

Project: Ghana Emergency Medicine Collaborative

Document Title: Cardiology – EKG Interpretation

Author(s): Patrick Carter (University of Michigan), MD 2012

License: Unless otherwise noted, this material is made available under the terms of the **Creative Commons Attribution Share Alike-3.0 License:**
<http://creativecommons.org/licenses/by-sa/3.0/>

We have reviewed this material in accordance with U.S. Copyright Law **and have tried to maximize your ability to use, share, and adapt it.** These lectures have been modified in the process of making a publicly shareable version. The citation key on the following slide provides information about how you may share and adapt this material.

Copyright holders of content included in this material should contact open.michigan@umich.edu with any questions, corrections, or clarification regarding the use of content.

For more information about **how to cite** these materials visit <http://open.umich.edu/privacy-and-terms-use>.

Any **medical information** in this material is intended to inform and educate and is **not a tool for self-diagnosis** or a replacement for medical evaluation, advice, diagnosis or treatment by a healthcare professional. Please speak to your physician if you have questions about your medical condition.

Viewer discretion is advised: Some medical content is graphic and may not be suitable for all viewers.

for more information see: <http://open.umich.edu/wiki/AttributionPolicy>

Use + Share + Adapt

{ Content the copyright holder, author, or law permits you to use, share and adapt. }



Public Domain – Government: Works that are produced by the U.S. Government. (17 USC § 105)



Public Domain – Expired: Works that are no longer protected due to an expired copyright term.



Public Domain – Self Dedicated: Works that a copyright holder has dedicated to the public domain.



Creative Commons – Zero Waiver



Creative Commons – Attribution License



Creative Commons – Attribution Share Alike License



Creative Commons – Attribution Noncommercial License



Creative Commons – Attribution Noncommercial Share Alike License



GNU – Free Documentation License

Make Your Own Assessment

{ Content Open.Michigan believes can be used, shared, and adapted because it is ineligible for copyright. }



Public Domain – Ineligible: Works that are ineligible for copyright protection in the U.S. (17 USC § 102(b)) *laws in your jurisdiction may differ

{ Content Open.Michigan has used under a Fair Use determination. }



Fair Use: Use of works that is determined to be Fair consistent with the U.S. Copyright Act. (17 USC § 107) *laws in your jurisdiction may differ

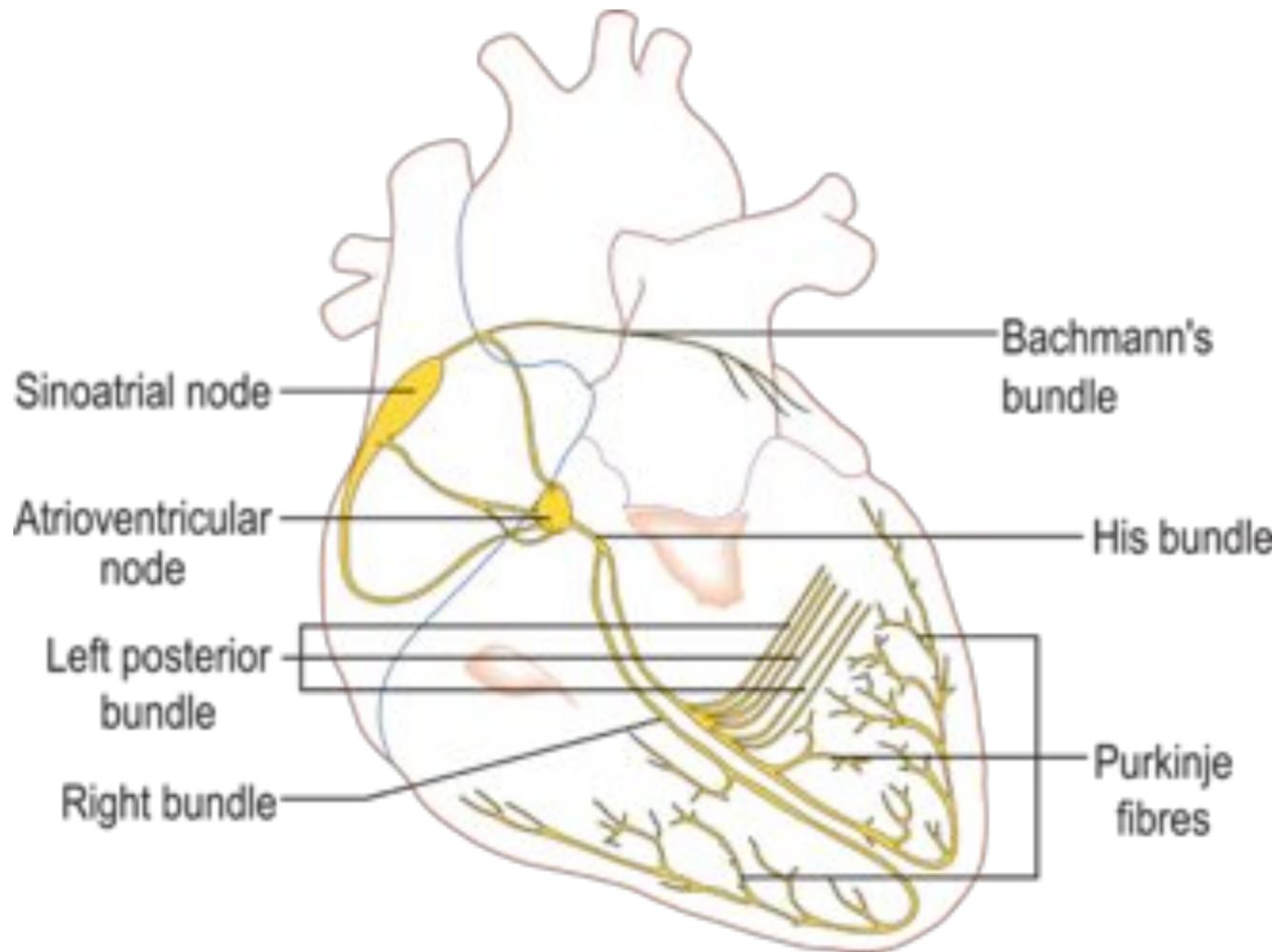
Our determination **DOES NOT** mean that all uses of this 3rd-party content are Fair Uses and we **DO NOT** guarantee that your use of the content is Fair.

To use this content you should **do your own independent analysis** to determine whether or not your use will be Fair.

Objectives

- Review of Cardiac Electrophysiology
- ECG Waves and Intervals
- EKG Leads: Limb, Anterior and Augmented Leads
- The Basics of EKG Interpretation
- Example Cases

Cardiac Electrophysiology



EKG Waves and Intervals



EKG Waves and Intervals

- P wave: the *sequential* activation (depolarization) of the right and left atria
- QRS complex: right and left ventricular depolarization (normally the ventricles are activated *simultaneously*)
- ST-T wave: ventricular repolarization

EKG Waves and Intervals

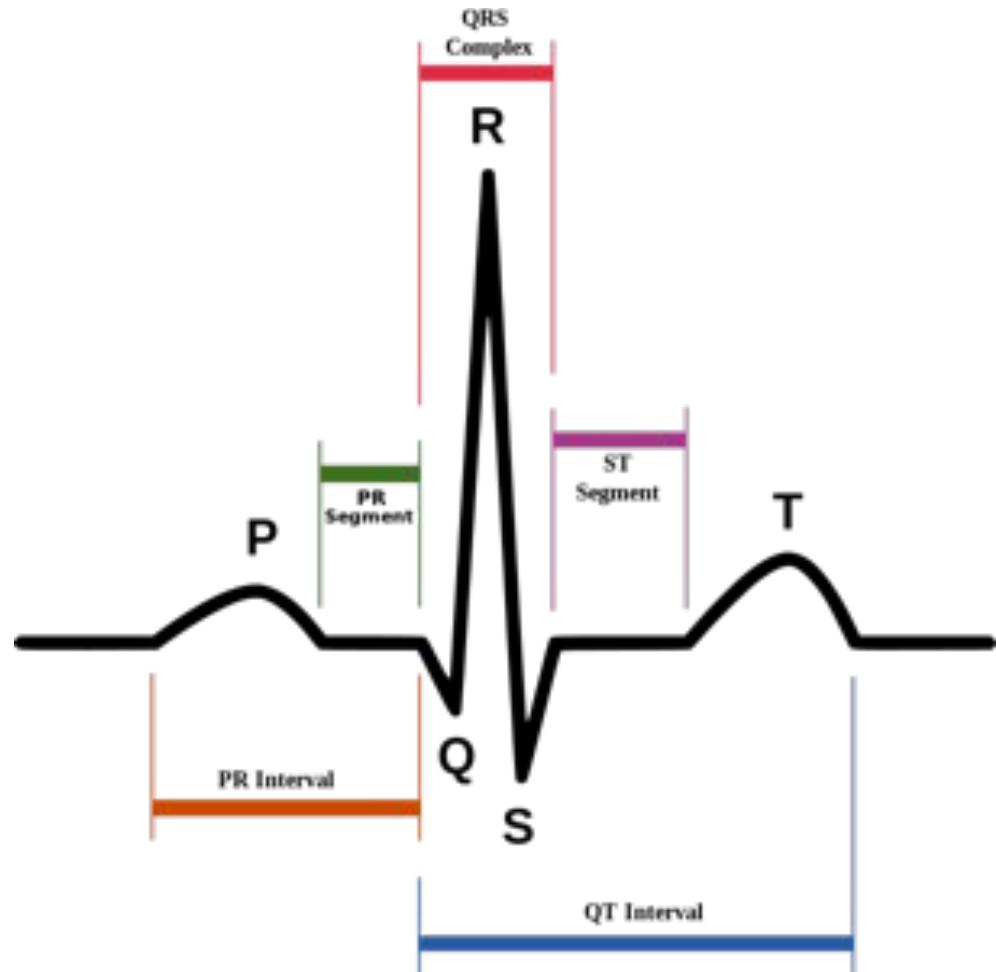
- U wave: origin for this wave is not clear - but probably represents "after depolarizations" in the ventricles
- PR interval: time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)
- QRS duration: duration of ventricular muscle depolarization

EKG Waves and Intervals

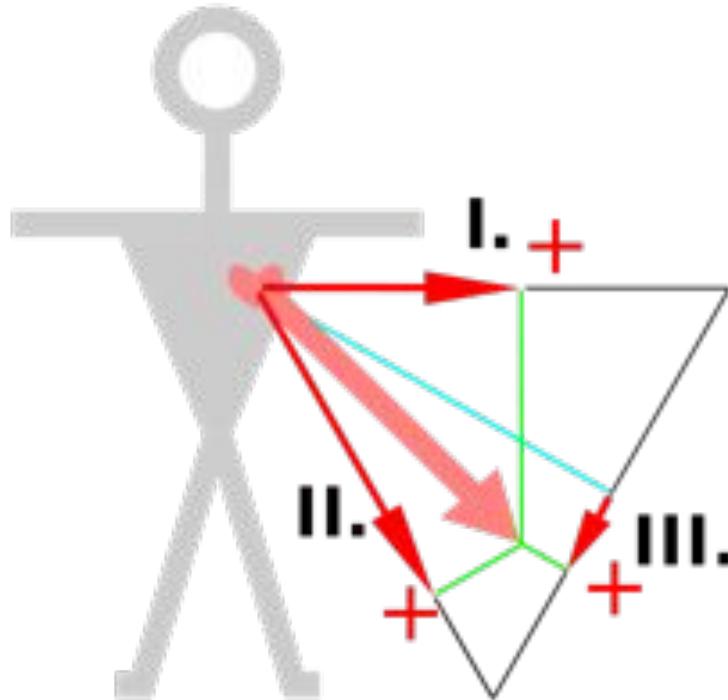
- QT interval: duration of ventricular depolarization and repolarization
- RR interval: duration of ventricular cardiac cycle (an indicator of ventricular rate)
- PP interval: duration of atrial cycle (an indicator of atrial rate)

Normal Intervals

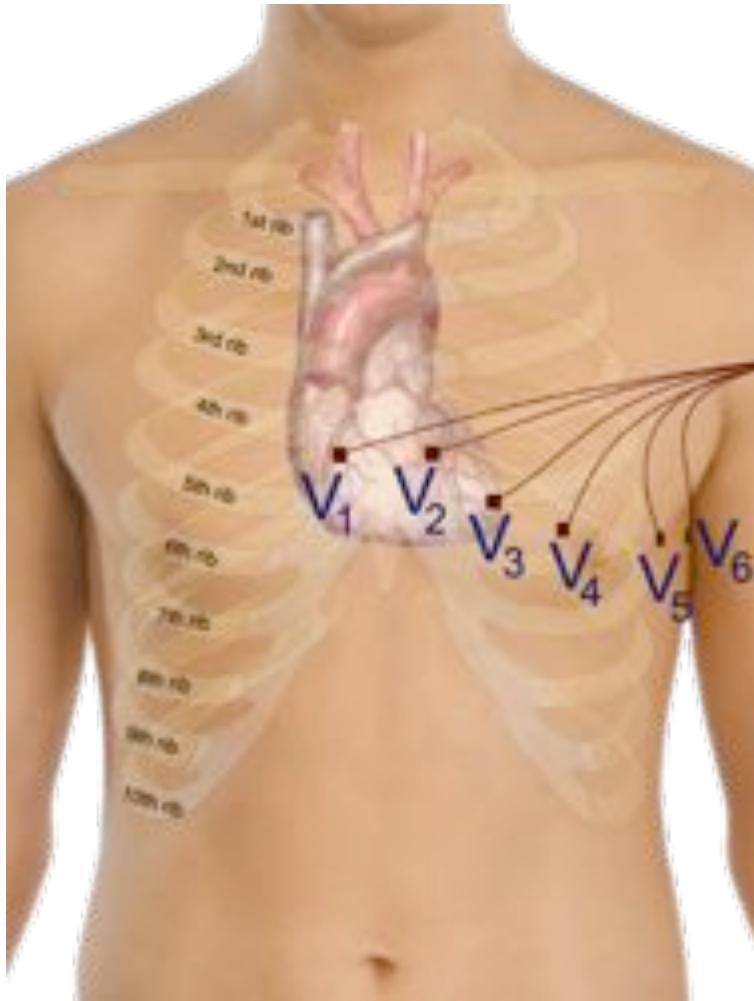
- PR
 - 0.20 sec (less than one large box)
- QRS
 - 0.08 – 0.10 sec (1-2 small boxes)
- QT
 - 450 ms in men, 460 ms in women
 - Based on sex / heart rate
 - Half the R-R interval with normal HR



Standard Limb Leads

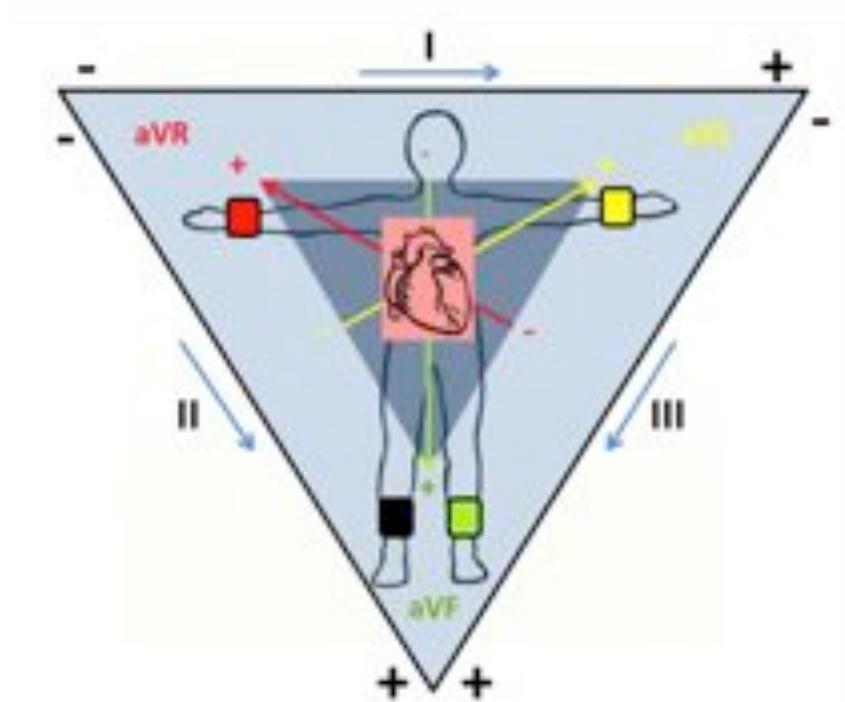


Anterior Limb Leads



- V₁: right 4th intercostal space
- V₂: left 4th intercostal space
- V₃: halfway between V₂ and V₄
- V₄: left 5th intercostal space, mid-clavicular line
- V₅: horizontal to V₄, anterior axillary line
- V₆: horizontal to V₅, mid-axillary line

Bipolar and Augmented Leads



The Basics of EKG Interpretation

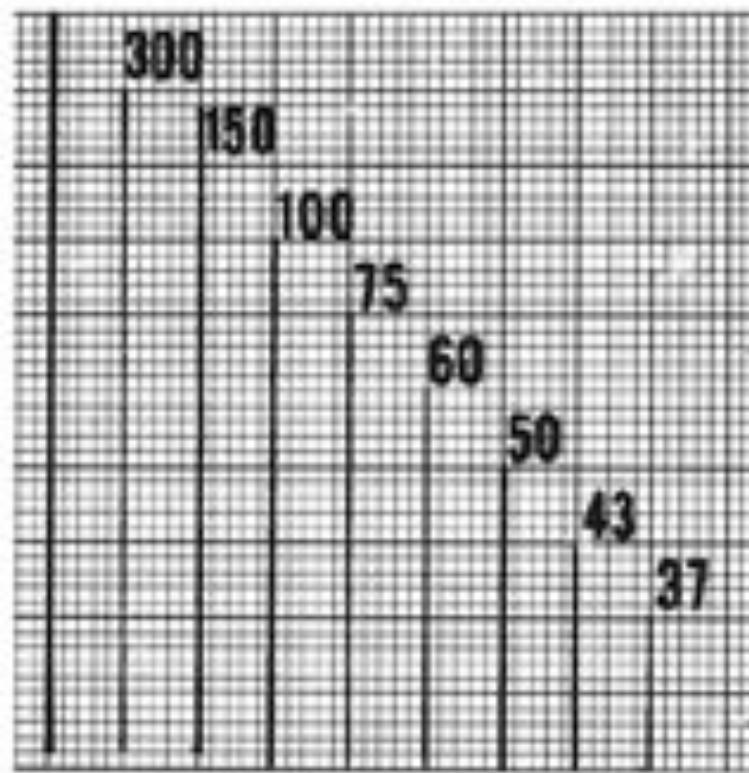
- Rate
- Rhythm
- Axis
- AV Blocks and Intervals
- Bundle Branch Blocks
- Hypertrophy
- Infarction/Ischemia

Rate

- Sinus Rhythm = SA Node Discharge
 - 60-100/min
 - Overdrive Suppresses Automaticity Foci
- HR > 100 = Tachycardia
- HR < 60 = Bradycardia
- Automaticity Foci
 - Atria 60-80/min
 - AV Junction 40-80/min
 - Ventricles 20-40/min

Rate Interpretation

- 1 small box = 0.04 sec
- 1 big box = 0.2 sec or $1/300$ min
- For bradycardia use the "3 seconds" marks
- Count cycles in 6 seconds and multiply by 10



Rhythm

- Sinus Rhythm
 - Originating from SA node
 - P wave before every QRS
 - P wave in same direction as QRS



Normal Sinus Rhythm



Source Undetermined

PD-INEL

Sinus Bradycardia



Source Undetermined

PD-INEL

Sinus Tachycardia

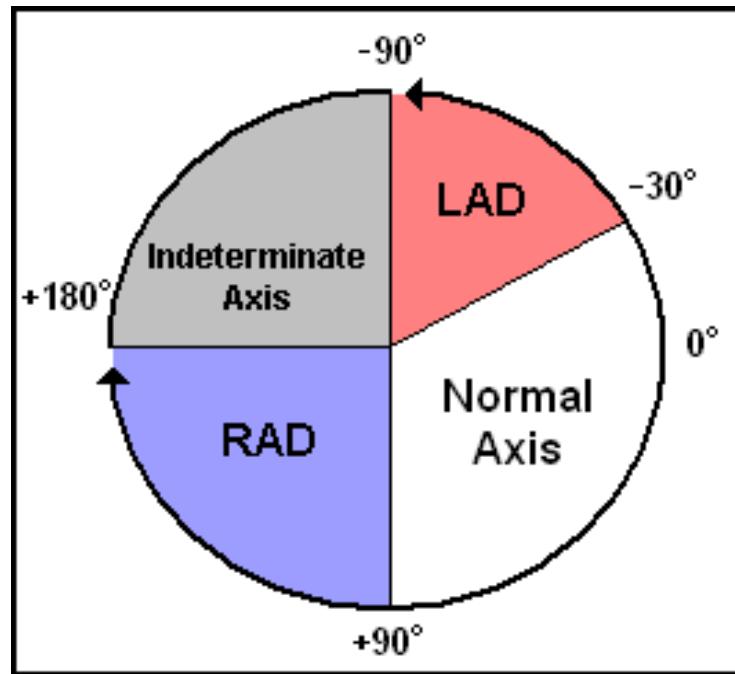


Source Undetermined

PD-INEL

Axis Interpretation

- Represents the overall direction of the heart's activity
- Axis of –30 to +90 degrees is normal



The Quadrant Approach

- QRS up in I and up in aVF = Normal

		Lead aVF	
		Positive	Negative
Lead I	Positive	Normal Axis	LAD
	Negative	RAD	Indeterminate Axis

Atrioventricular Blocks

- AV blocks
 - First degree block
 - PR interval fixed and > 0.2 sec
 - Second degree block, Mobitz type 1 (Wenkebach)
 - PR gradually lengthened, then drop QRS
 - Second degree block, Mobitz type 2
 - PR fixed, but drop QRS randomly
 - Type 3 block
 - PR and QRS dissociated

1st Degree AV Block



1st degree AV block (PR = 280 ms)

2nd Degree AV Block

Mobitz Type I (Wenkebach)



Source Undetermined

PD-INEL

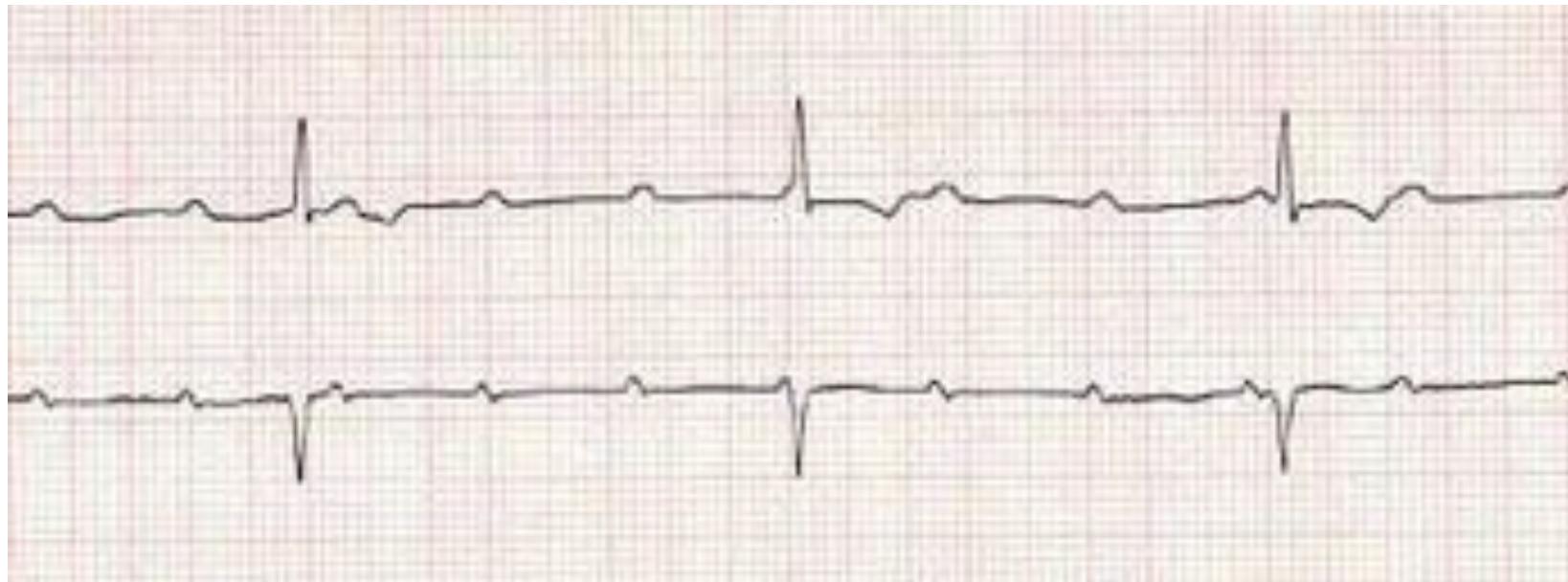
Mobitz Type II



Source Undetermined

PD-INEL

3rd Degree AV Block (Complete Heart Block)



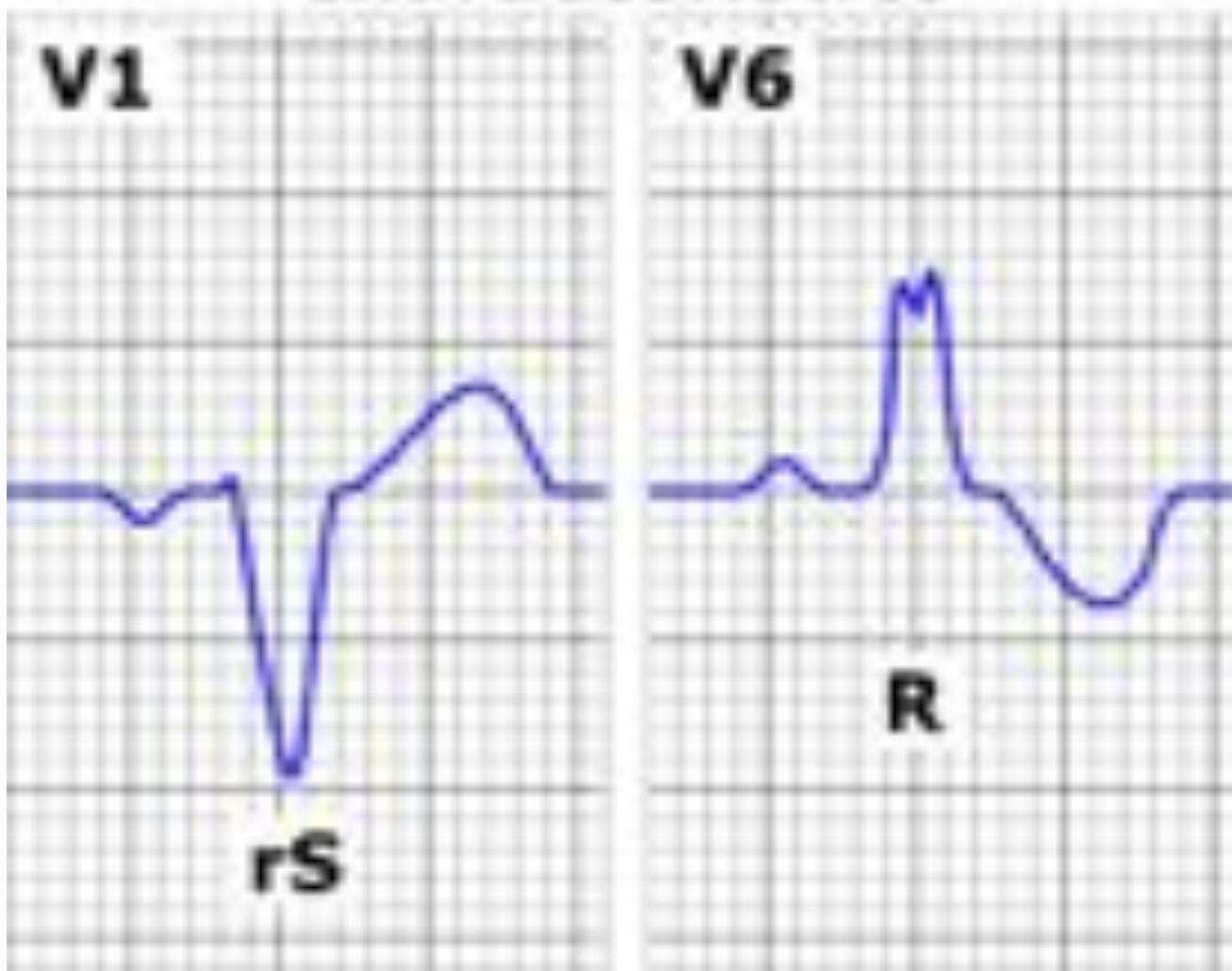
Prolonged QT

- Normal
 - Men 450ms
 - Women 460ms
- Corrected QT (QTc) Calculation
 - $QT_m/\sqrt{R-R}$
- Causes
 - Drugs (Na channel blockers)
 - Hypocalcemia, hypomagnesemia, hypokalemia
 - Hypothermia
 - Acute Myocardial Infarction
 - Congenital
 - Increased Intracranial Pressure

Bundle Branch Blocks

- Left Bundle Branch Block
 - Monophasic R wave in I and V6, QRS > 0.12 sec
 - Loss of R wave in precordial leads
 - QRS T wave discordance I, V1, V6
 - Consider cardiac ischemia if a new finding
- Right Bundle Branch Block
 - V1: RSR prime pattern with inverted T wave
 - V6: Wide deep slurred S wave

Left bundle branch block characteristics

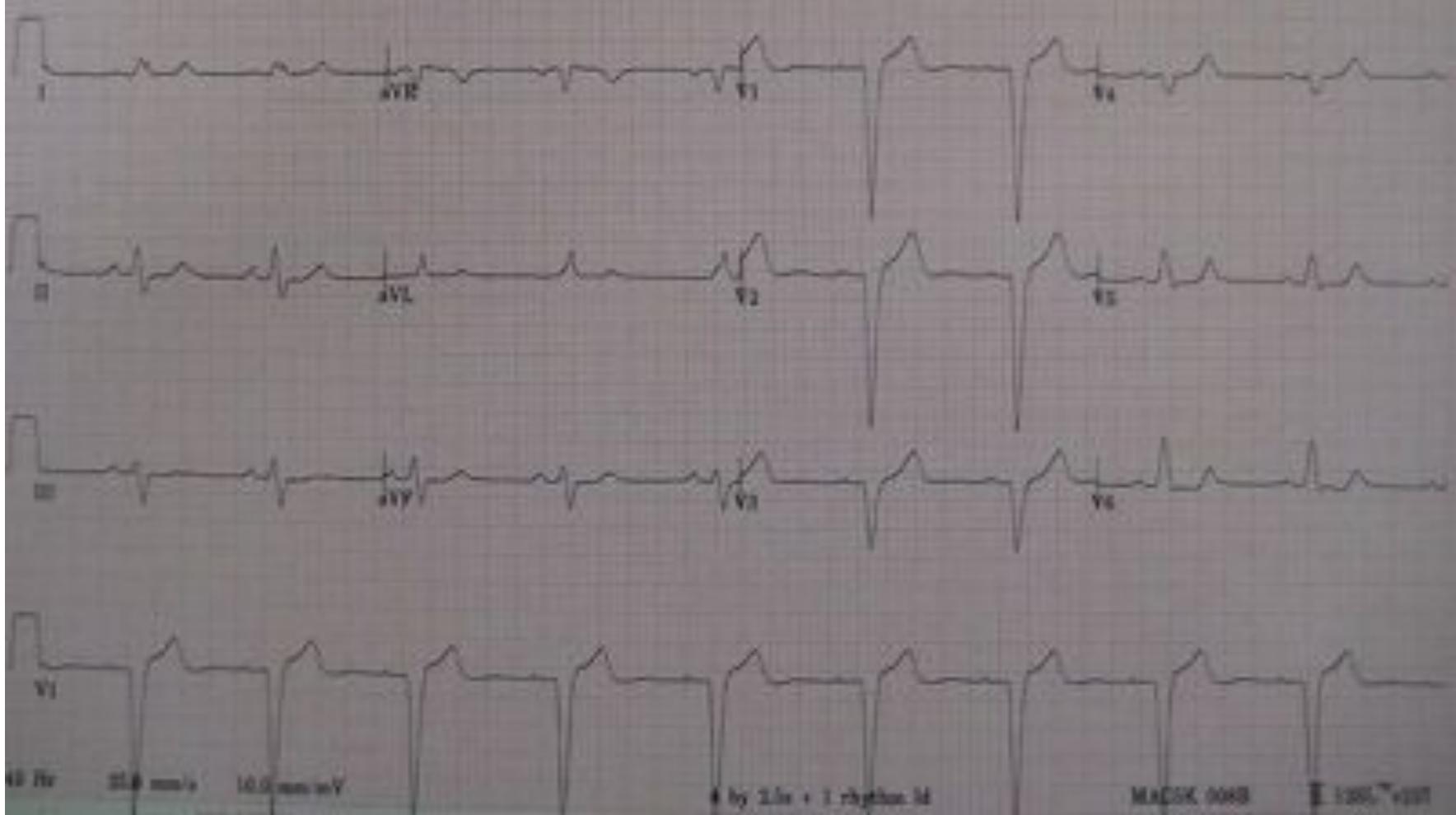


PIN: 90725

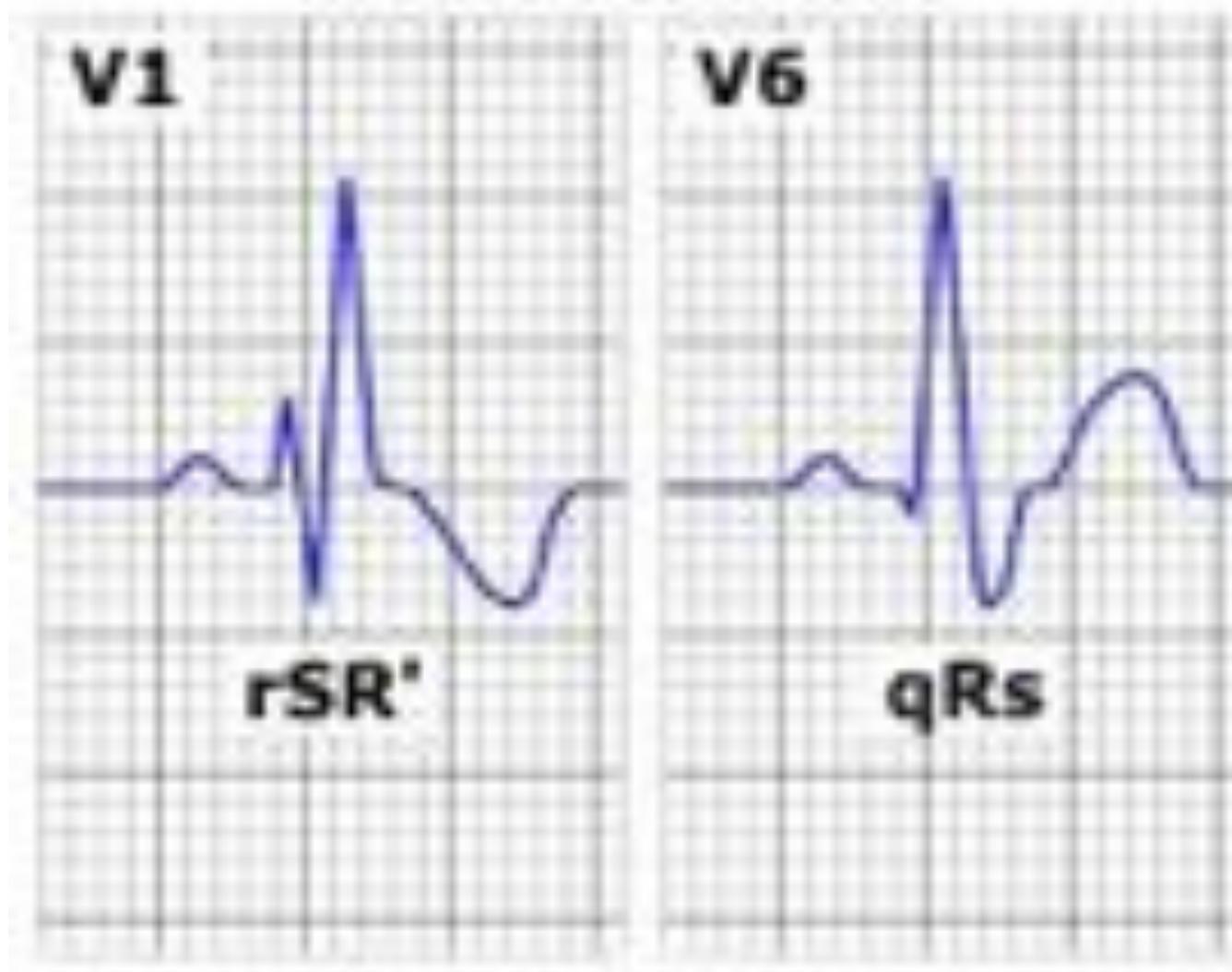
DATE READ:

TIME READ:

DATE SENT:



Right bundle branch block characteristics

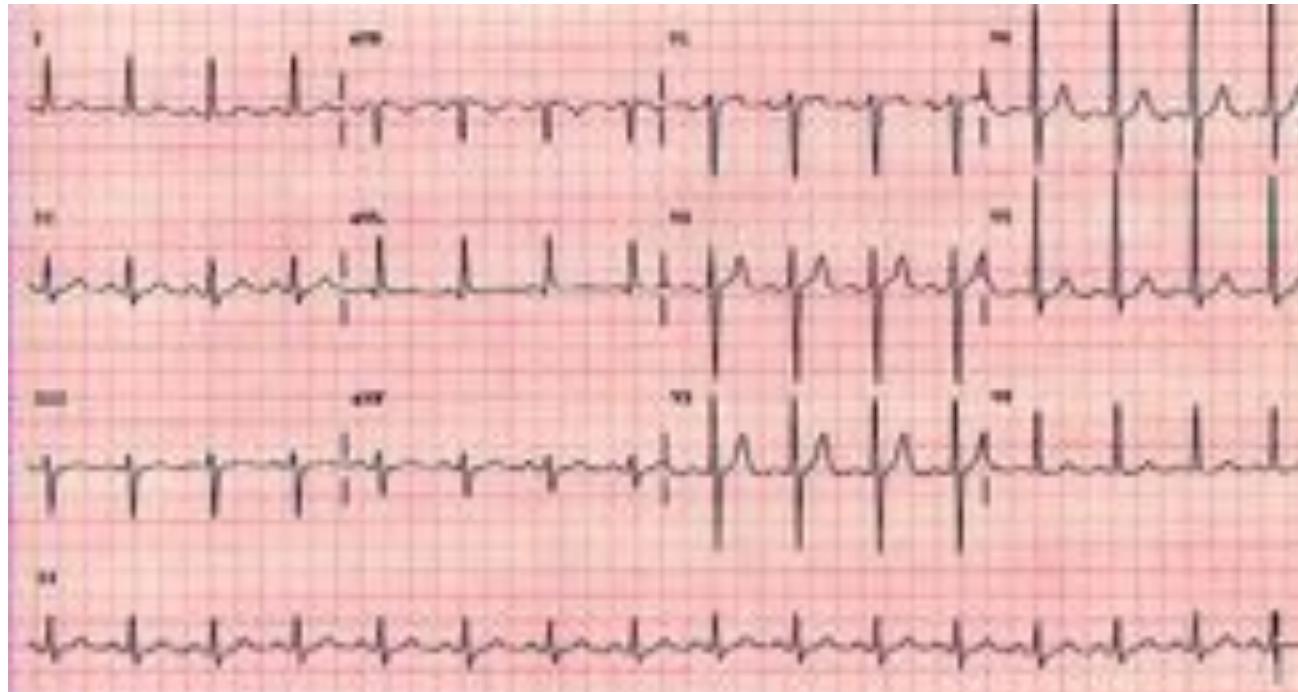




Source Undetermined

Hypertrophy

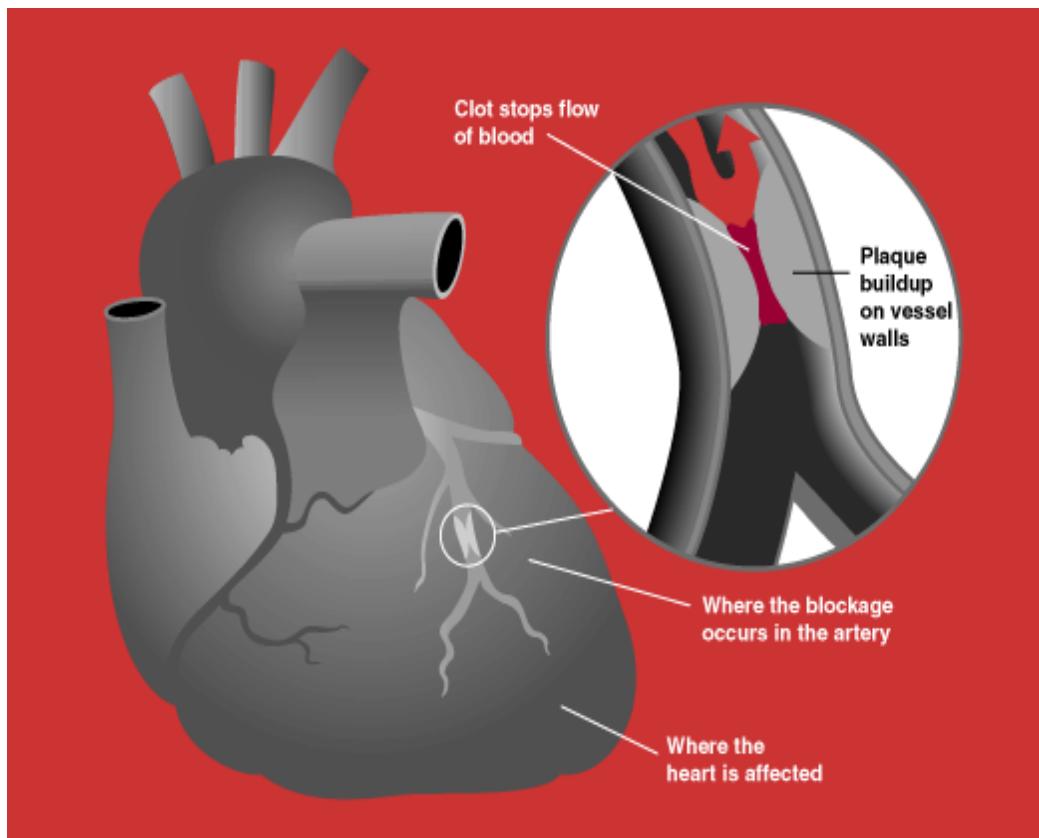
- Left Ventricular Hypertrophy Criteria:
 - Add the larger S wave of V1 or V2 in mm, to the larger R wave of V5 or V6.
 - Sum is $> 35\text{mm}$ = LVH



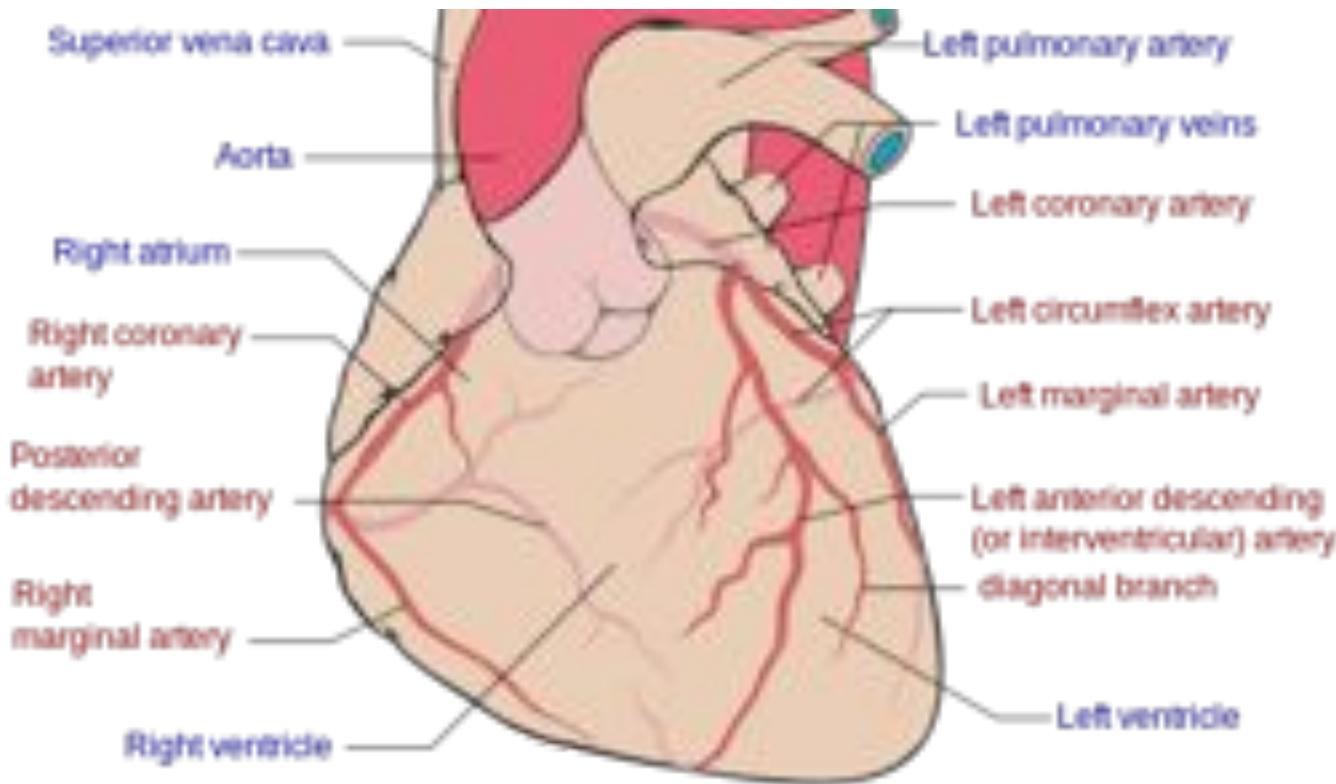
Ischemia

- Usually indicated by ST changes
 - Elevation = Acute infarction
 - Depression = Ischemia
- Can manifest as T wave changes
- Remote ischemia shown by Q waves

Evolution of Myocardial Ischemia



Coronary Blood Supply



Characteristics of a Myocardial Infarct

- A. Anterior Infarction
 - A. V1,V2,V3,V4
 - B. Left Anterior Descending (LAD)
- B. Lateral Infarction
 - A. I, AVL
 - B. Circumflex branch of Left Coronary Artery
- C. Posterior Infarction
 - A. Depression in V1,V2,V3
 - B. Right Coronary
 - C. Provides blood supply to SA Node, AV Node, His Bundle
- D. Inferior Infarction
 - A. II, III, AVF
 - B. Right or Left Coronary
 - A. Most Commonly Right Coronary

CLASSIC CARDIAC CASE EXAMPLES

Case # 1

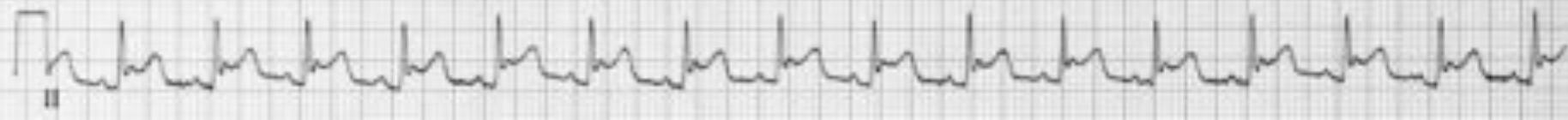
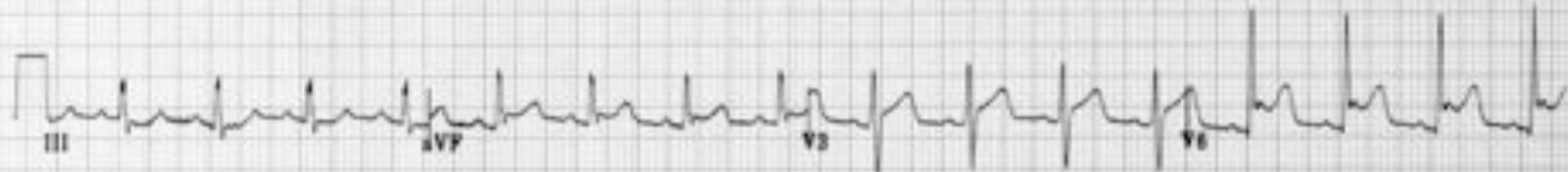
- 29 y/o male presents with chief complaint of “Chest pain”
 - Sharp chest pain localized to sub-sternal region
 - Pleuritic - worse w/ deep breathing, no radiation
 - Associated with shortness of breath
 - No nausea or diaphoresis
 - Recent low-grade fever, chills
 - No abdominal pain, vomiting, diarrhea

Case # 1

- Physical Exam
 - T = 38.2, P=100, BP = 115/75, RR = 12, SaO₂ = 98%
 - GENERAL: A+O x 3, NAD
 - HEENT: NC/AT, PERRL, EOMI, OP Clear
 - NECK: Supple, No LAD
 - HEART: RRR, No Murmurs, Gallops
 - LUNGS: CTA bilaterally
 - ABD: Soft, ND, NT, No masses
 - EXT: WWP, 2+ Pulses
 - NEURO: A+O x 3, No focal Neuro Deficits



Source Undetermined



Pericarditis

- EKG Findings
 - Diffuse Concave ST Elevation
 - Concordant T wave changes w/ ST segment
 - ST Depression in aVR, V1
 - PR Depression
 - No Reciprocal Changes

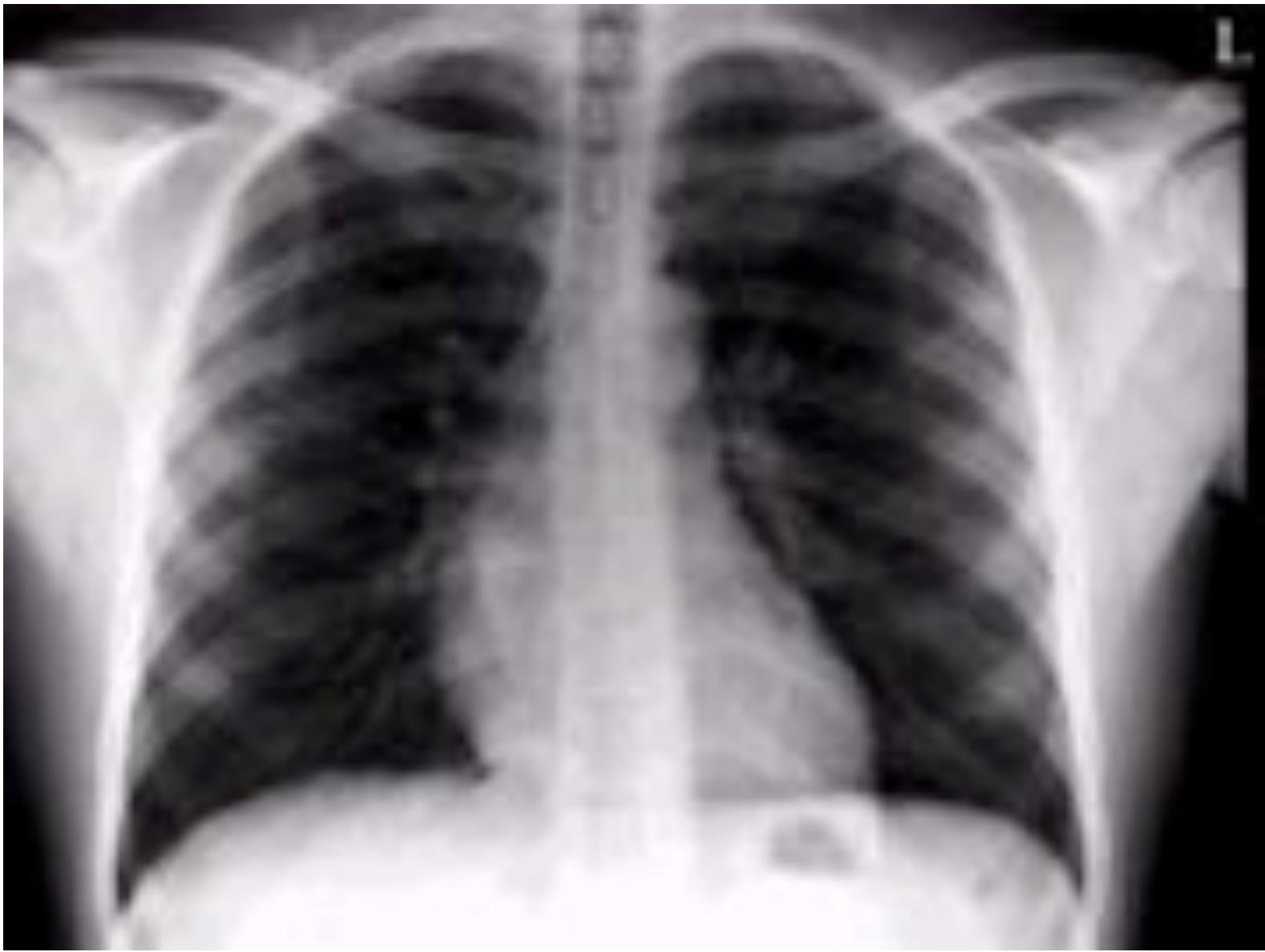
Case # 2

- 46 y/o male presents with CC of Syncope
 - Patient reports he was standing at sink in kitchen and felt lightheaded
 - Patient noted chest pressure and tightness in sub-sternal region
 - No radiation. No nausea or diaphoresis.
 - Patient passed out and LOC x 2 min. No seizure activity.
 - Patient continues to note shortness of breath, lightheadedness and near syncopal sensation
- Past Medical History: Diabetes, Coronary Artery Disease, Myocardial Infarction
- Meds: Aspirin, Plavix, Metoprolol, Lipitor
- Allergies: NKDA
- SH: + Smoker, No ETOH, No IVDU

Case # 2

- Physical Exam
 - VS: T=37.6, P = 30, BP = 85/45, RR = 12, O₂ sat = 97%
 - GEN: Drowsy, no respiratory distress
 - HEENT: NC/AT, PERRL, EOMI, OP Clear
 - NECK: Supple, No LAD
 - HEART: Bradycardic, regular, No Murmurs
 - LUNGS: CTA b/l. No Wheezes/Rales.
 - ABD: BS+, Soft, NT, ND, no masses
 - EXT: Thready pulses, no cyanosis. No edema.
 - NEURO: Drowsy. No focal deficits.





Source Undetermined

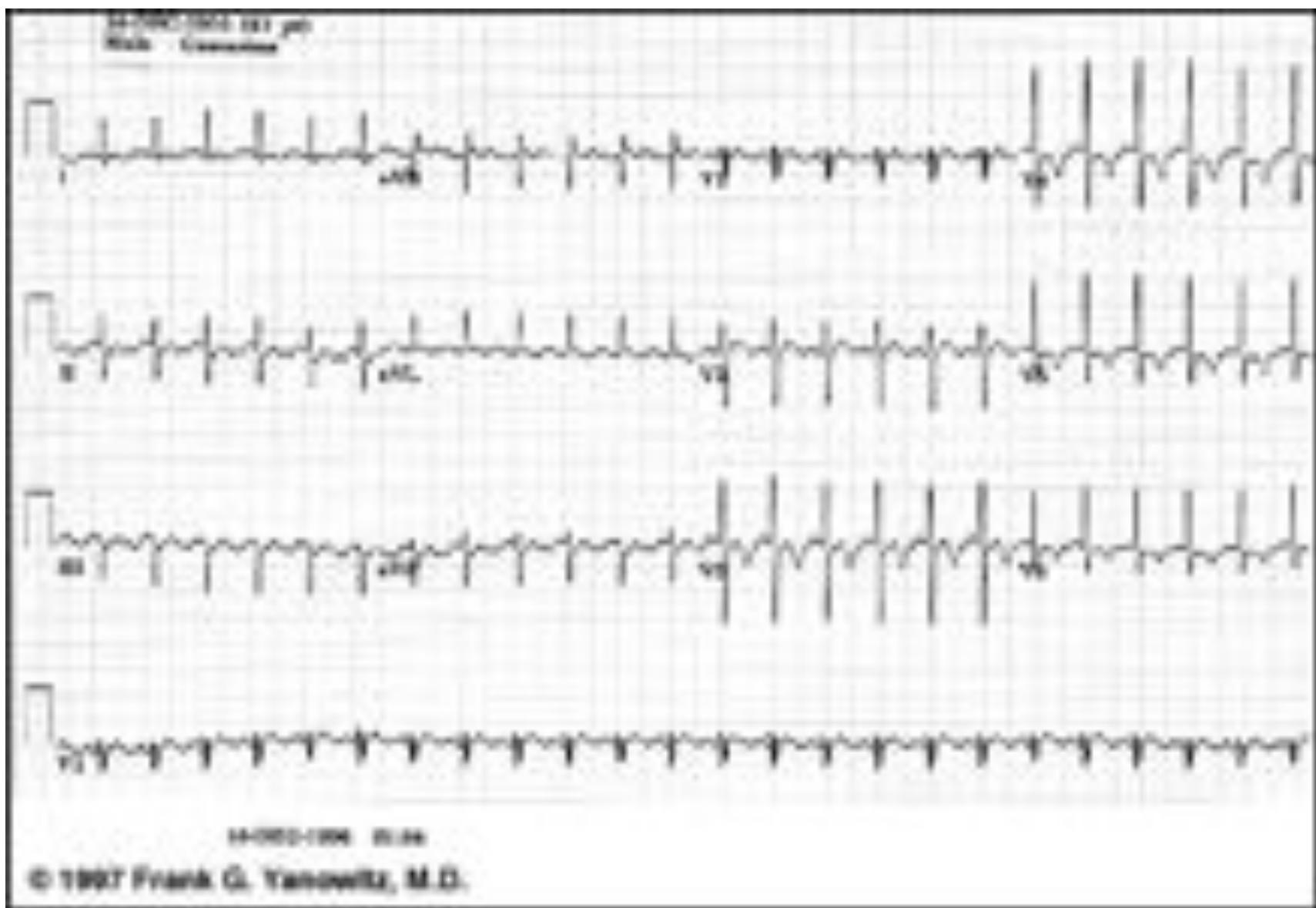
Complete Heart Block

- Complete dissociation of atrial and ventricular activity
- Results from conduction block
 - Level of the AV node
 - Bundle of His
 - Purkinje fibers
- Treatment
 - Atropine
 - Use Cautiously in patients w/ MI and wide QRS complexes
 - Transcutaneous Pacing
 - Transvenous Pacing

EKG PRACTICE

Differential Diagnosis of Tachycardia

Tachycardia	Narrow Complex	Wide Complex
Regular	ST SVT Atrial flutter	ST w/ aberrancy SVT w/ aberrancy VT
Irregular	A-fib A-flutter w/ variable conduction MAT	A-fib w/ aberrancy A-fib w/ WPW VT



Atrial Flutter



42 years

Caucasian

Heart rate: 166 bpm
 PR interval: 0 ms
 QRS duration: 22 ms
 QT/QTc: 273/614 ms
 P-R-T area: 14 - 30

ID:

Nov-200 06:42:04

EMERGENCY DEPT.

Race:
Loc: 3

Abnormal ECG

Technician:
Test code:

Referred by:

Classified

COMMENT:



100 Hz 25.0 mm/s 10.0 mm/mV

NORMAL STYLUS

4 by 2.5s + 3 rhythm strips

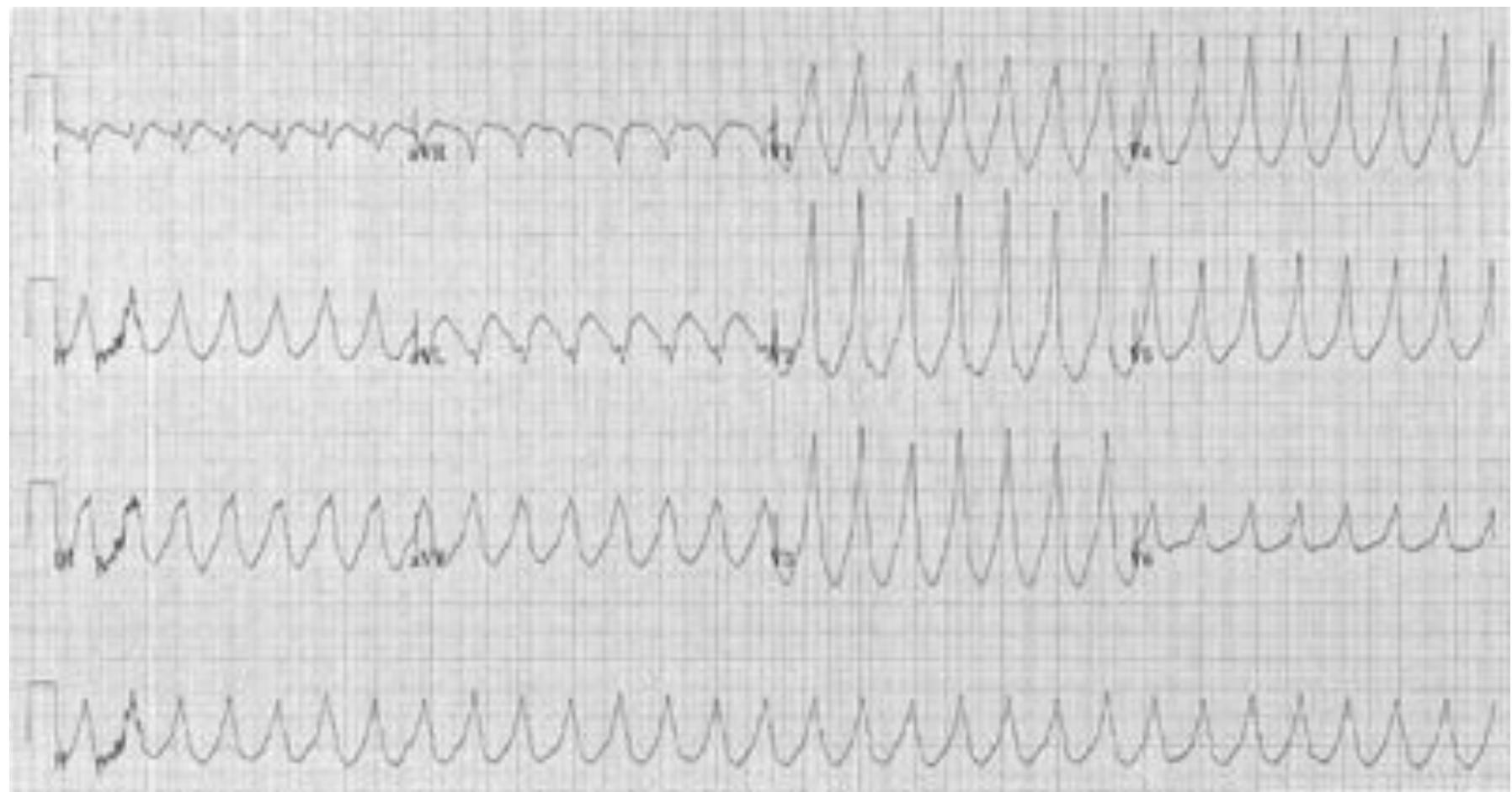
PRINTED IN U.S.A.

MACS 009A

E 125L™ v200

Atrial Fibrillation



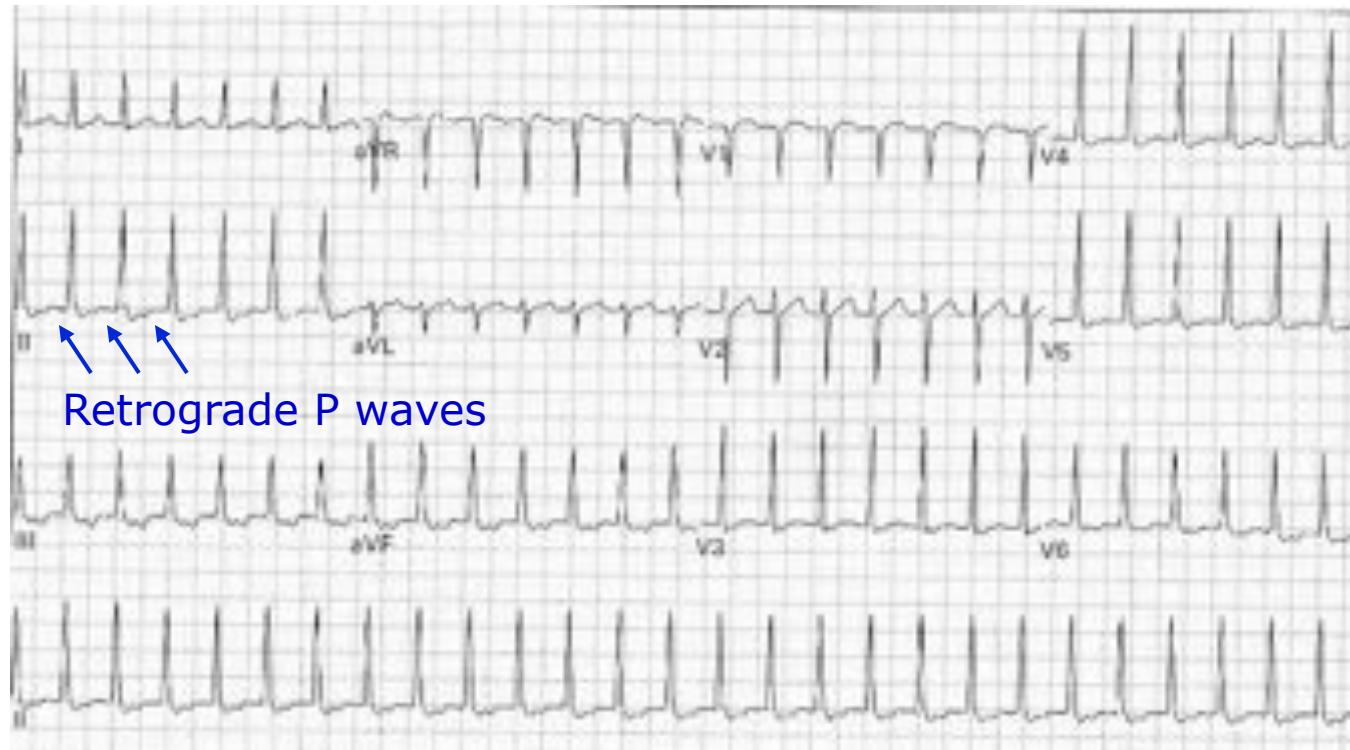


Wide Complex Tachycardia

- Differential Diagnosis
 - Ventricular Tachycardia
 - SVT with Aberrancy



Supraventricular Tachycardia

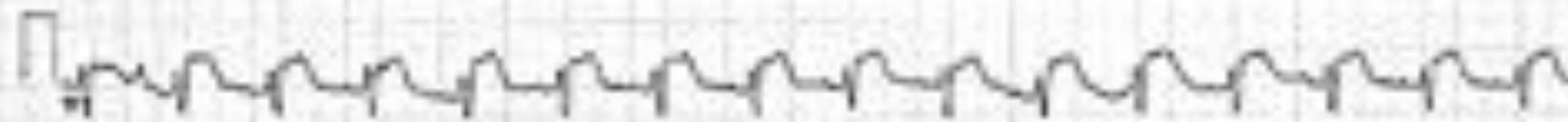
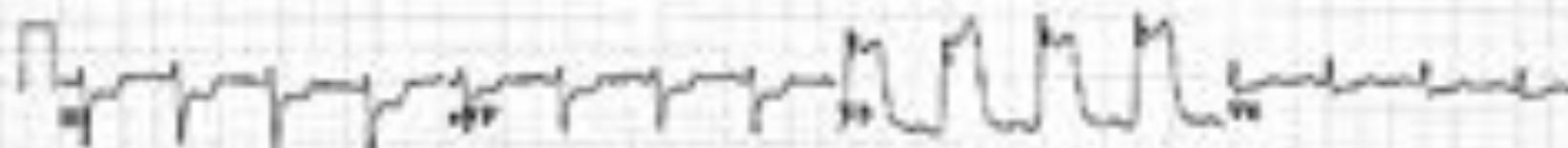
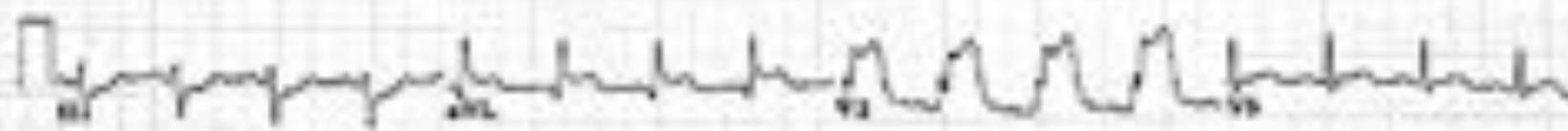
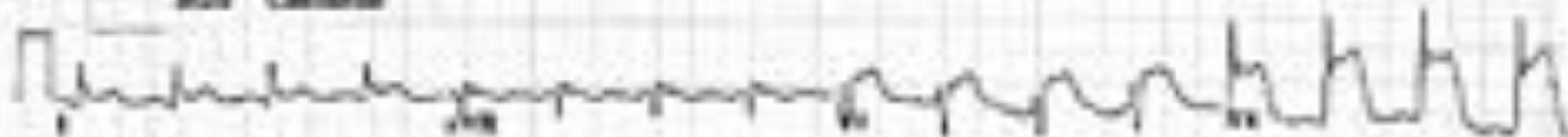


Narrow complex, regular; retrograde P waves



ATRIAL FLUTTER WITH VARIABLE BLOCK

11 OCTOBER 1993 100 gm
Maha (Continued)



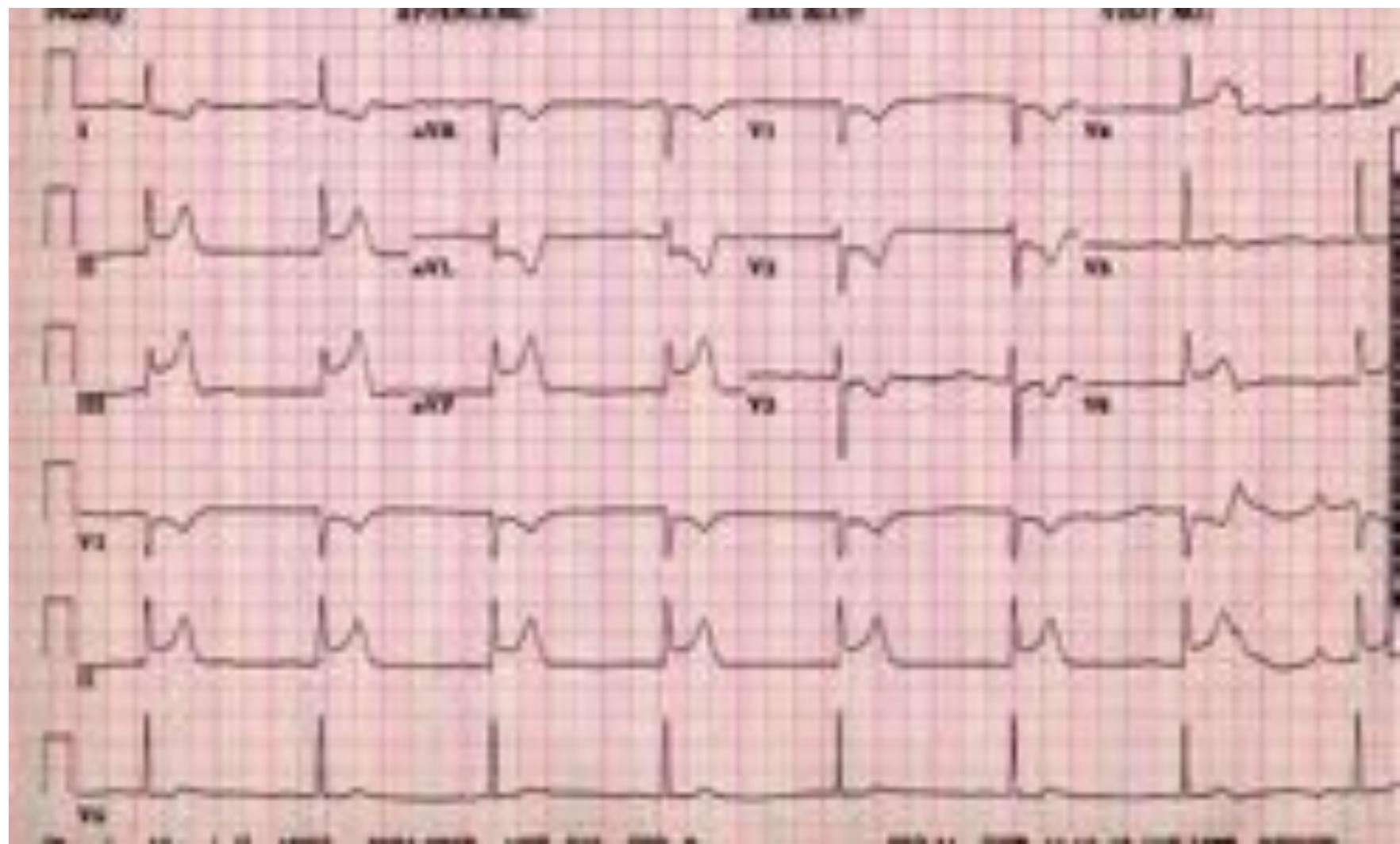
Sherry Sherrill Sherry

卷之三

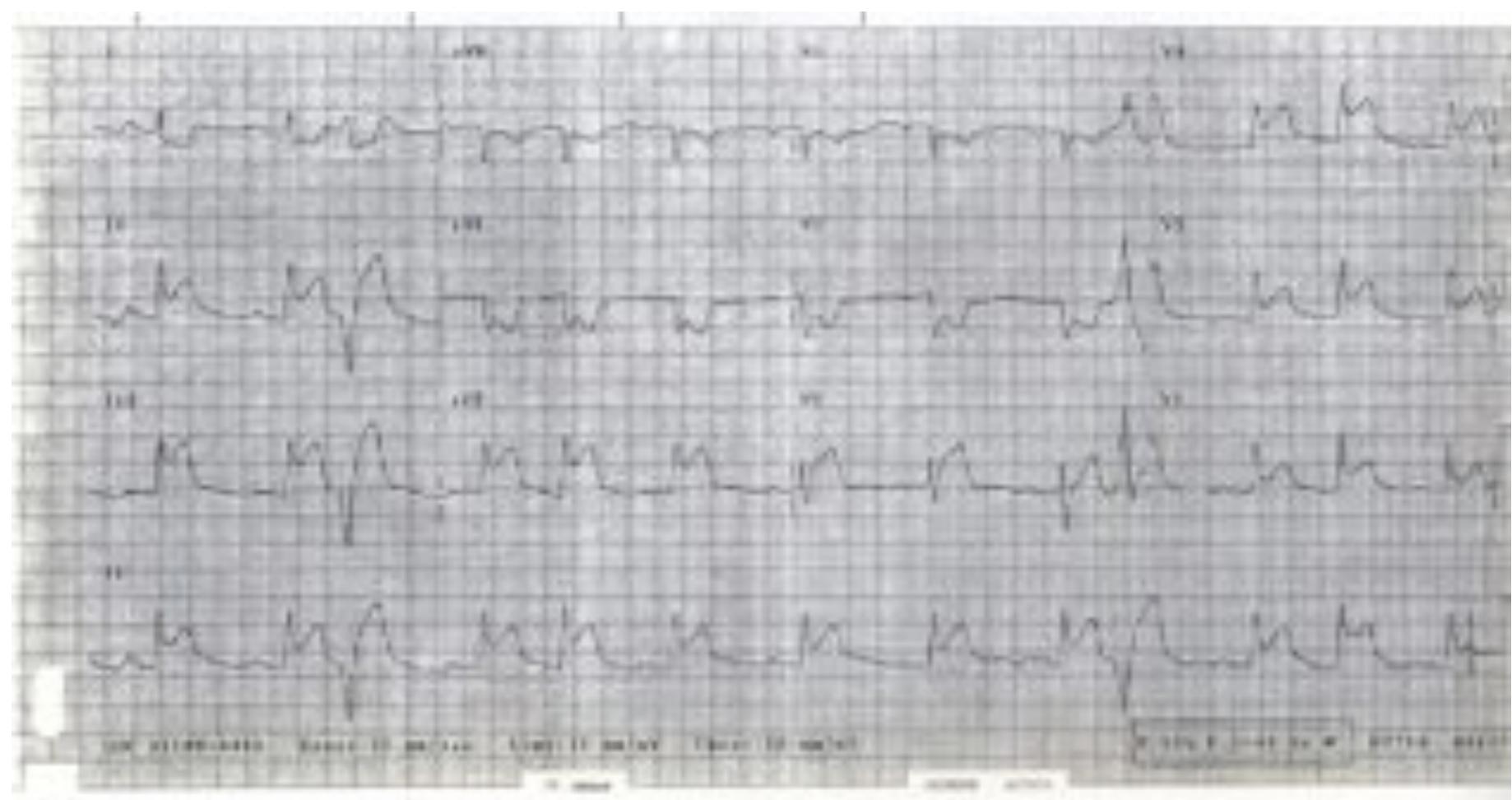
2025 RELEASE UNDER E.O. 14176

© 1997 Frank G. Yanowitz, M.D.

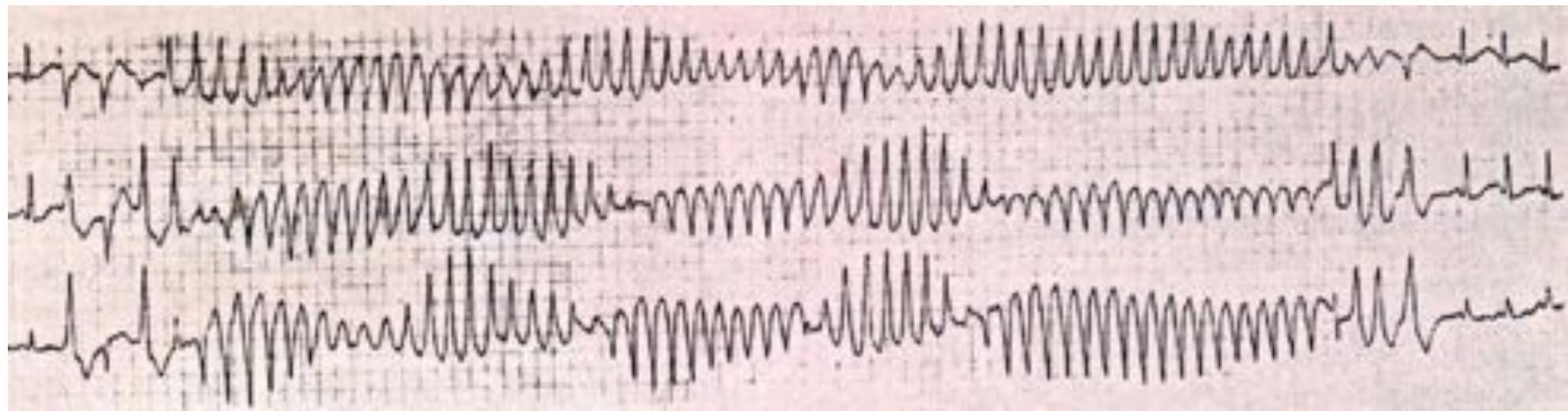
ANTEROSEPTAL MYOCARDIAL INFARCTION



INFERIOR POSTERIOR MYOCARDIAL INFARCTION

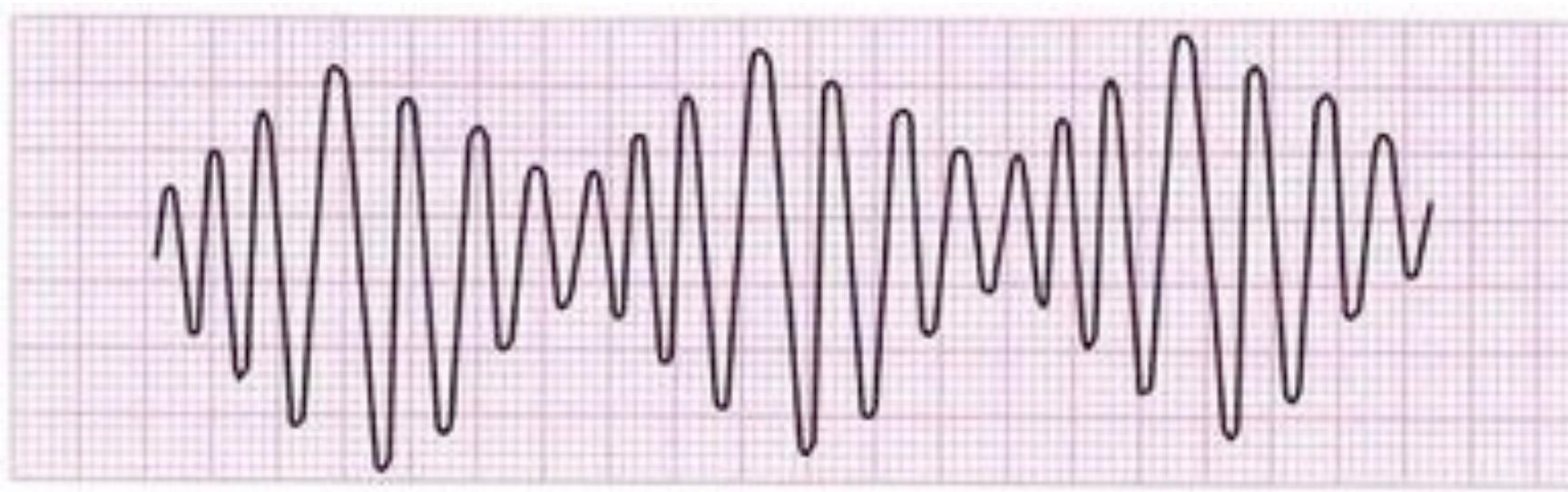


MASSIVE AMI!!!!



Source Undetermined

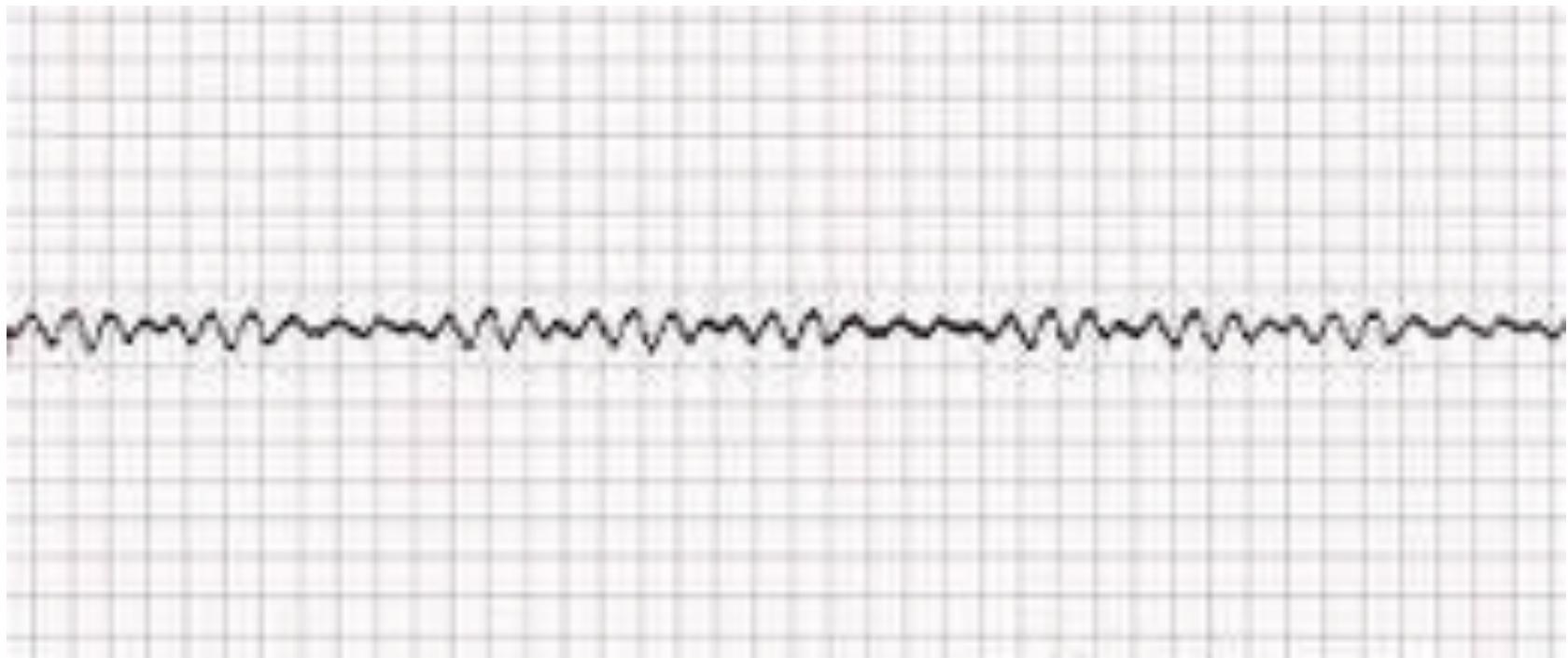
© PD-INEL



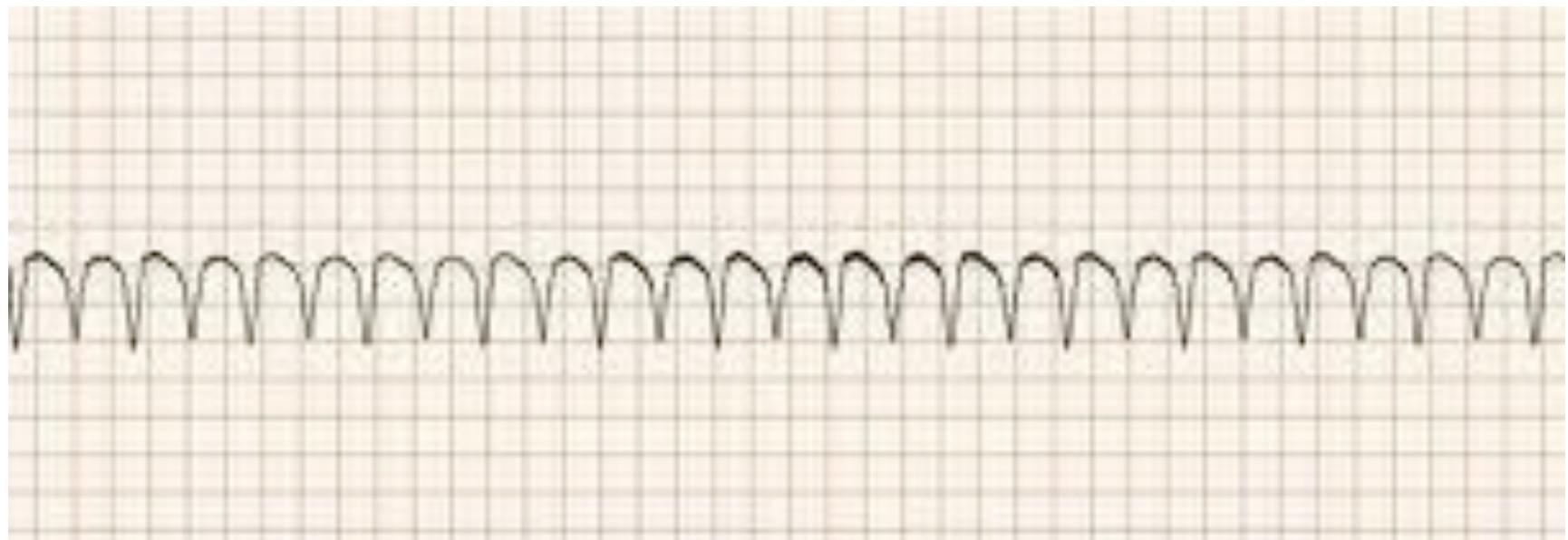
Source Undetermined

© PD-INEL

POLYMORPHIC VENTRICULAR TACHYCARDIA TORSADES DE POINTES

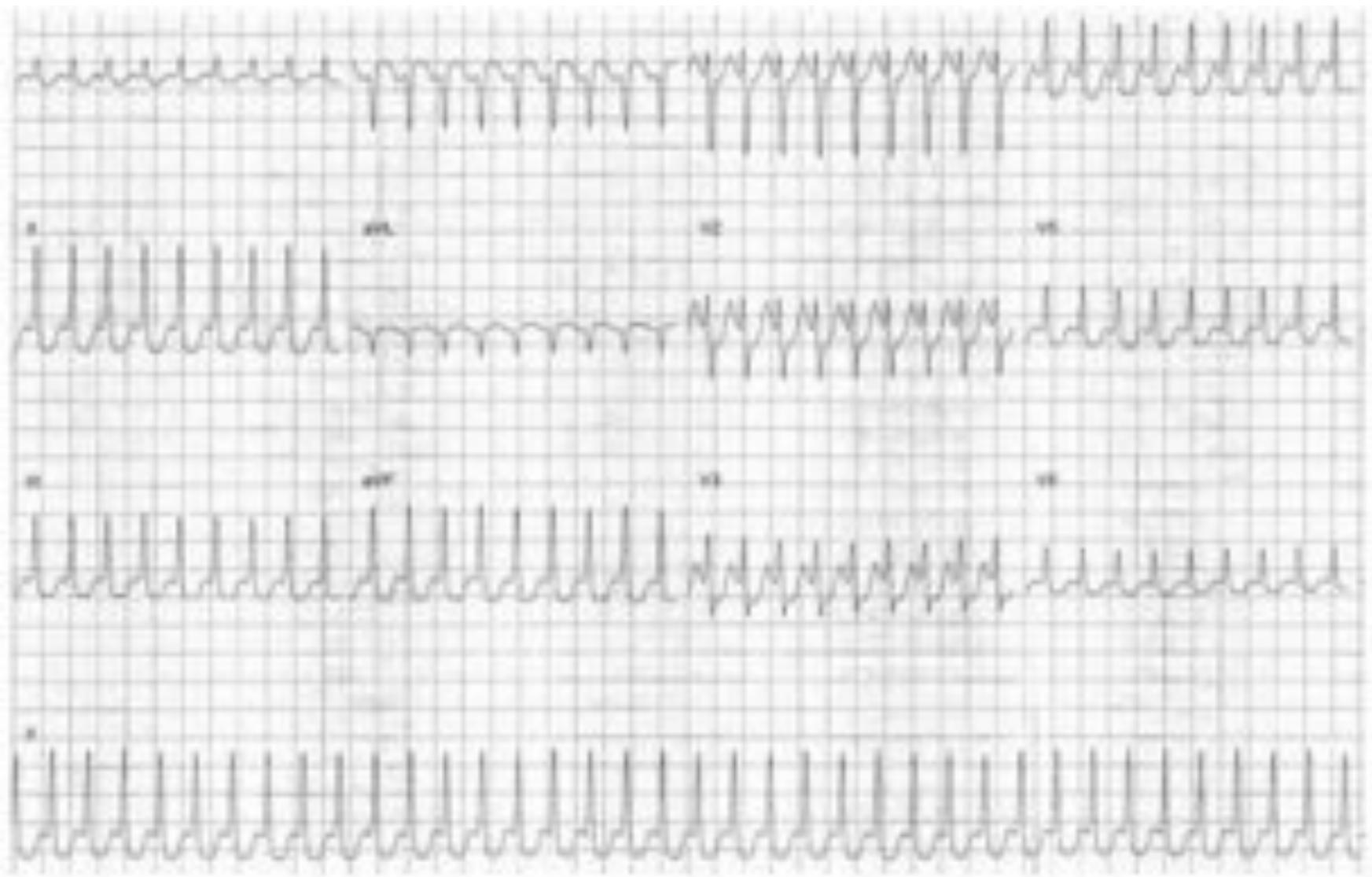


VENTRICULAR FIBRILLATION



(Most Likely, Monomophic Ventricular Tachycardia)

WIDE COMPLEX TACHYCARDIA



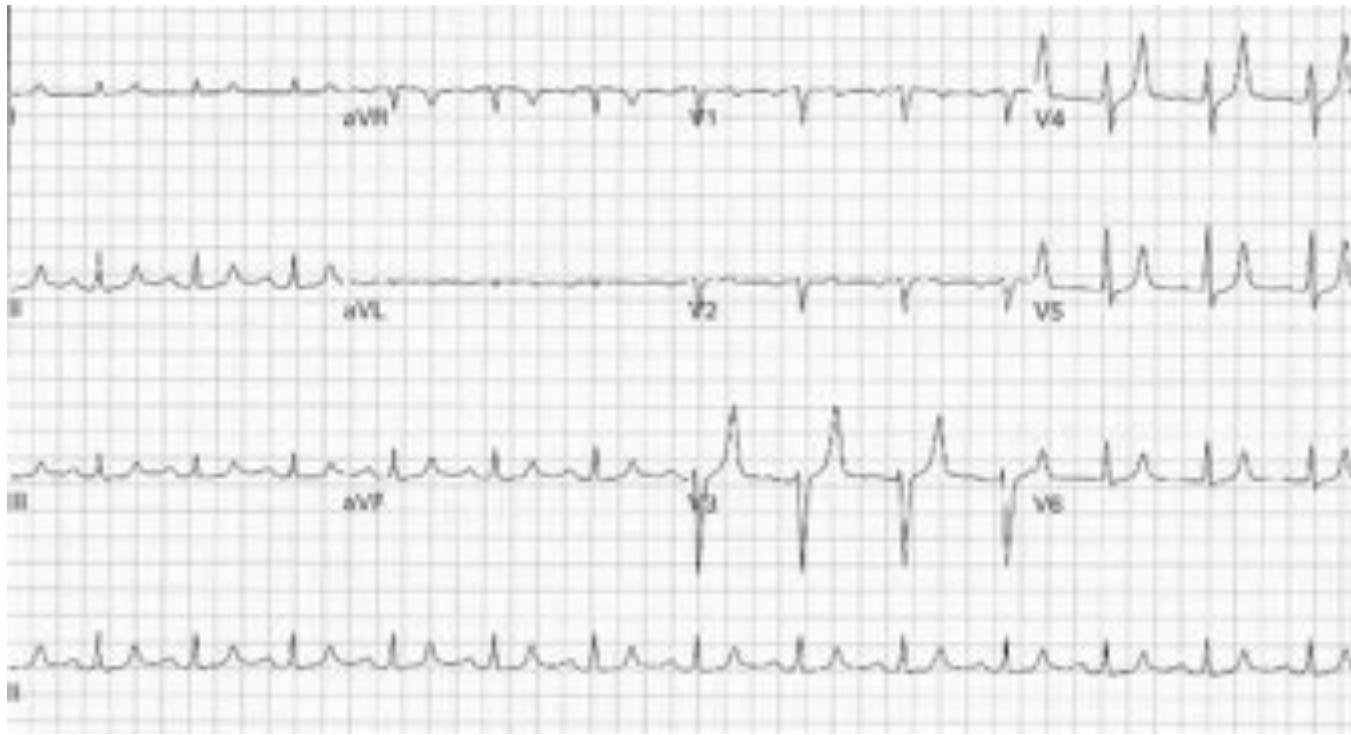
SVT WITH SIGNS OF RATE DEPENDENT ISCHEMIA

Hypokalemia



U waves; Can also see PVCs, ST depression, small T waves

Hyperkalemia



Tall, narrow and symmetric T waves

Questions?



Dkscully, [Flickr](#)

