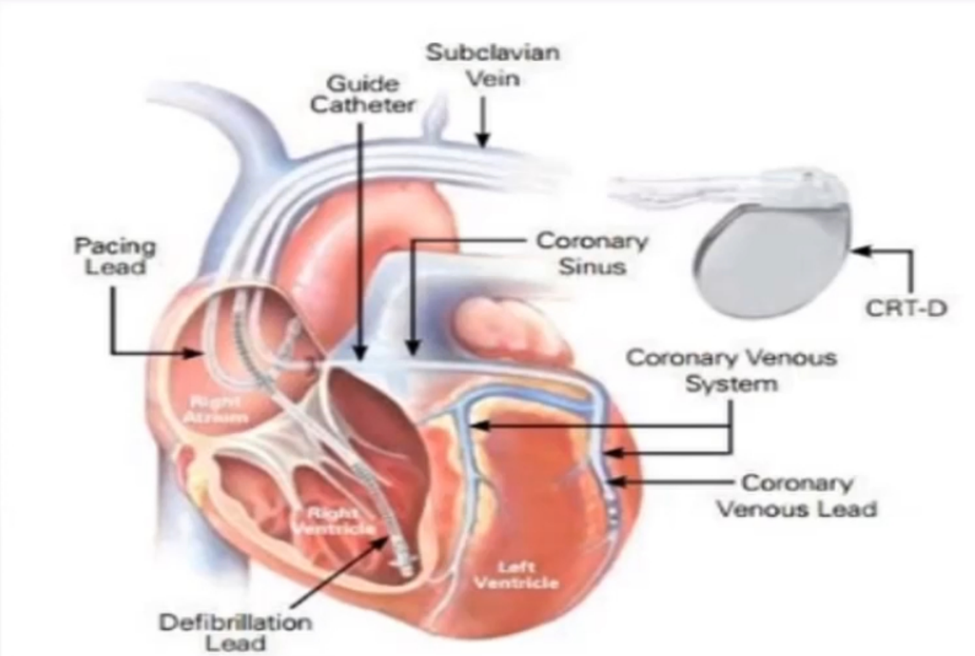
Implantable Cardiac Defibrillator (ICD)

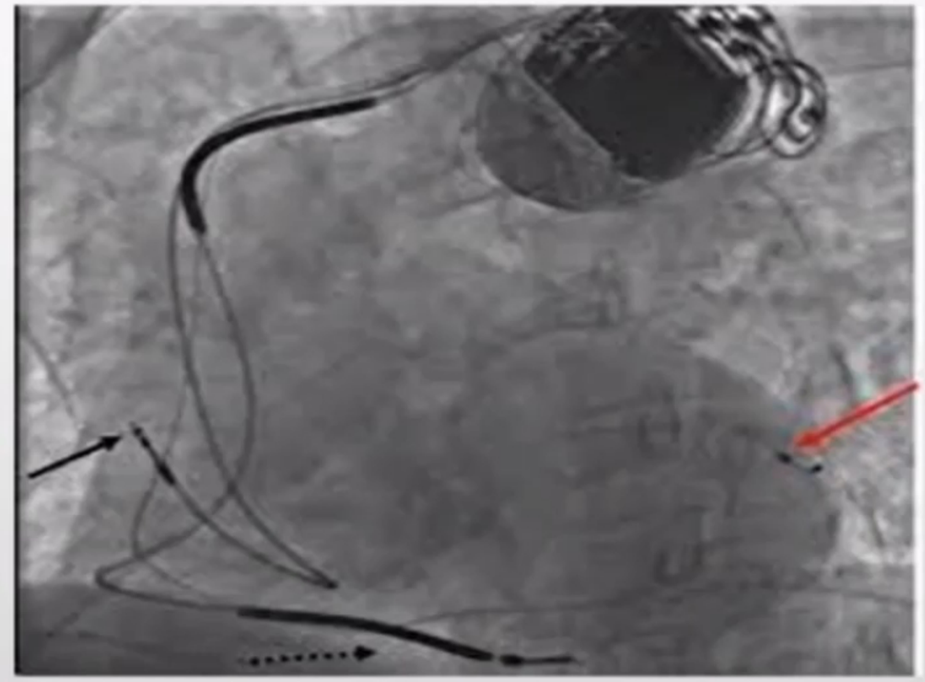


Anti-Tachycardia Pacing (ATP)

Cardiac Resynchronization Therapy (CRT)

AKA
Bi Ventricul
(BiV P





Type
CRT - P
CRT only

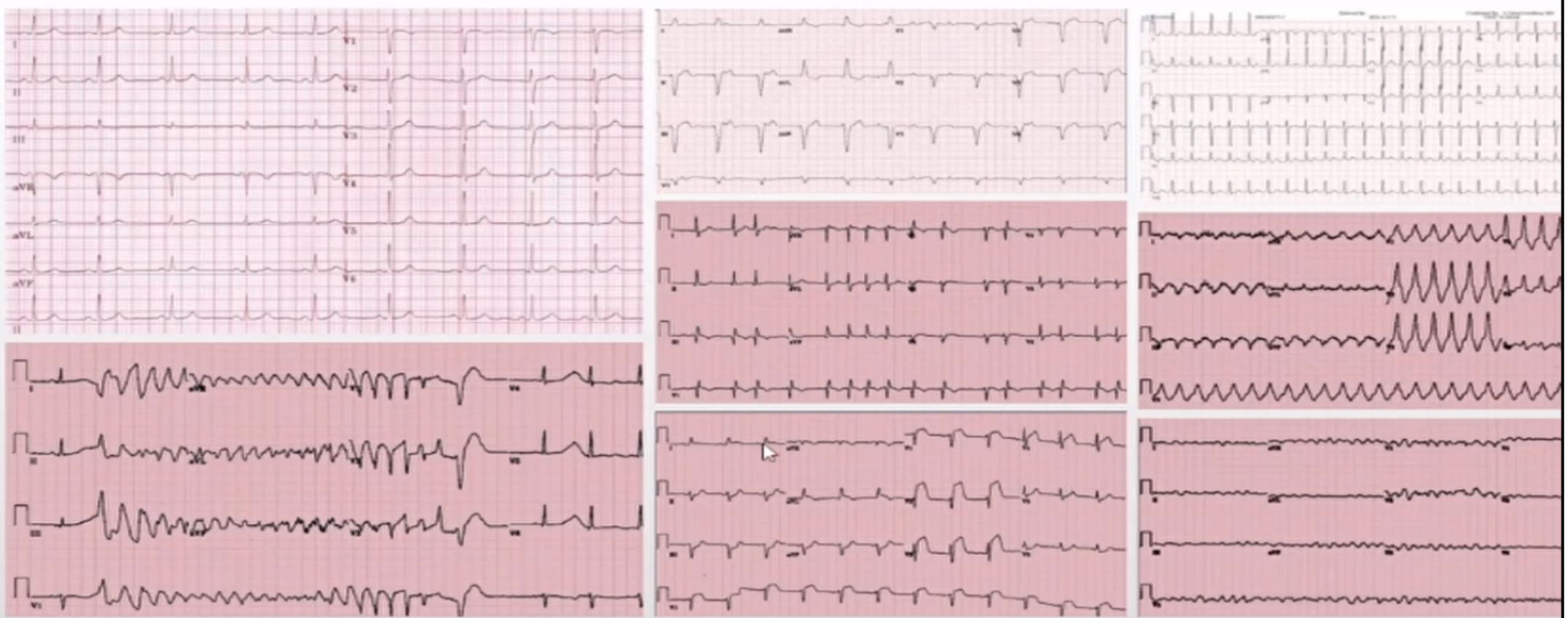
Pacemakers & Cardiac Devices

Figure 1: 174105-2 Magnet

Magnet Mode

	Magnet Mode ON
Pacemaker	Asynchronous Pacing
ICD	Defibrillator OFF

Cardiac Arrhythmias



Akram Al-Saleh