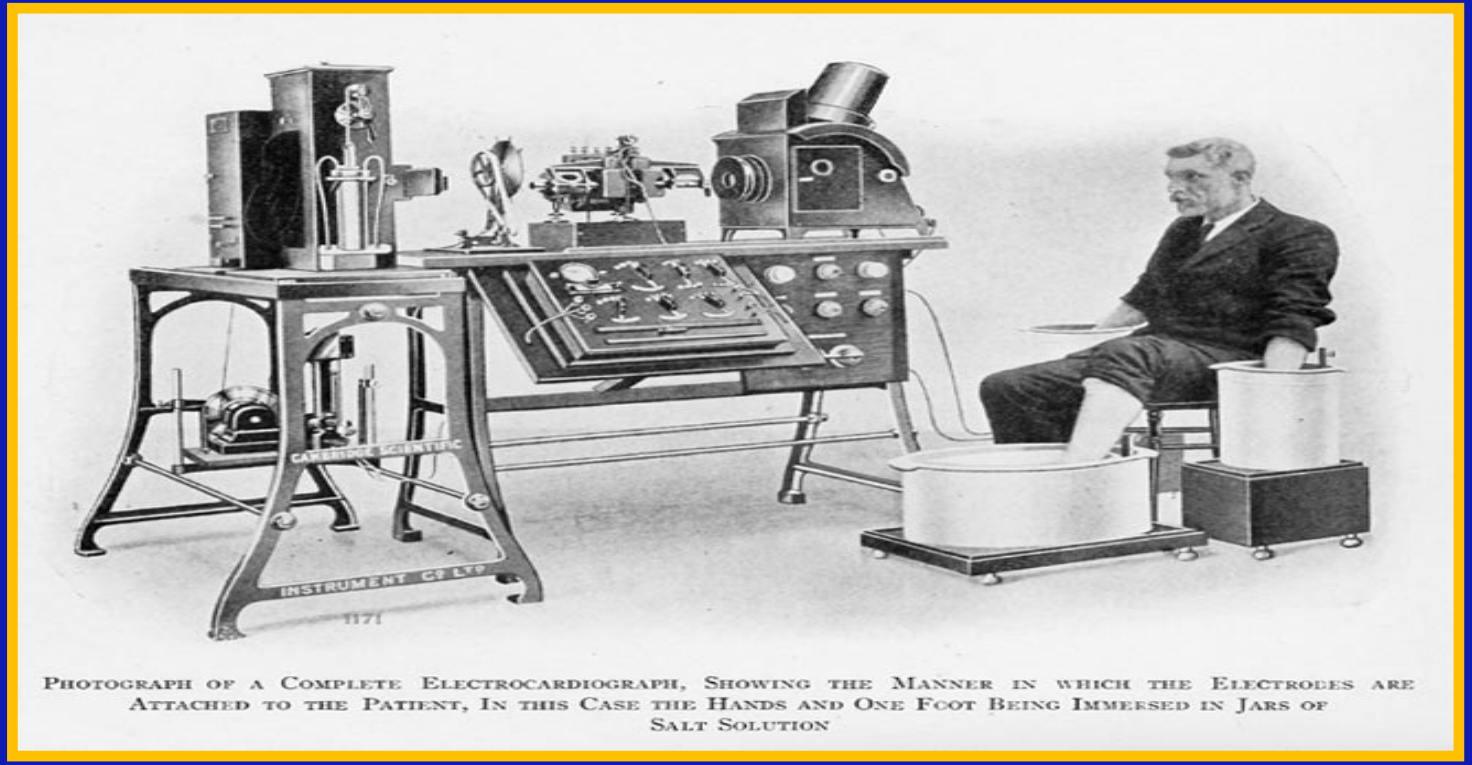
Advanced EKGs and AI



PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

Ross MacKenzie MD FRCPC, FACC, FAAIM
Emoke Posan MD, PHD

2023 AAIM Annual Meeting – Washington DC

Added Value of The Modern Insur. Co. Med. Director

- In-depth medical knowledge

Added Value of The Modern Insur Co Med Director

- In-depth medical knowledge
- Health care system business experience

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Added Value of The Modern Insur. Co. Med.Director

- In-depth medical knowledge
- Health care system business experience
- Respectful of underwriters
- EKG expertise

EKG Challenges Facing the Medical Director

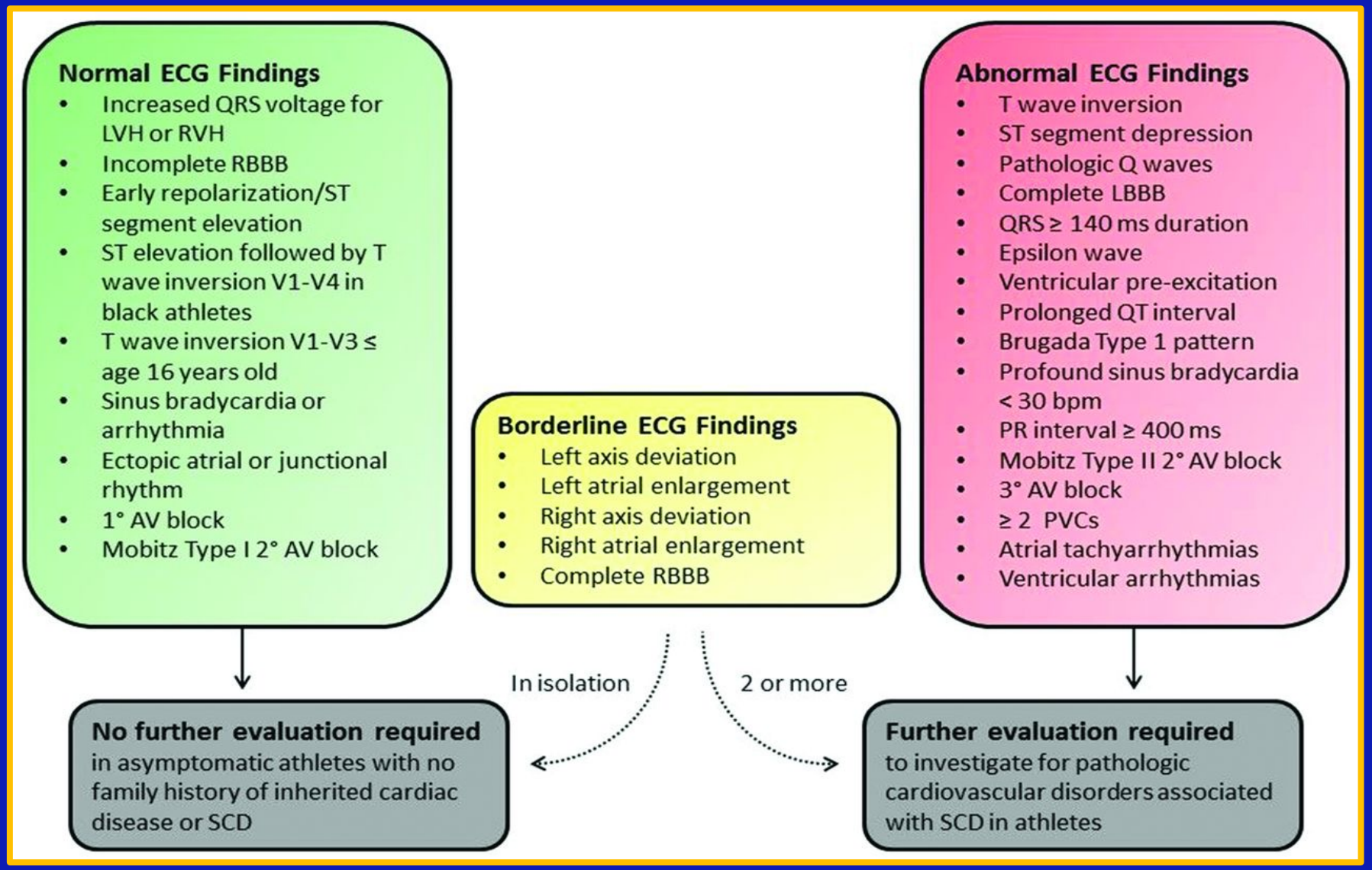
- New high-risk patterns
- Improved UW interpretation
- Computerized interpretation
- ? AI improved interpretation/prognosis estimation

(Gazette, Jean-Pierre Rivest)
Dr. Ross MacKenzie, cardiologist, and technician Debbie McKenzie give Pete Mahovlich an EKG.

Montreal Canadiens' Training Camp, Montreal Forum September 1973

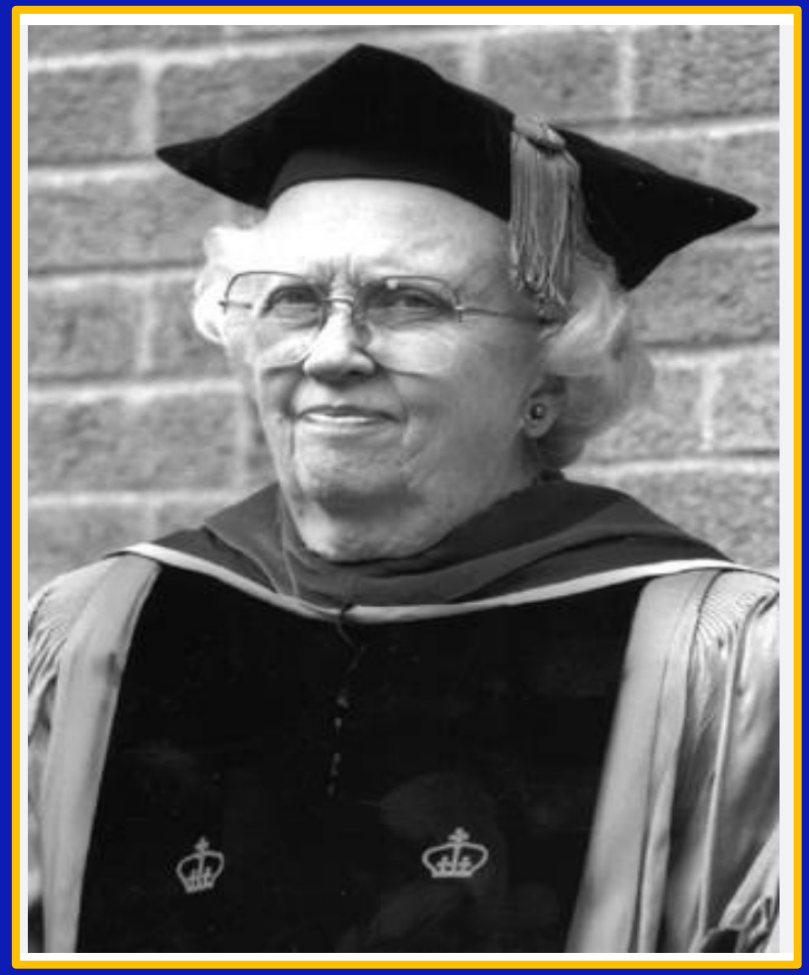
Source: Montreal Gazette's Sport's Section September 1973

Int'l Standards for EKG Interpretation in Athletes.

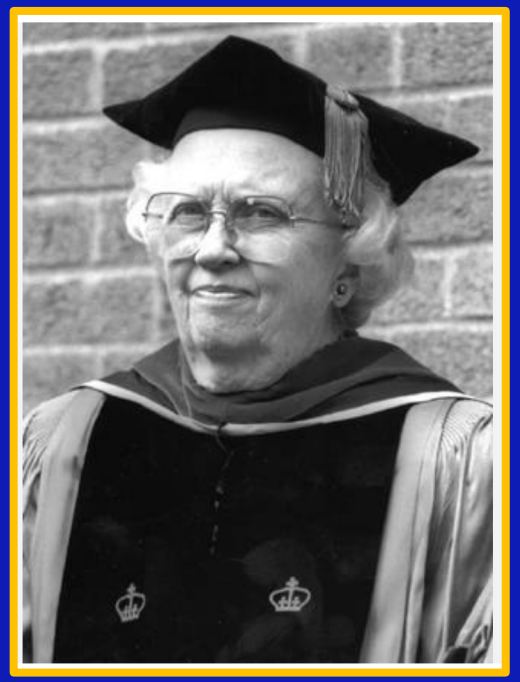


Drezner JA et al. Br J Sports Med 2017;51:704-731

Who is this?

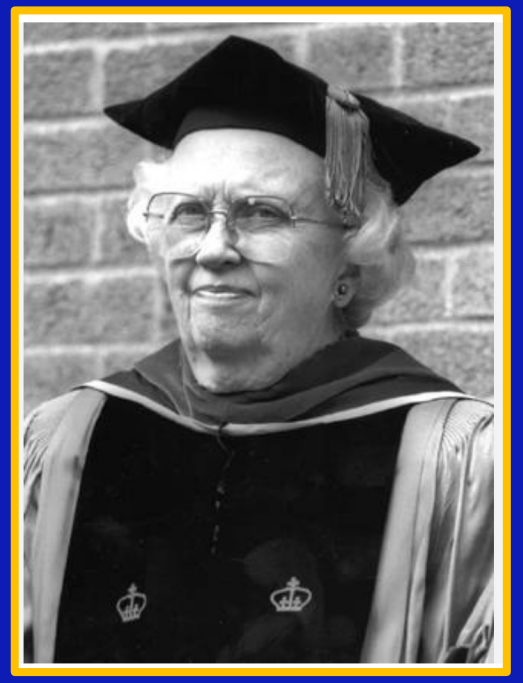


Who is this?



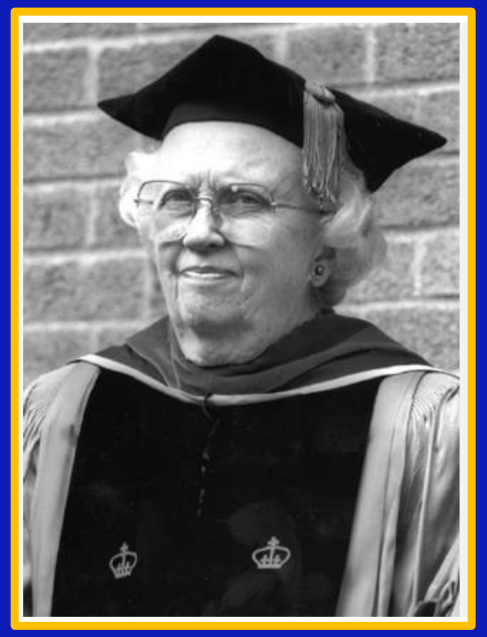
Dr. M. Irene Ferrer,
Director, ECG Laboratory,
Columbia-Presbyterian
Medical Center, N.Y.

Who is this?



M. Irene Ferrer, Director, ECG Laboratory, Columbia-Presbyterian Medical Center, N.Y.

M.D. Cardiologist, Metropolitan Life Insurance Company

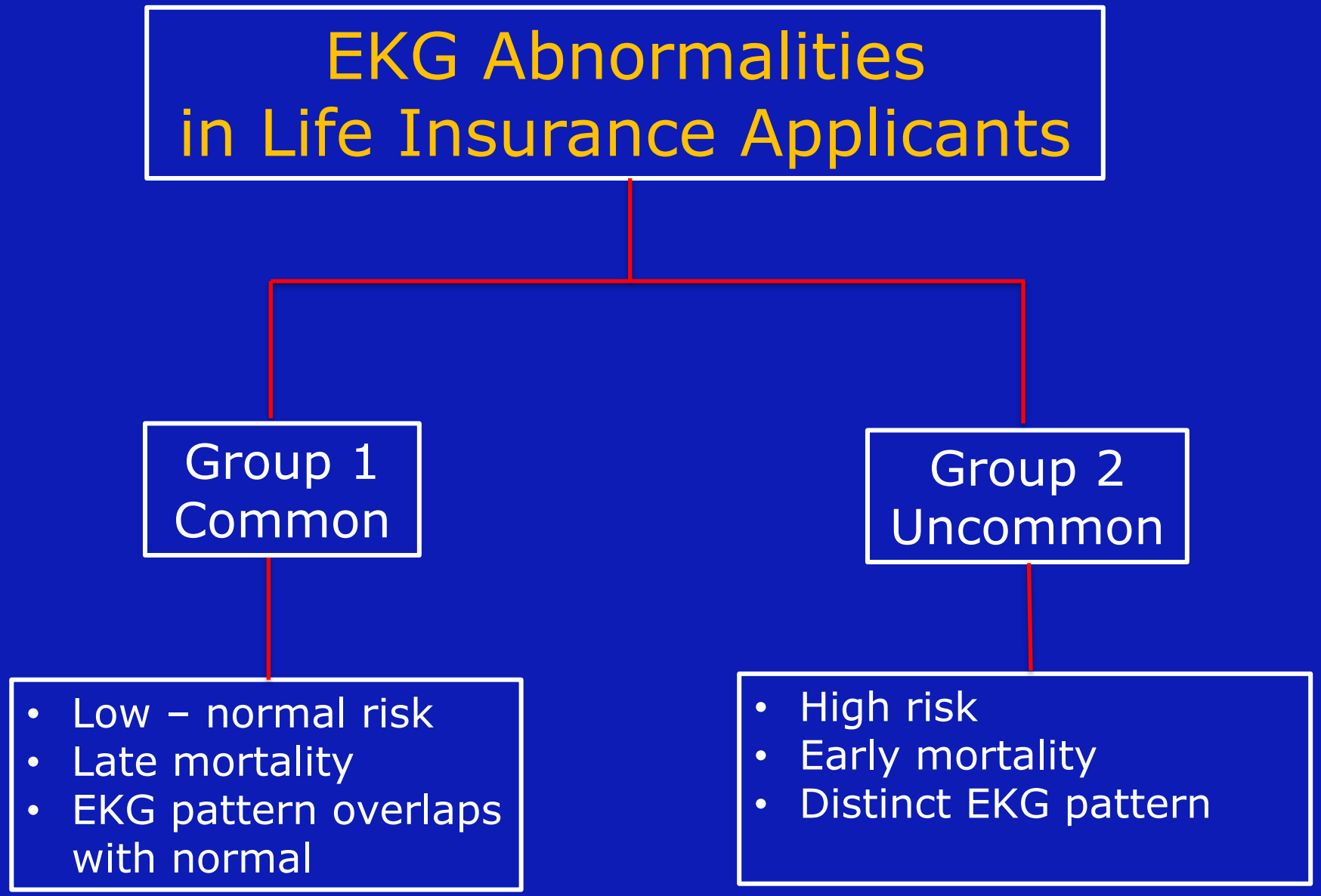


Ferrer MI.

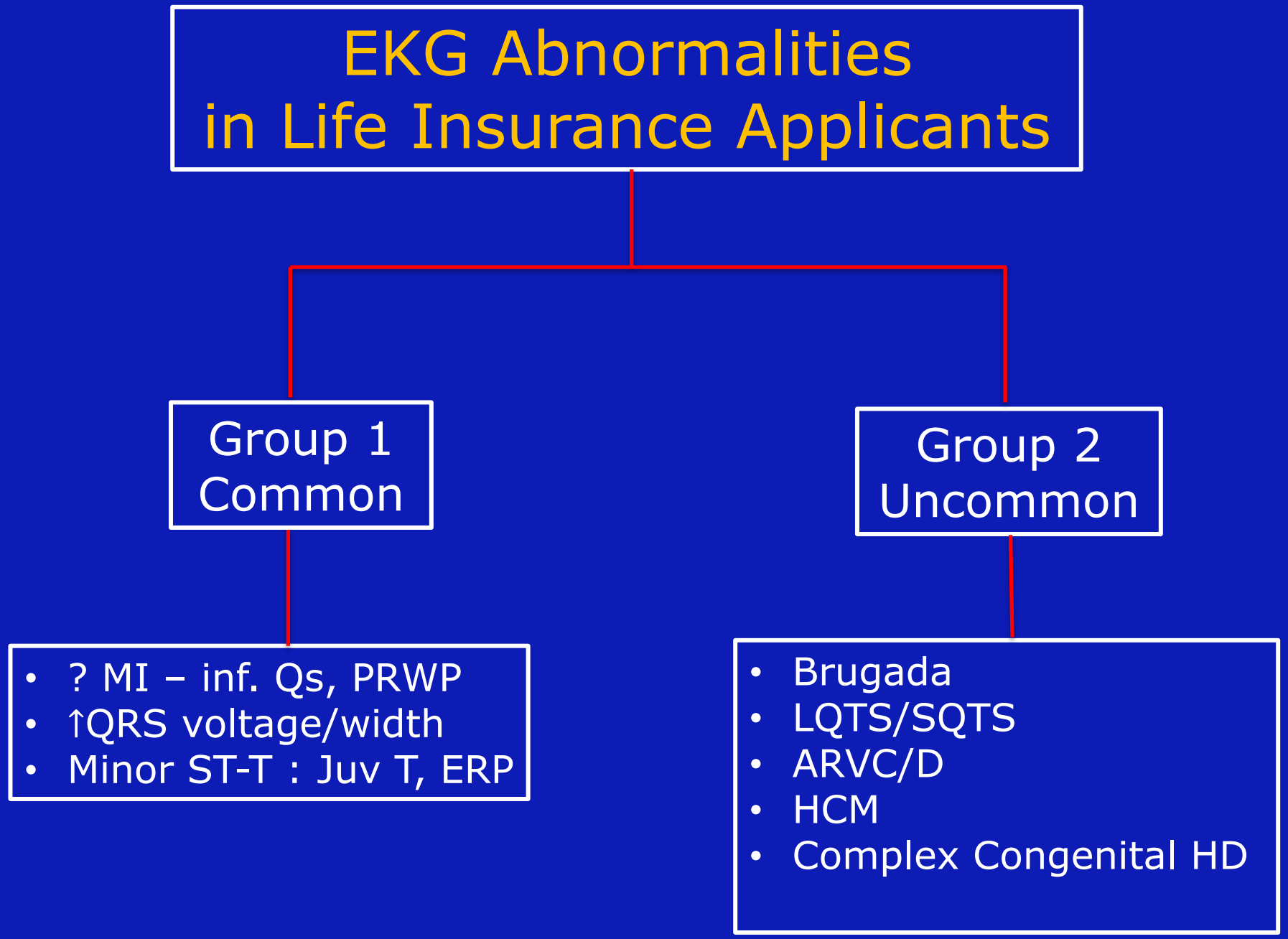
A Survey of 19,734 ECGs Obtained in Insurance Applicants

*J Insur Med (*1985) 16 (2):6-13.

EKG Abnormalities in Life Insurance Applicants



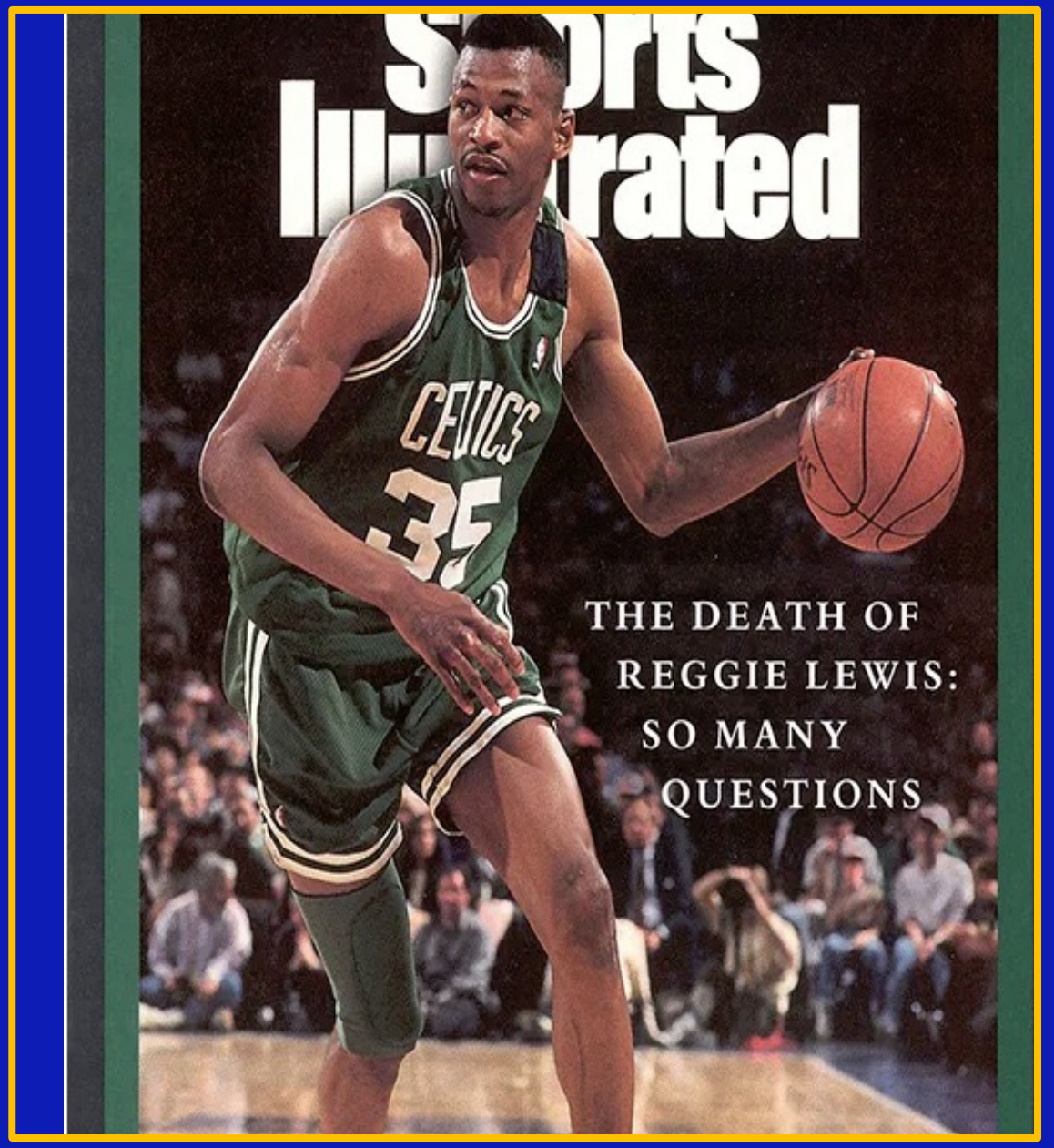
EKG Abnormalities in Life Insurance Applicants



Jumbo Cases

Sudden Death

Difficult Conversations

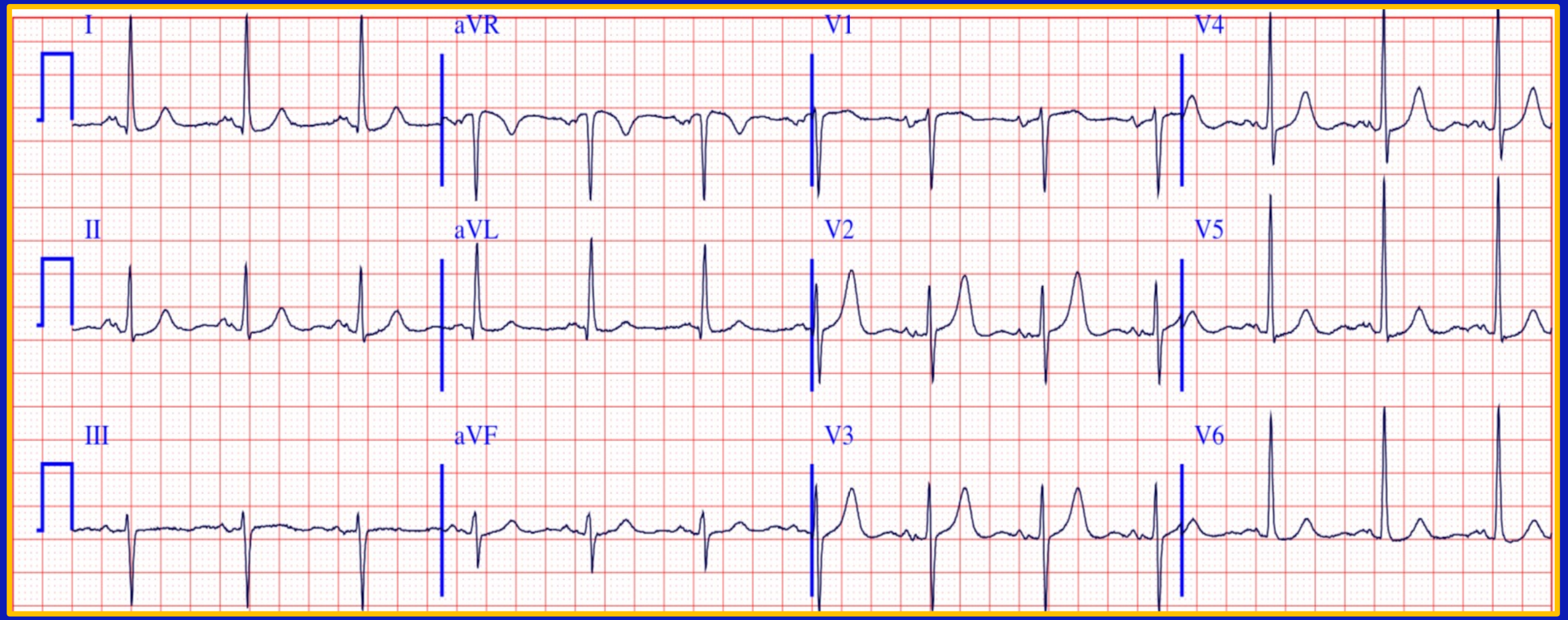


Advanced EKGs

Plan:

- Common EKG risk assessment dilemmas
- Uncommon EKG patterns with high mortality implications
- Focus on EKG morphology

62 y.o. woman with history of mild hypertension
Any concern about the lack of anti-hypertensive Rx?



Common ECG Criteria for the Diagnosis of LVH

Sokolow-Lyon voltage criteria

SV1 + RV5 or RV6 ≥ 3.5 mV (35 mm) (b)or RaVL ≥ 1.1 mV (11 mm)

Cornell voltage criteria

SV3 + RaVL ≥ 2.0 mV (28 mm) in men

SV3 + RaVL ≥ 2.8 mV (20 mm) in women

(some variations use a lower cutoff value in men)

Cornell product criteria

SV3 + RaVL (+8 in women) (a) x QRS duration ≥ 2,440 mm × ms

Romhilt-Estes point score system

(a score ≥ 5 is diagnostic of LVH, a score of 4 is "probable" LVH)

Voltage criteria (3 points):

Any S or R in limb leads ≥ 20 mm , SV1, SV2, RV5, or RV6 ≥ 30 mm

ST-T wave changes of LVH (3 points, 1 point on digitalis)

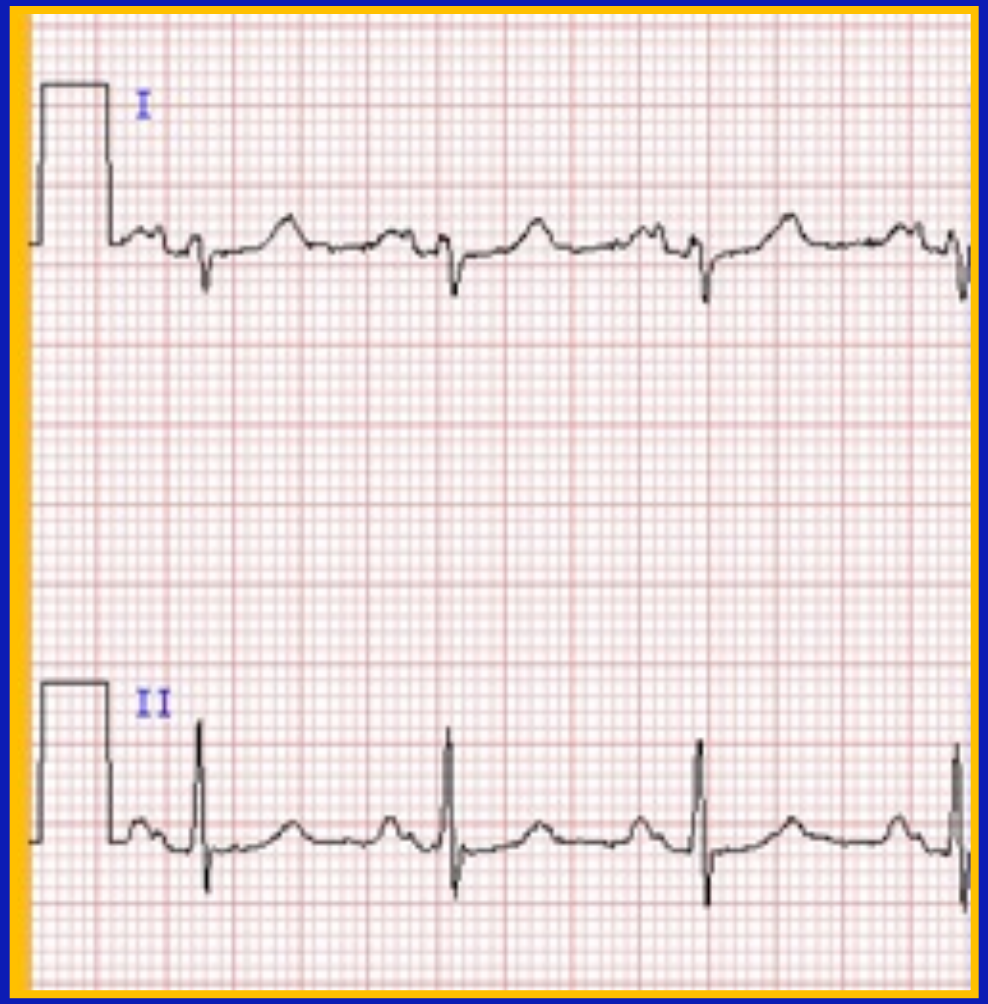
Left atrial abnormality (3 points):Terminal component of the P wave in V1 ≥ 1 mm and ≥ 40 ms

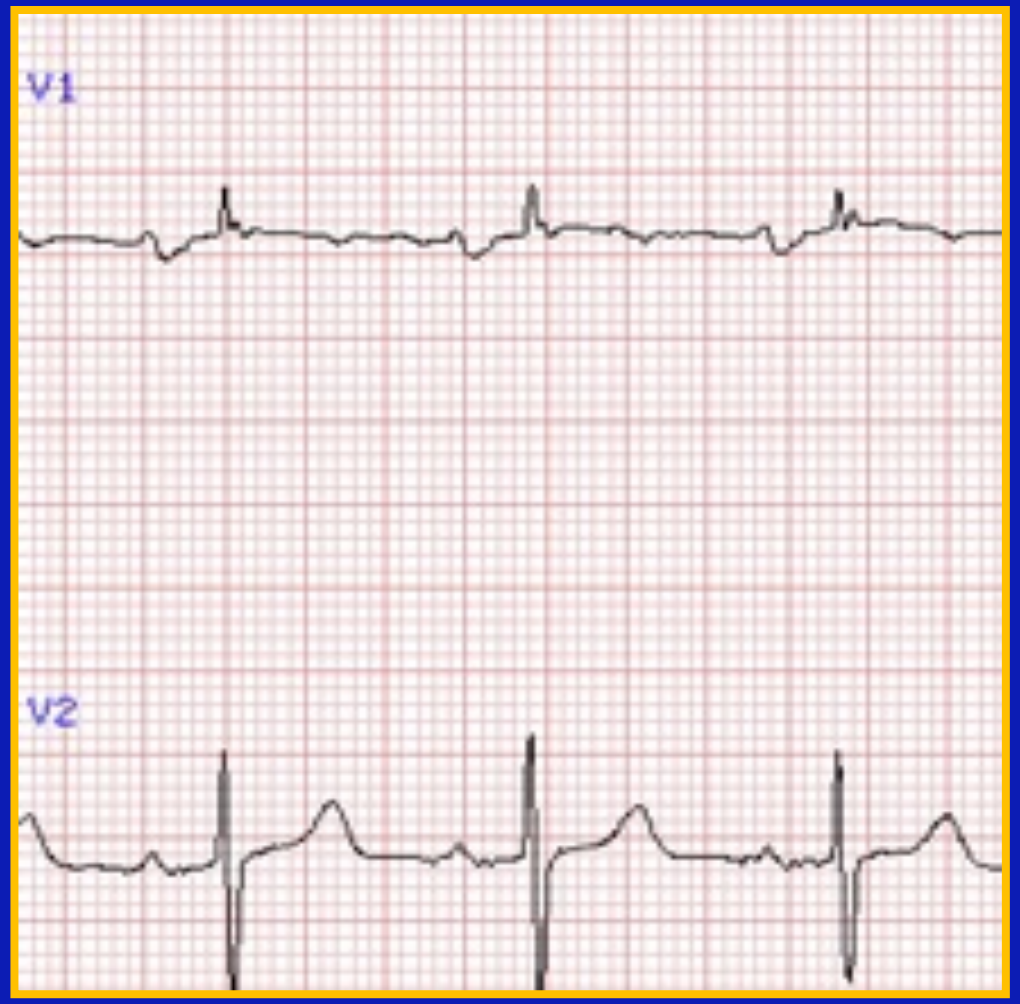
Left axis deviation (2 points):QRS axis of –30 degrees or more negative

Prolonged QRS duration (1 point):

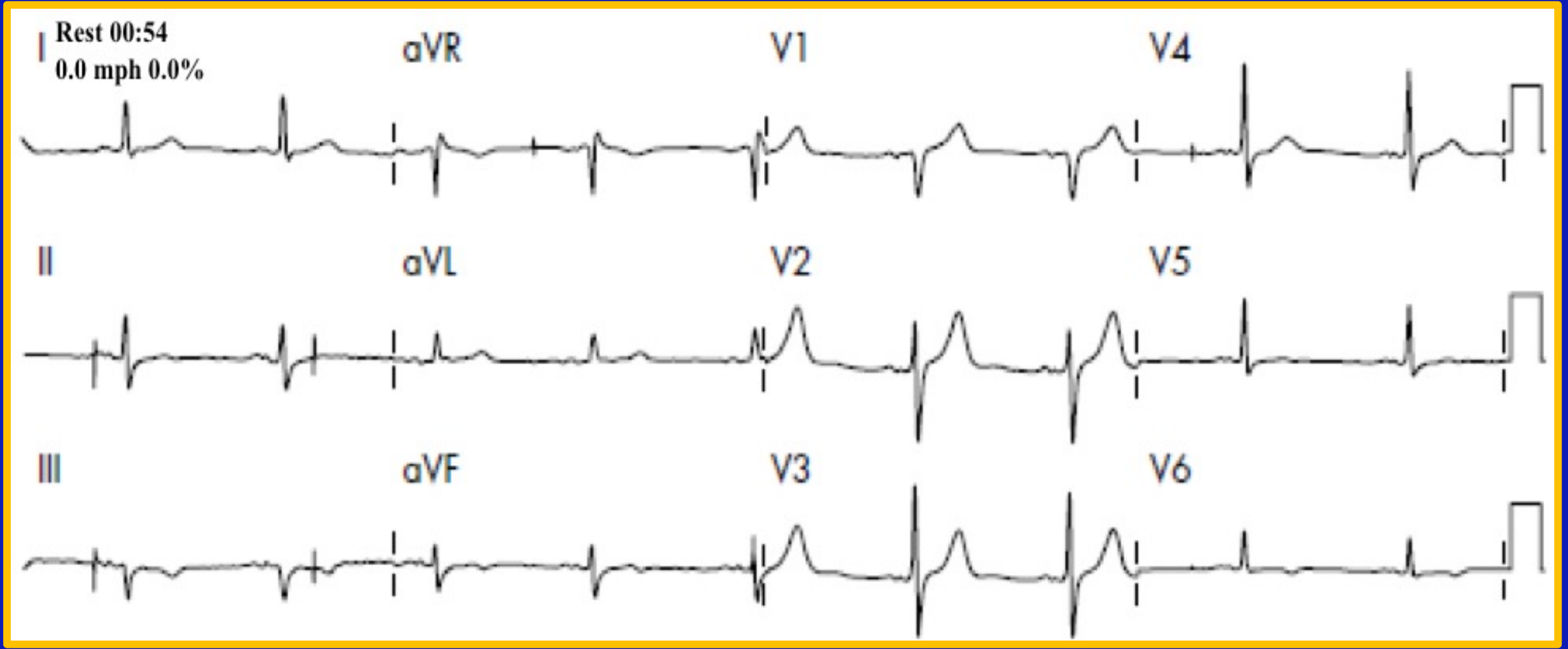
≥ 90 ms Delayed intrinsicoid deflection time (1 point): ≥ 50 ms in V5 or V6

Left Atrial Abnormality – P Mitrale

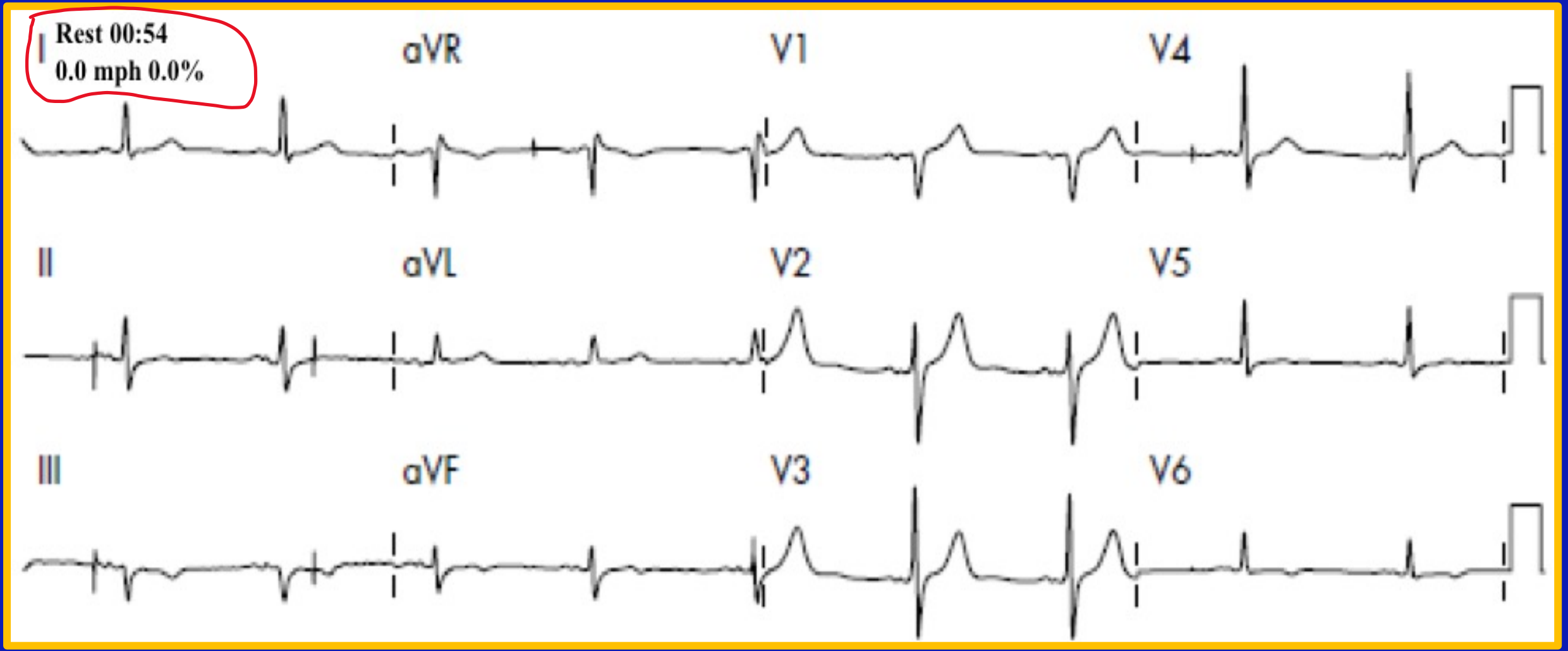




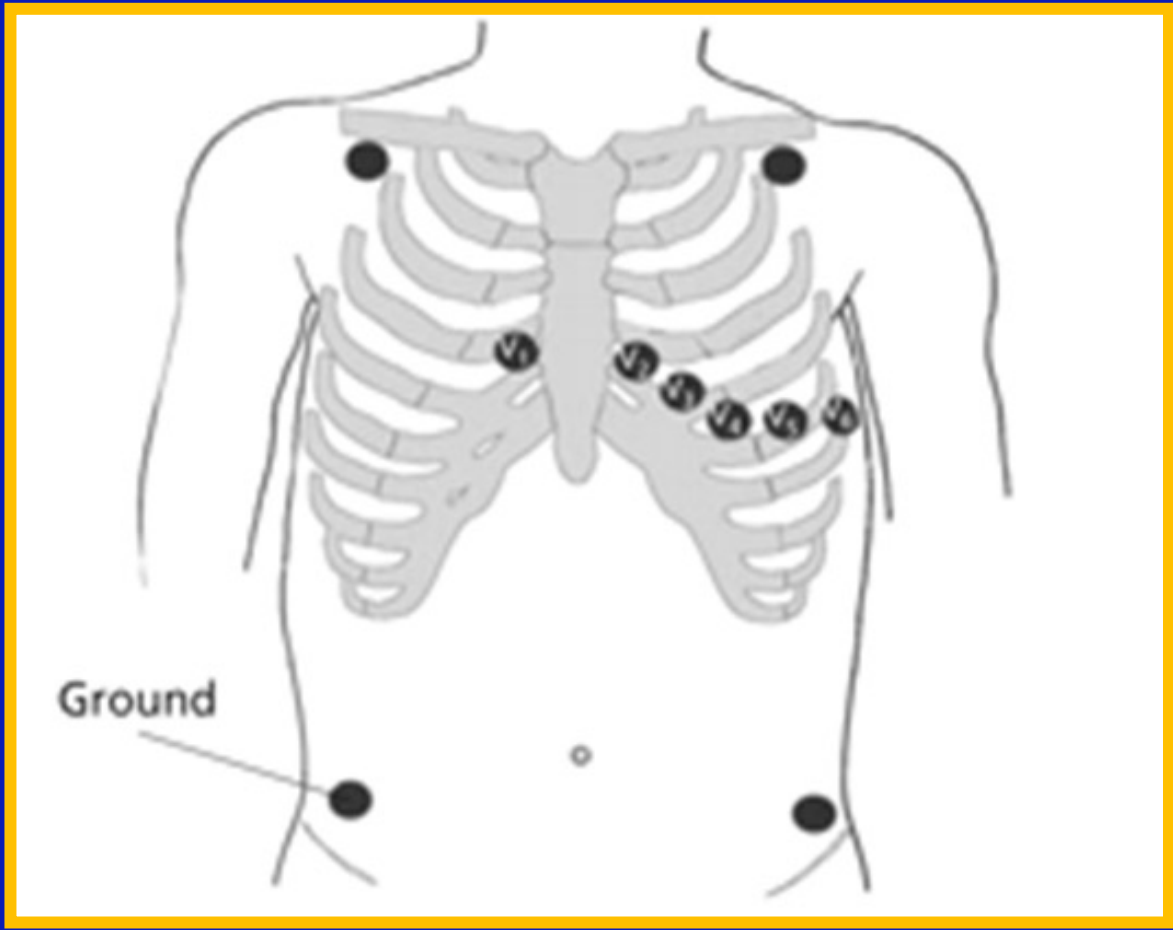
55 y.o. male applicant – MIB Code12A: inf. Q waves



55 y.o. male applicant – MIB Code12A: inf. Q waves



Mason Likar Ex. ECG Electrode Placement Configuration

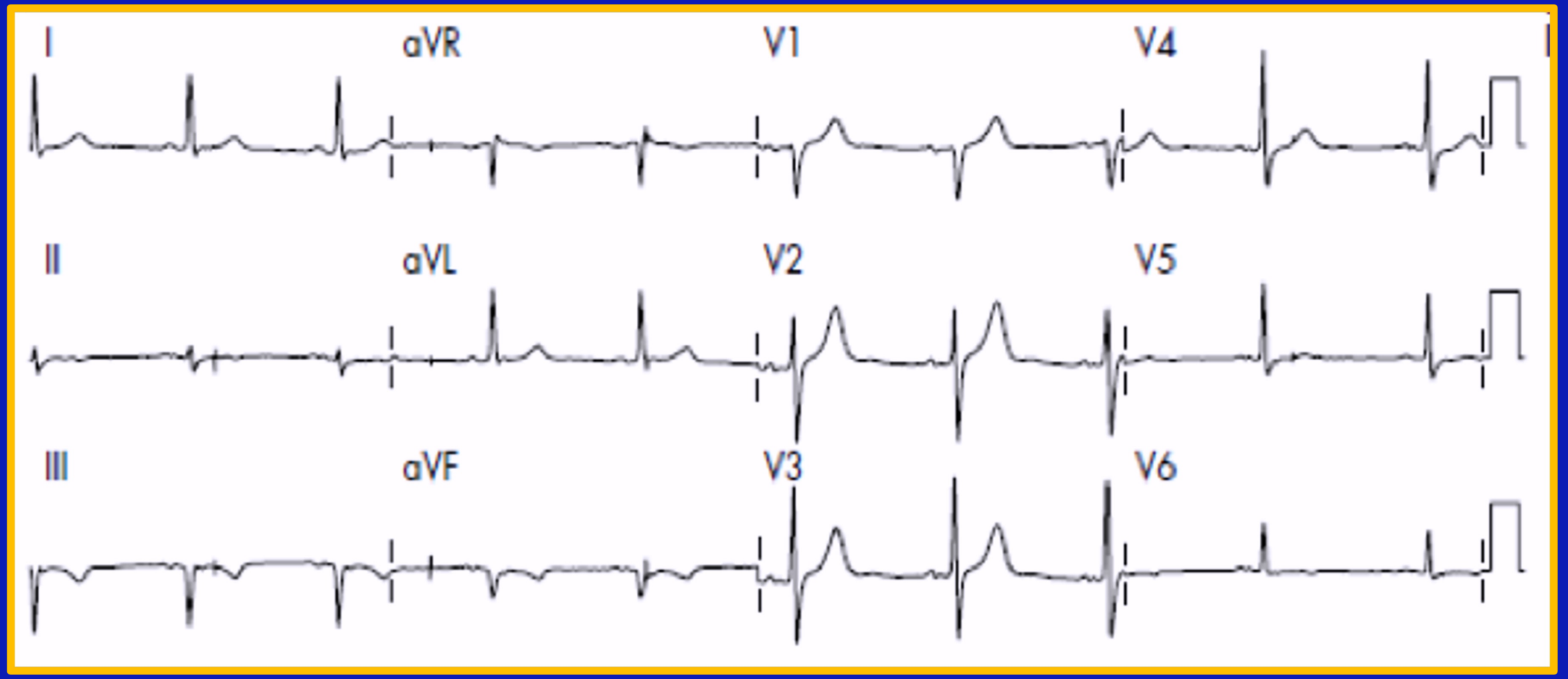


Mason Likar Exercise ECG Lead Modification

Results in:

- Right axis shift
- Increased voltage in the inferior leads
- May produce loss of inferior Q waves and development of new Q waves in AVL
- Body torso positions should not be used to interpret a diagnostic resting 12-lead ECG

Standard ECG Showing Previous Inferior MI



A 41 y.o. male applicant

A 59 y.o. female applicant

A Recent EKG Mystery

- Late 2022 – occasional bizarre EKGs

A Recent EKG Mystery

- Late 2022 – occasional bizarre EKGs
- Recently 3 identical EKGS on diff. applicants

A Recent EKG Mystery

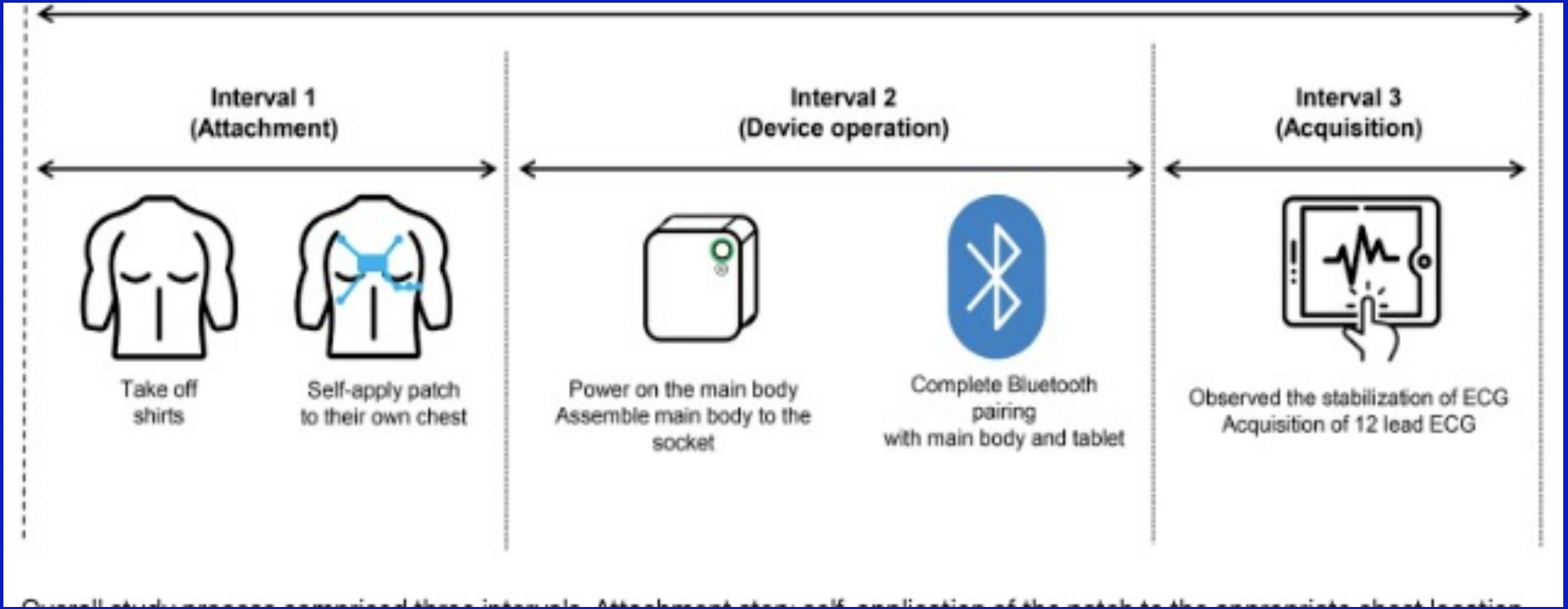
- Late 2022 – occasional bizarre EKGs
- Recently 3 identical EKGS on diff. applicants
- Recorded by same paramed company

A Recent EKG Mystery

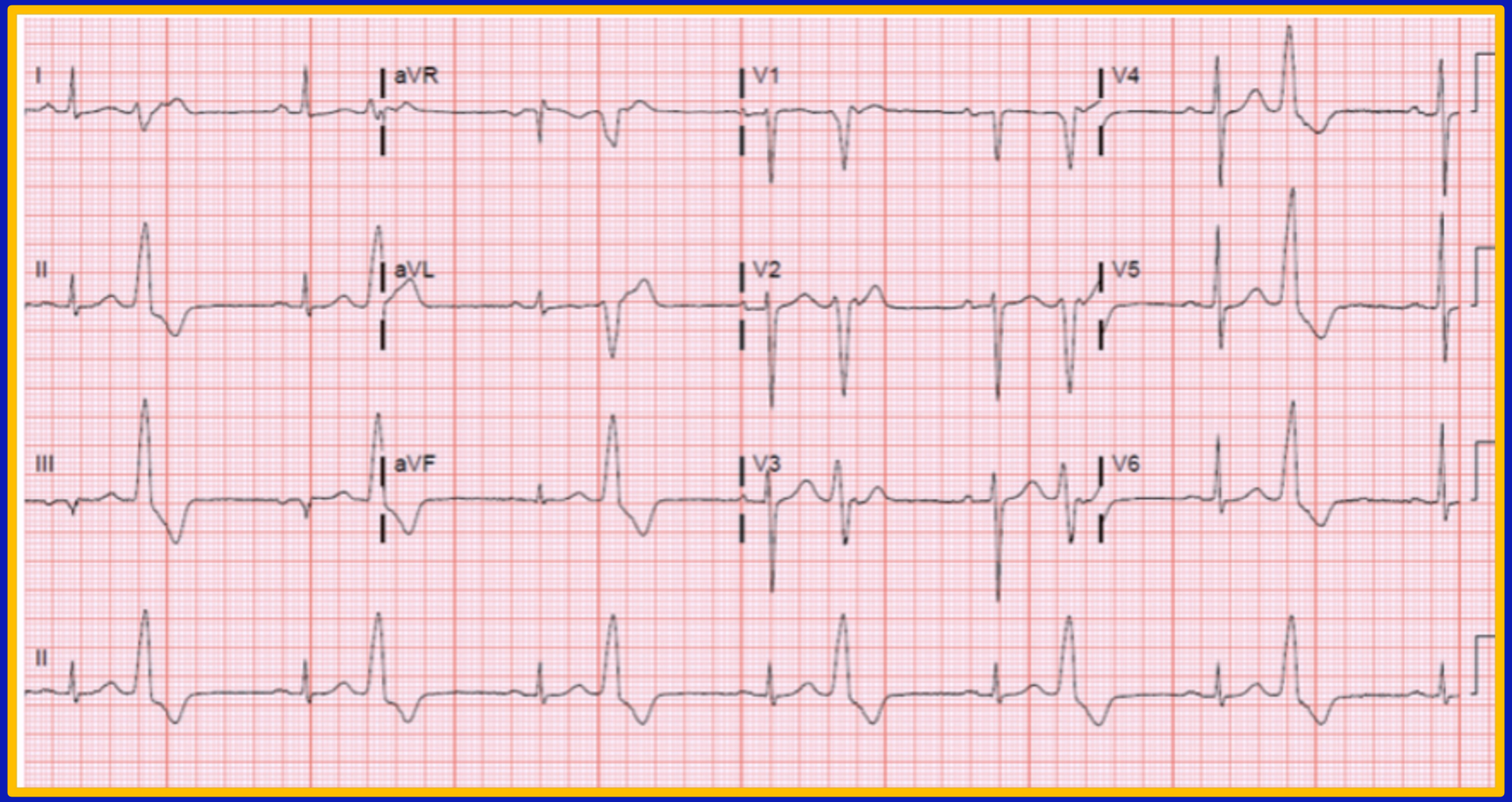
- Late 2022 at Gen Re – occasional bizarre EKGs
- Recently 3 identical EKGS on diff. applicants
- Recorded by same paramed company
- Machine-made EKGs from the demo mode saved in their portable ECG machines.

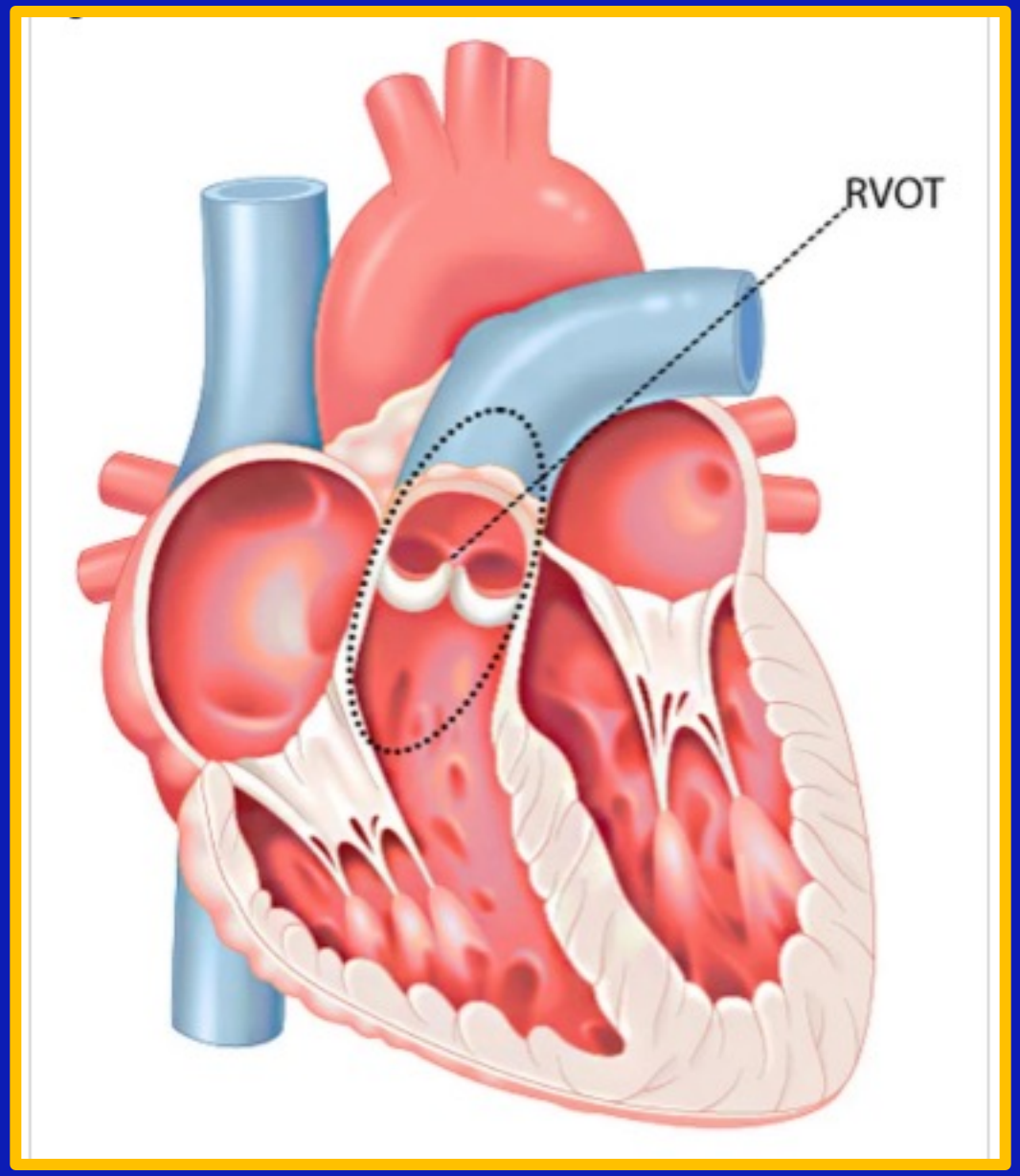
Paul Higgins. Gen Re Knowledge Center Blog Sept 21, 2023

Wireless Portable EKG Recording – Demo Mode

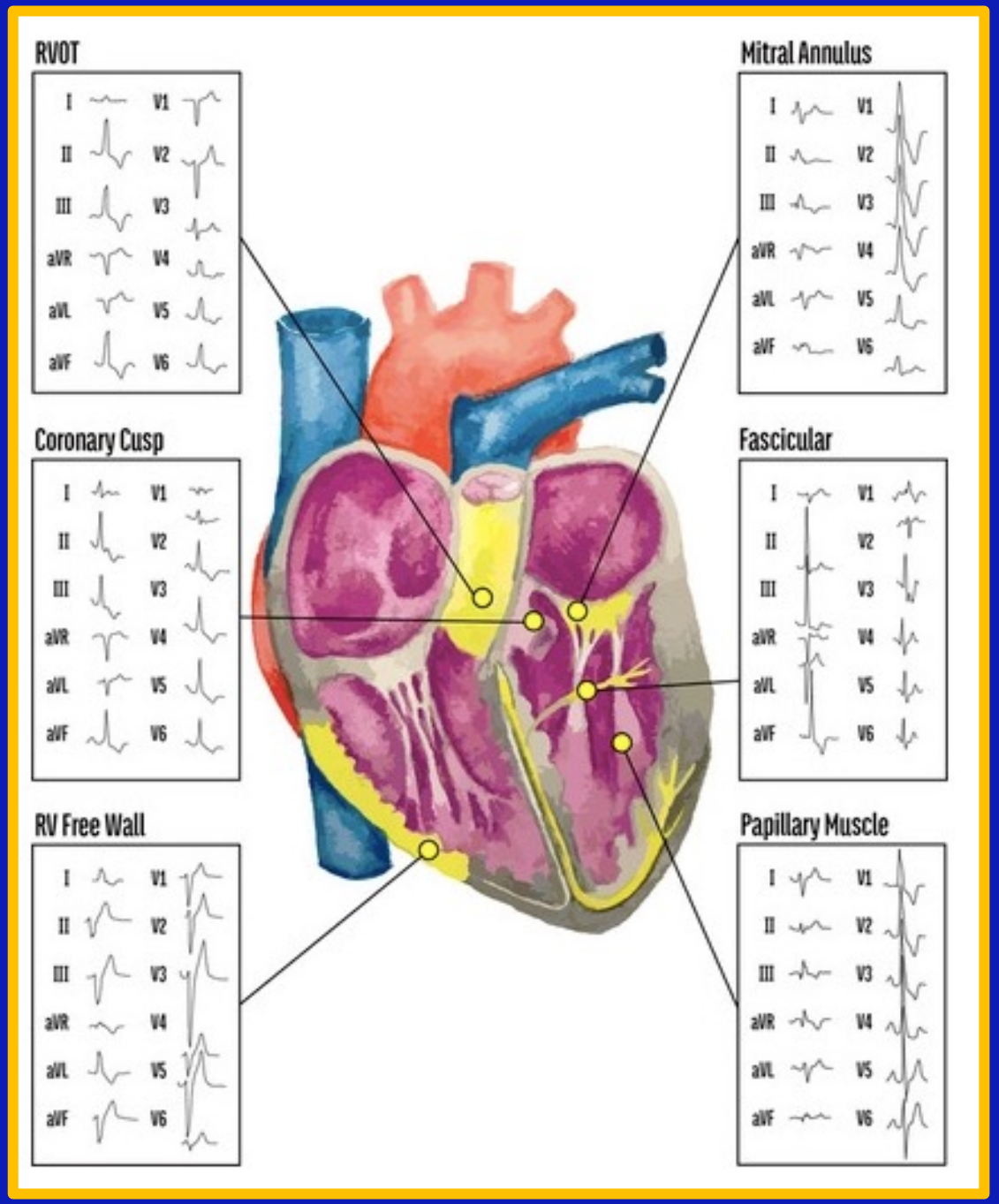


45 y.o. female with history of palpitations
"Boom Boom Pause Rhythm"




RVOT

Common locations of PVCs

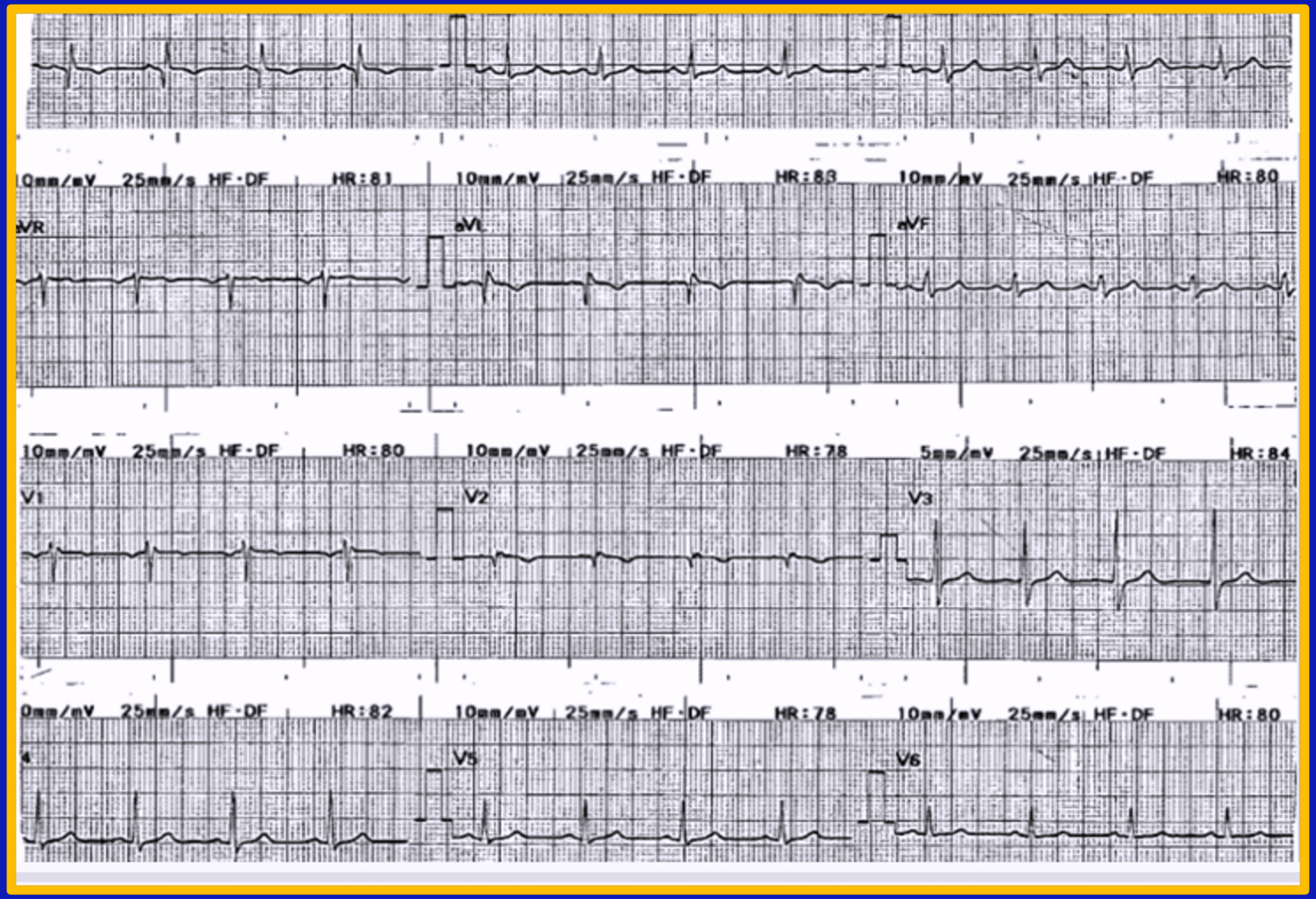


Factors Pointing to a Worse Prognosis

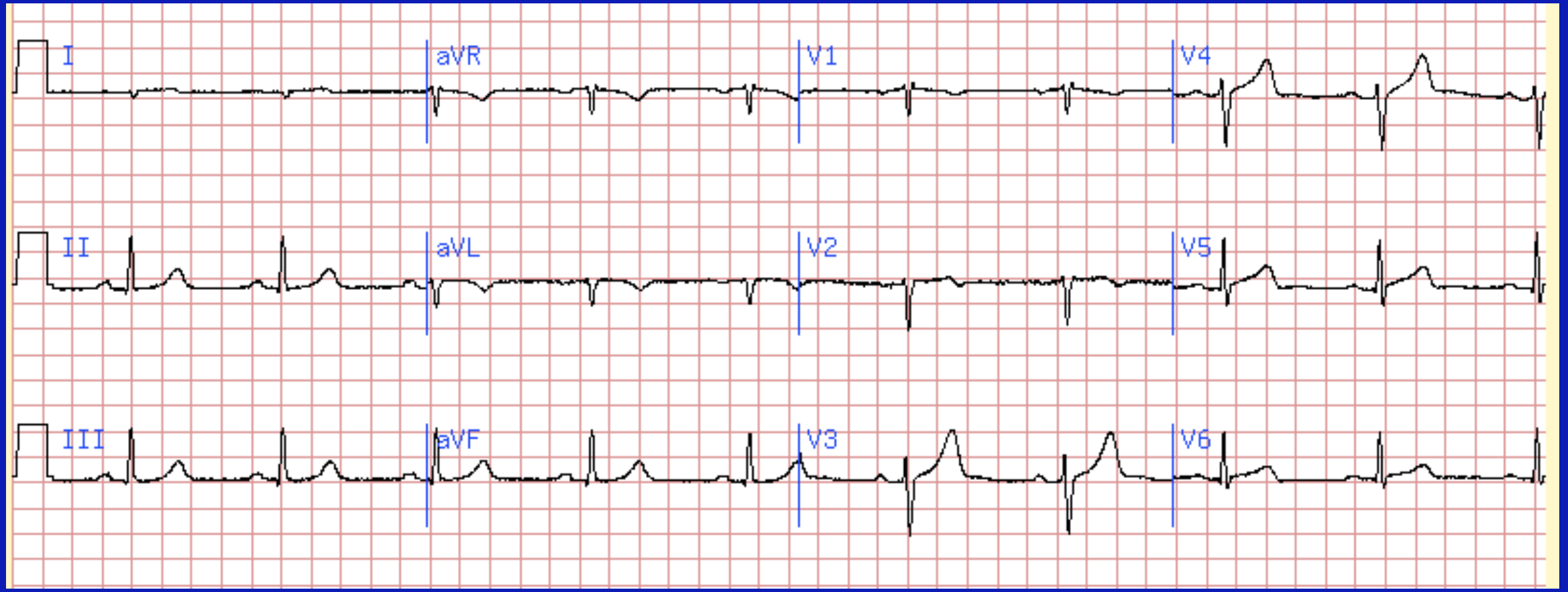
- Syncope, FH of SD
- Underlying HD
- Burden – number or percent
- Origin - non-outflow tract
- Complex PVCs - couplets, triplets, non-sustained VT, “R-on-T”
- Increasing PVCs with exercise

? Origin of this flag …. and why is it special?

50 y.o. male applicant – awaiting APS
Technical error?

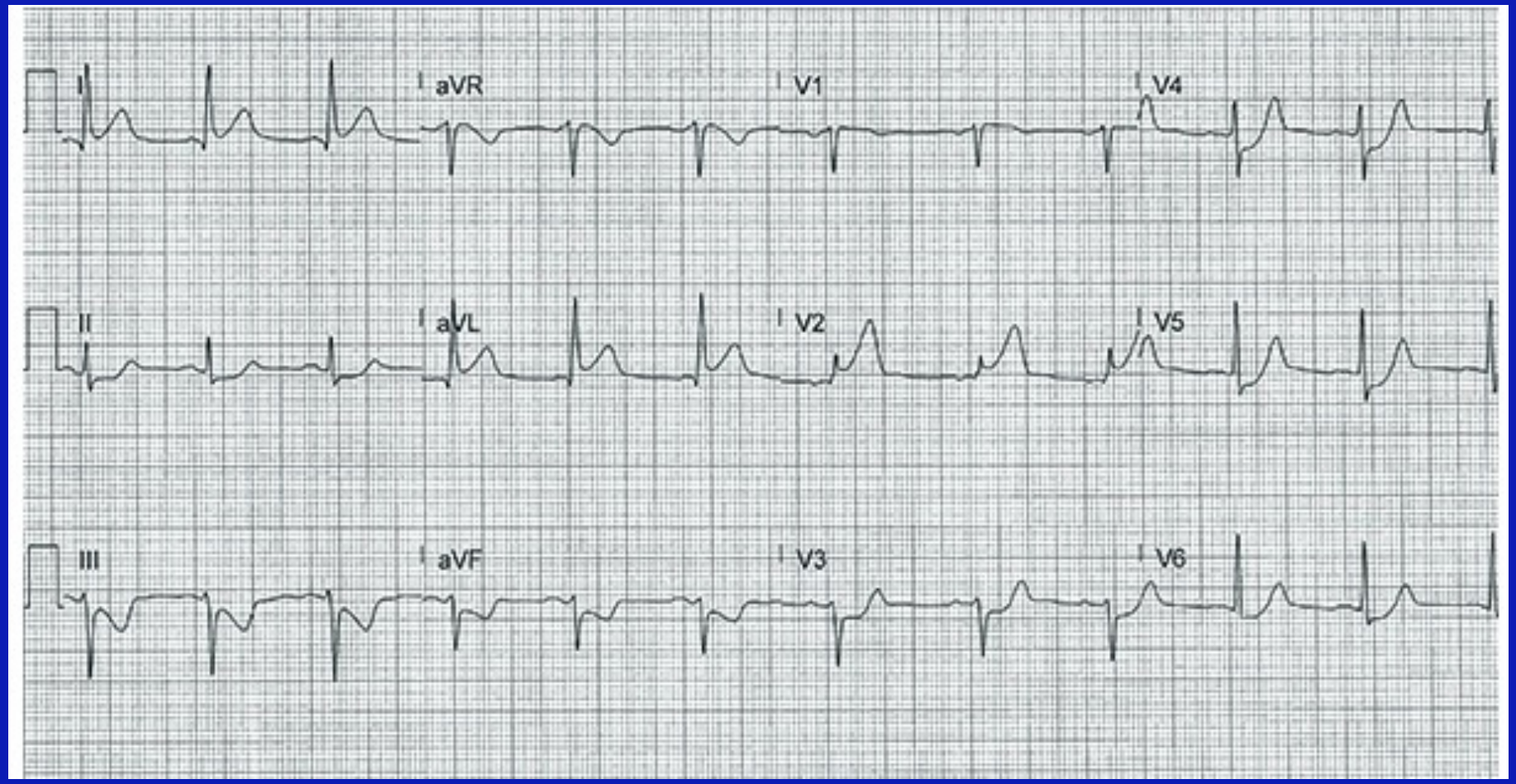


50 y.o. male applicant – awaiting APS
Technical error?

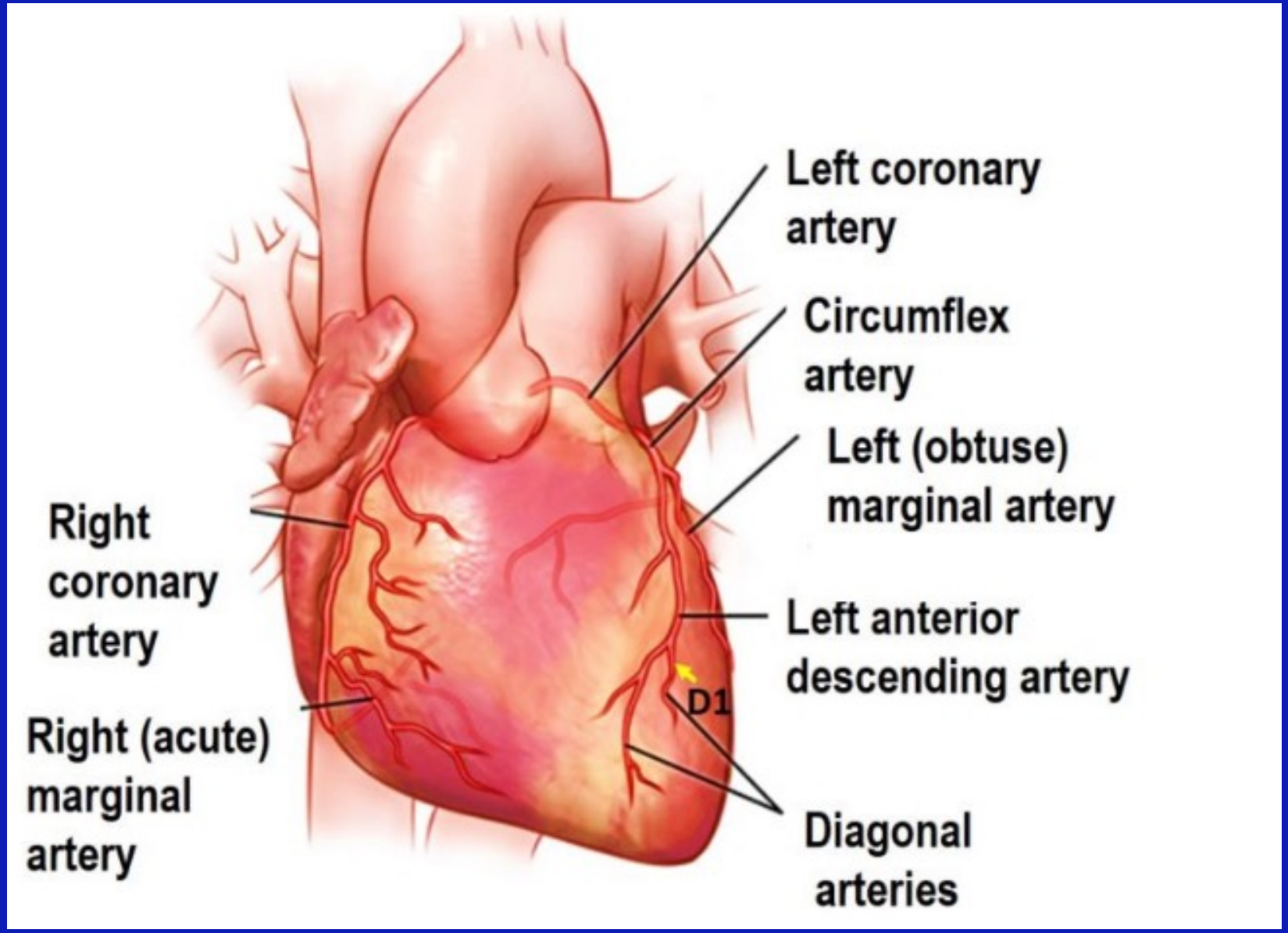


ECG One Year Ago – what do you think?

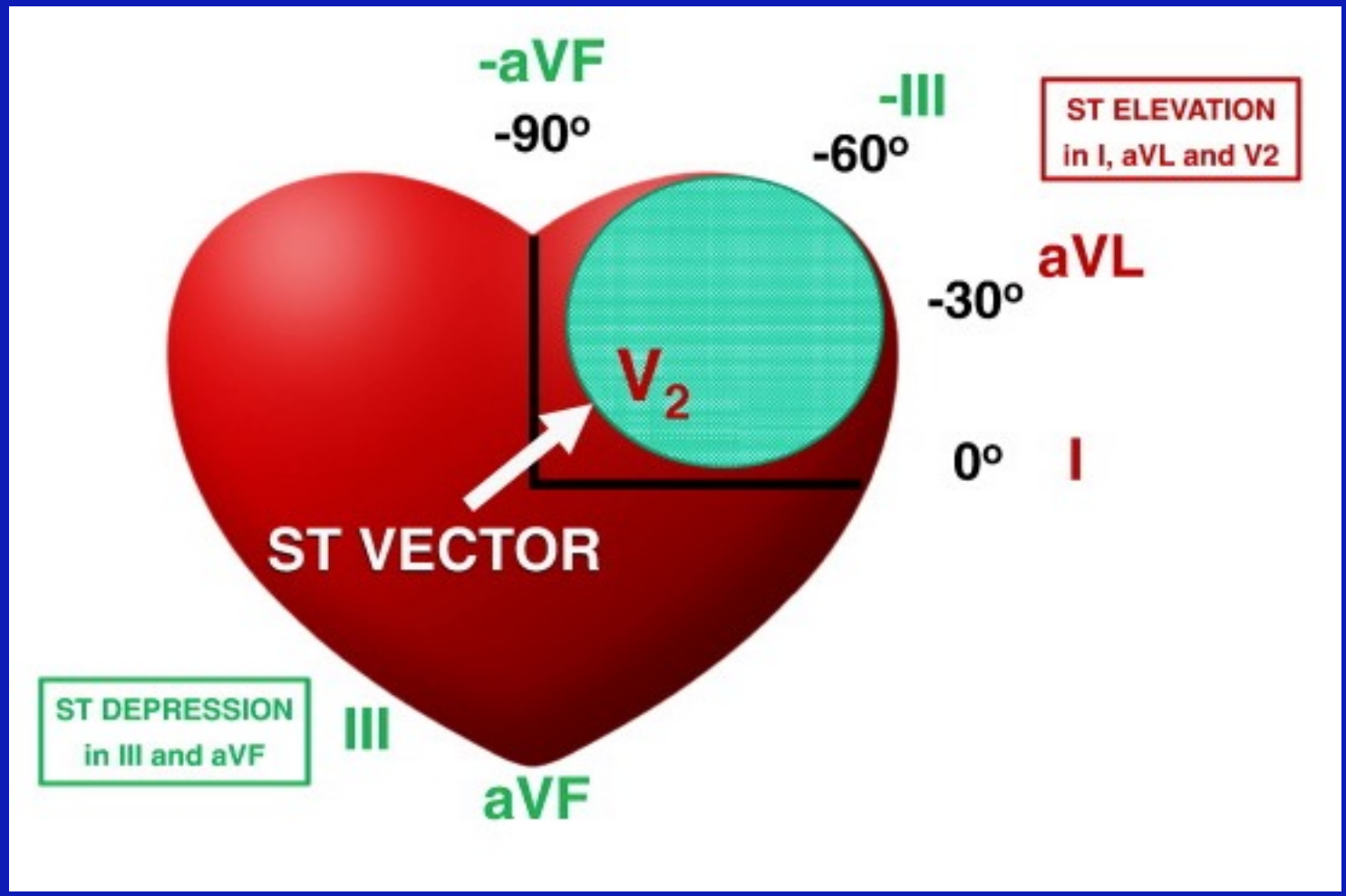
?



Diagonal Branches of LAD Coronary Artery



ST Vector in High Lateral Myocardial Infarction



Littmann L. AJEM. 2016; 34:107-109.

South African Flag ECG Sign – Acute High Lateral MI

SOUTH AFRICAN FLAG SIGN

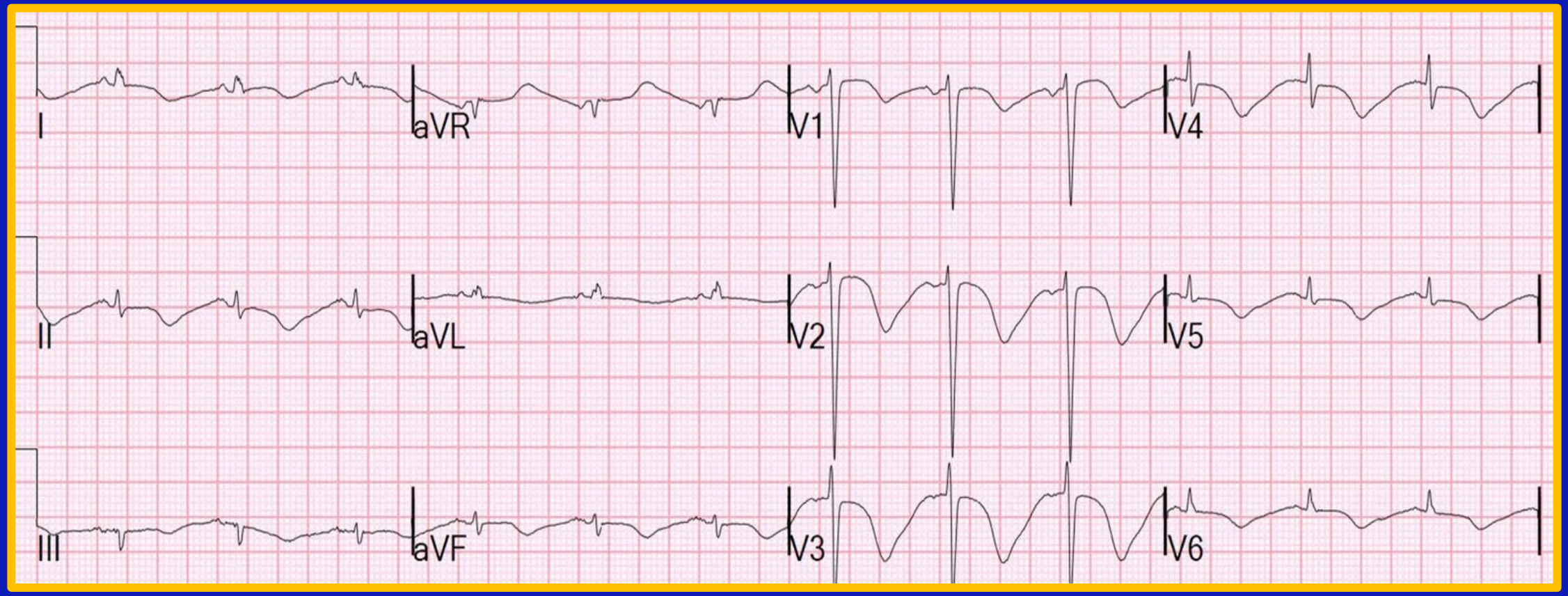
ST ELEVATION IN LEADS I, aVL AND V_2

ST DEPRESSION IN THE INFERIOR LEADS

39 y.o. female bank branch manager

- Asymptomatic, normal exercise ECG, normal echocardiogram, no meds
- One year ago during bank robbery threatened with gun
- Severe anxiety attack – taken to ER
- Abnormal ECG – admitted to hospital

Emergency room ECG one year ago



Investigations in hospital:

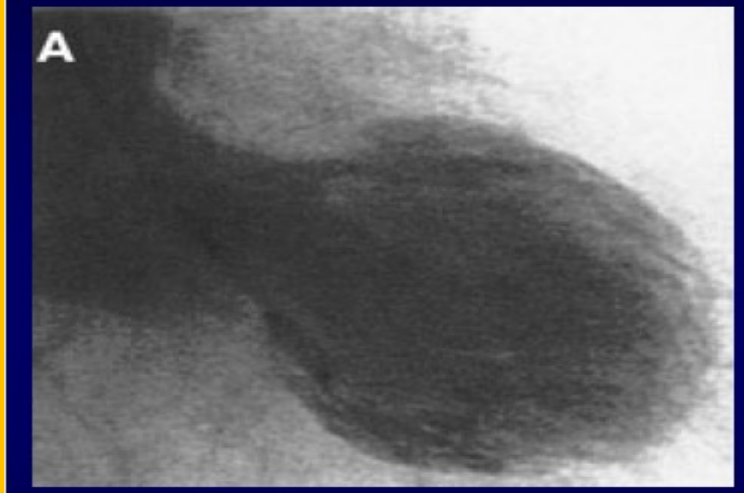
- Cardiac enzymes: borderline troponin
- Echo: apical wall motion abnormality
- Coronary angiography: normal
- LV angiography: apical ballooning

Takotsubo (Tah Ku Su Bu) Cardiomyopathy

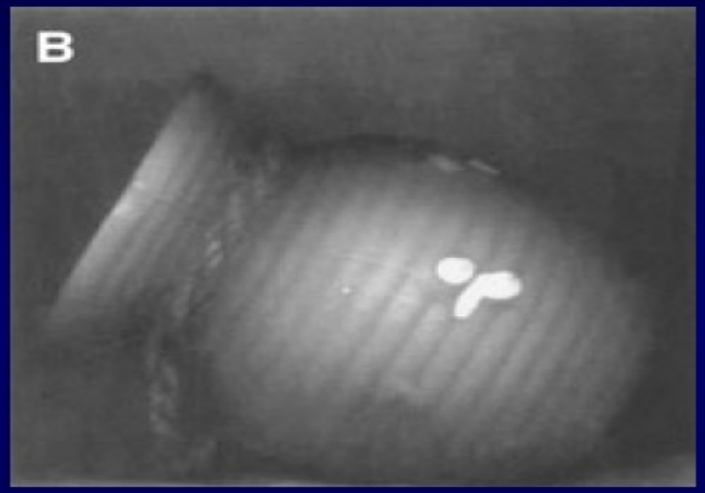
- AKA: stress CM, broken heart/apical ballooning syndrome
- Unique reversible cardiomyopathy
- Catecholamine mediated myocardial stunning
- Neurogenic or CNS/CVA T-wave pattern

“Tah Ku Su Bu”

Tako-tsubo cardiomyopathy



Systole



Tako-tsubo

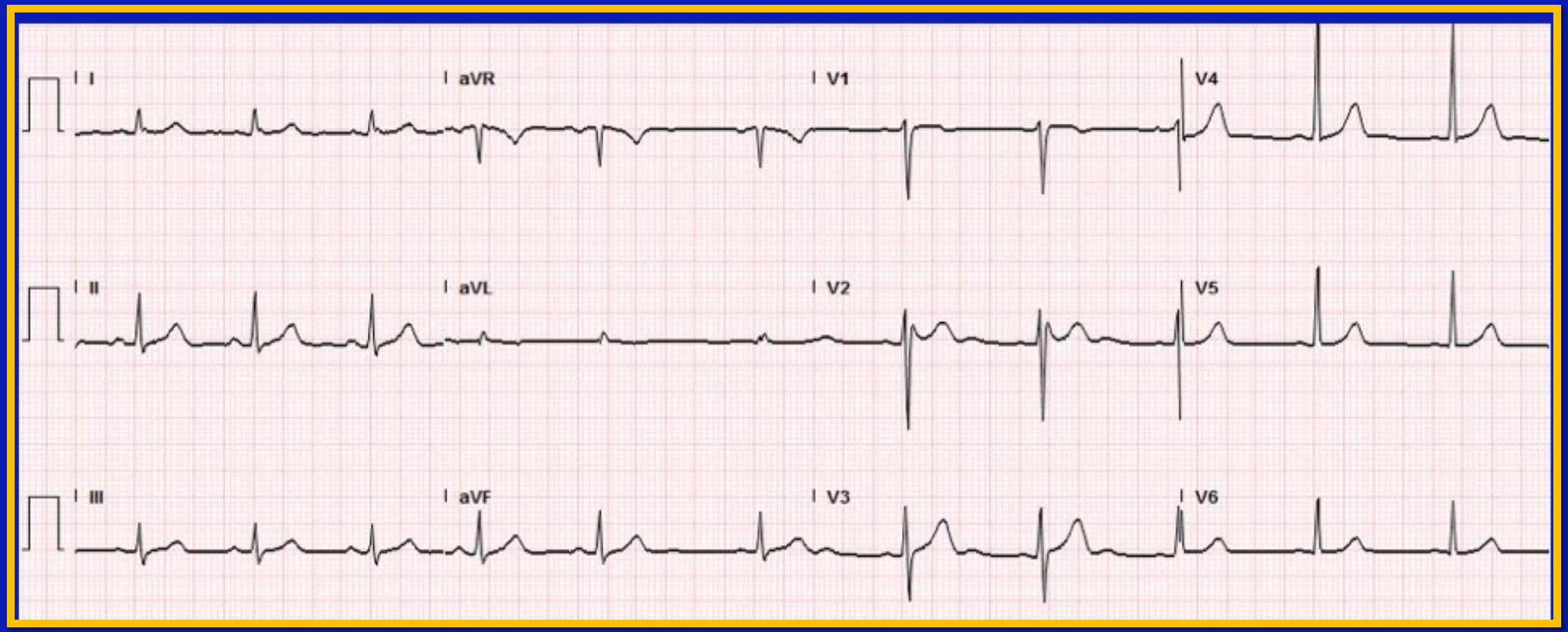
Octopus – fishing pot

Takotsubo Cardiomyopathy Mortality Implications

- Resembles acute MI but normal CAs and ↓ LVEF
- Early data: good to excellent prognosis
- Recent data = increased overall mortality
- Primary and secondary types
- Prognostic factors: gender, 1^{ary} vs 2^{ary}, trigger, severity of presentation, diabetes

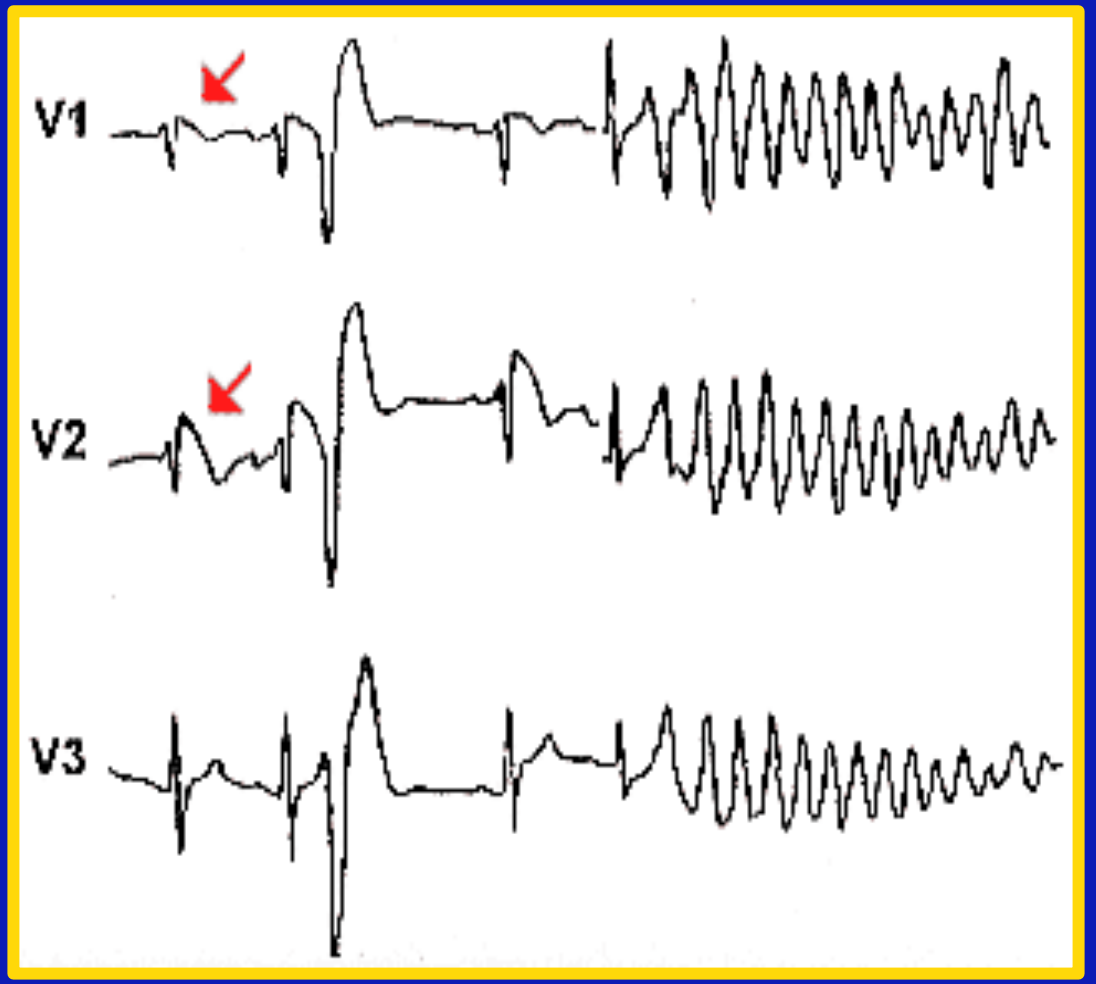
Mamaladze T. J Insur Med, Summer 2018

52 y.o. owner of a popular Thai restaurant
Any concerns?



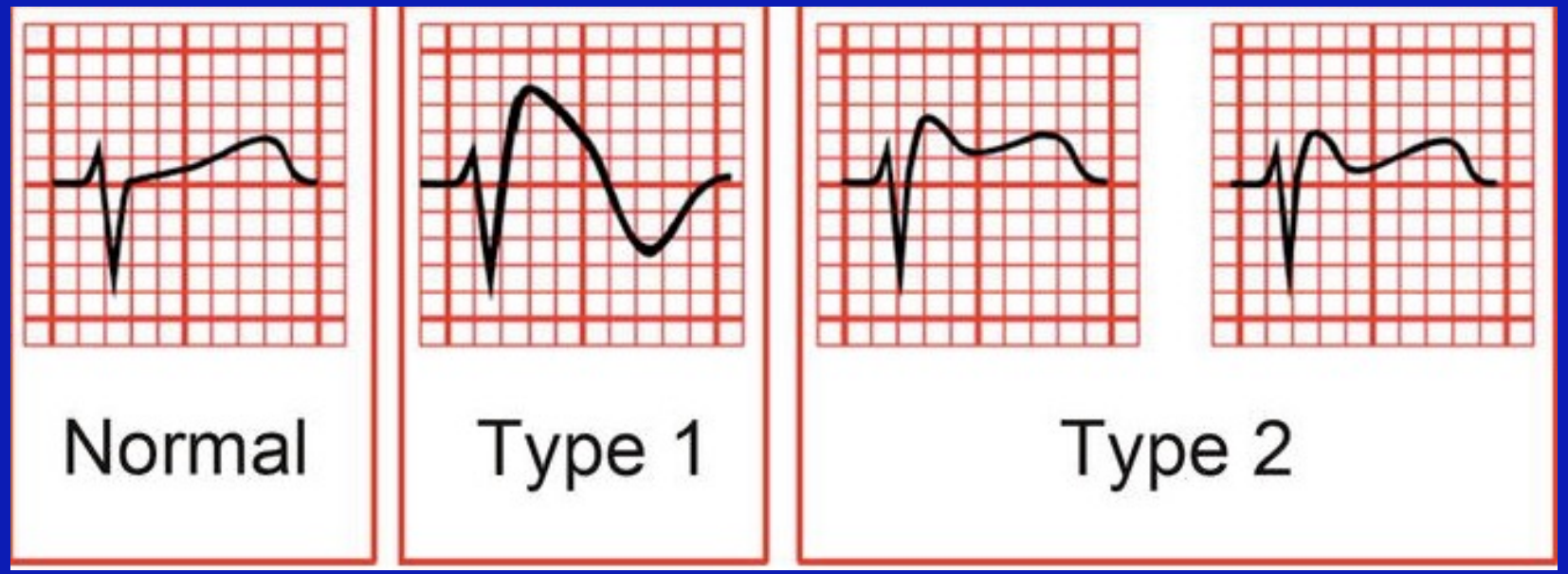
Brugada Syndrome

- A clinical and ECG syndrome
- A very specific ECG: apparent RBBB + ST elevation in leads V1-V3
- No demonstrable structural heart disease
- Prone to sudden unexpected death




LUCID
Ross MacKenzie
LUCID
Kevin Somerville

Brugada “saddleback” EKG Pattern



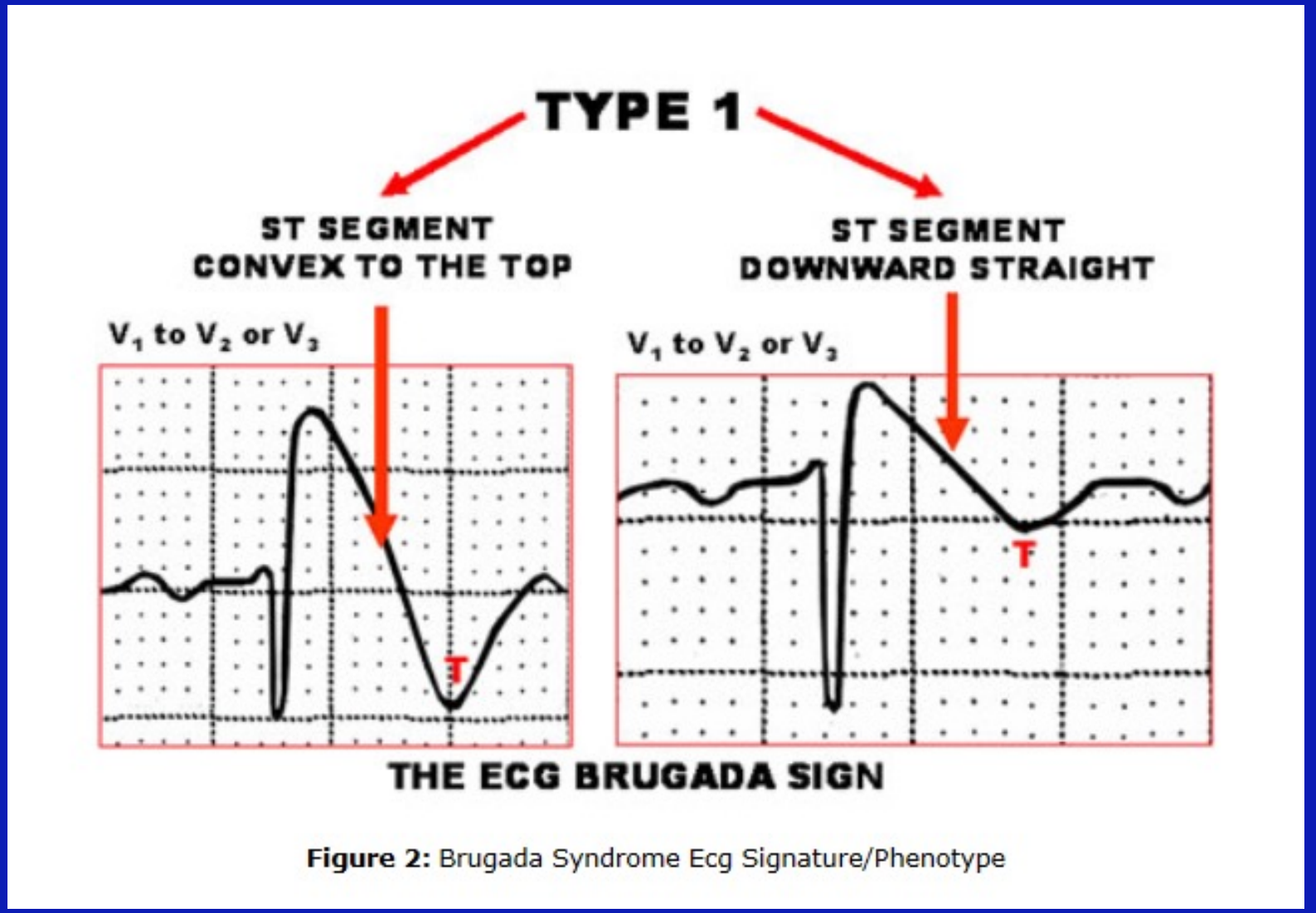
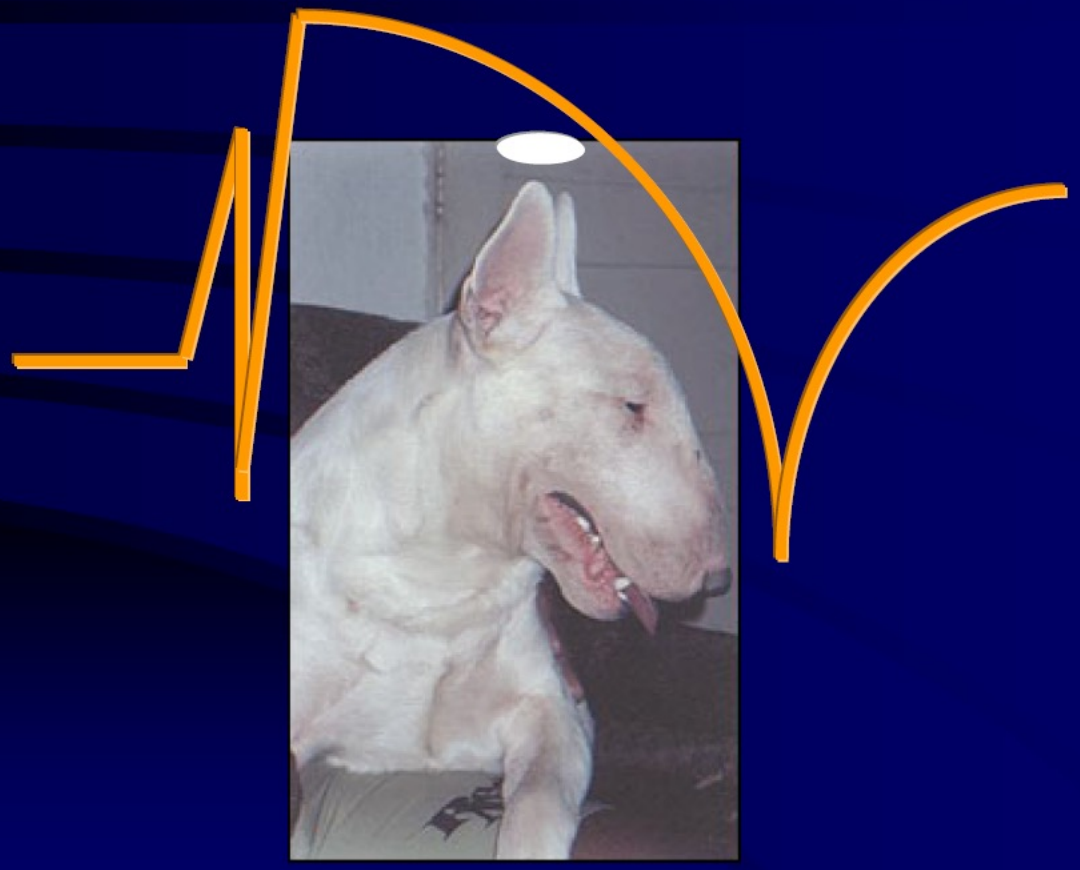


Figure 2: Brugada Syndrome Ecg Signature/Phenotype

http://www.fac.org.ar/qcvc/llave/c053i/perezriera.php

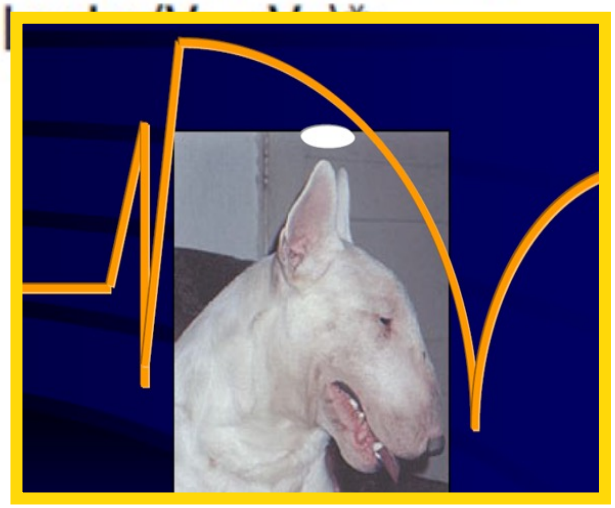
"BULL TERRIER" OR TYPE IA BRUGADA PATTERN



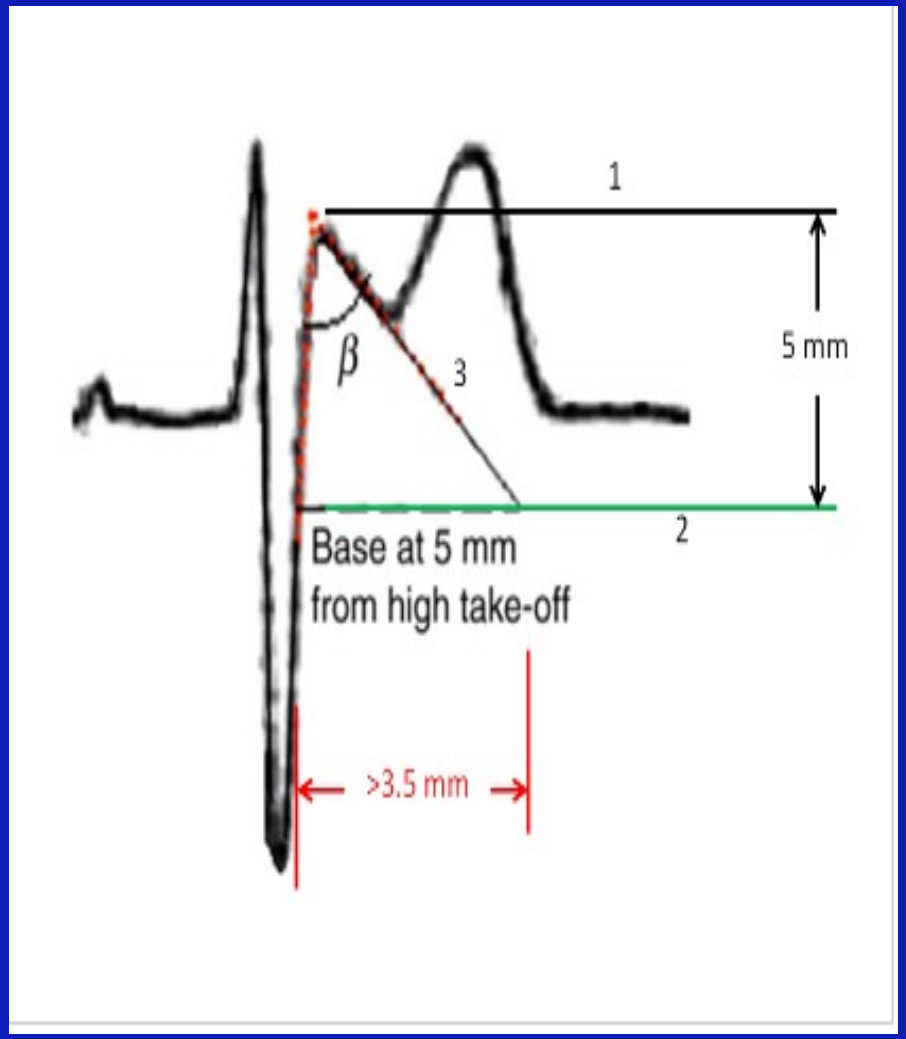
Bull Terrier

Diagnostic Criteria for Brugada Syndrome

Diagnostic ECG criteria	One of the following must also be present
Type 1 BrS pattern in ≥2 ECG	Documented VF
	Documented polymorphic VT
	Family history of SCD <40 years old
	Type 1 BrS ECG patterns in family members
	Inducible VT with programmed electrical stimulation
	Syncope
	Nocturnal agonal respiration



Criteria for Type 2 Brugada "Saddleback" ECG Pattern



1. Draw a **horizontal** line from top of r' wave (black line 1)

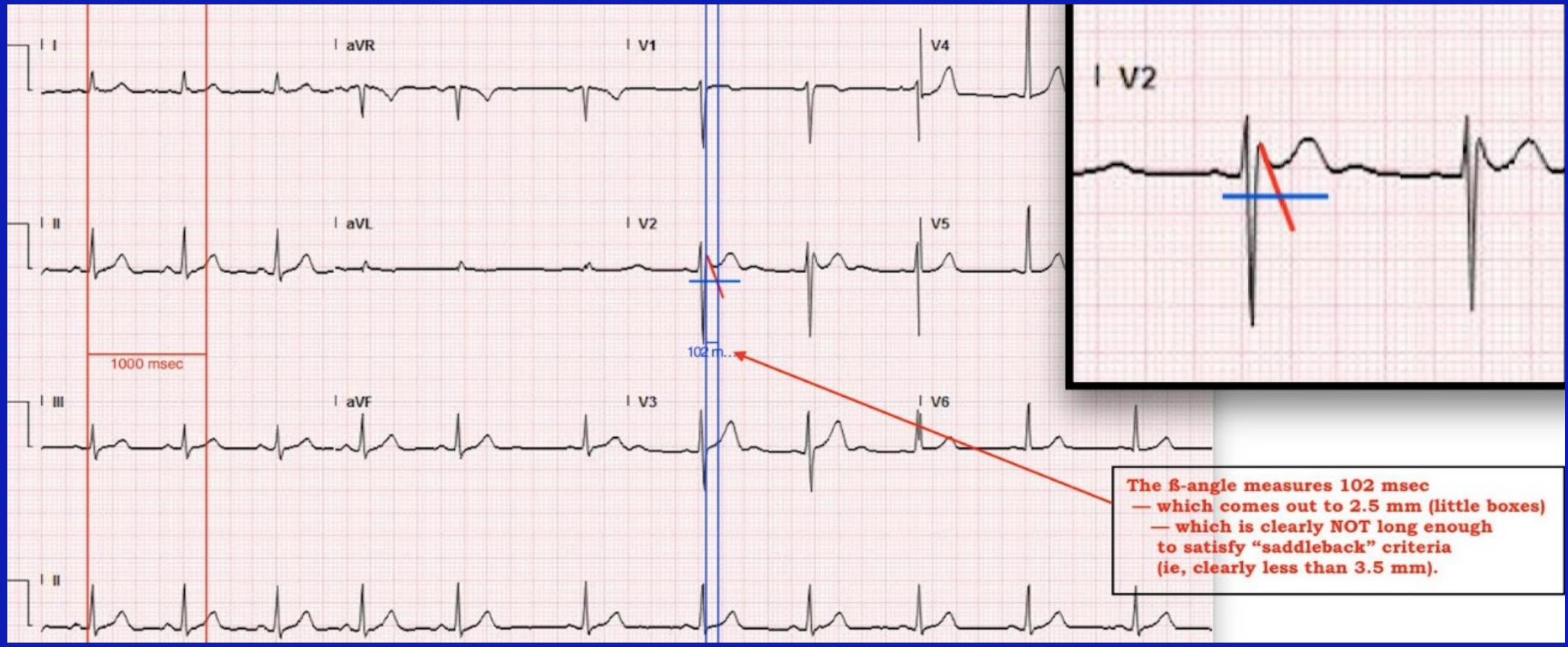
2. Draw a horizontal line 5 mm below this (green line 2)

3. Extend the downsloping r'-ST segment (black line 3) until it intersects the green line

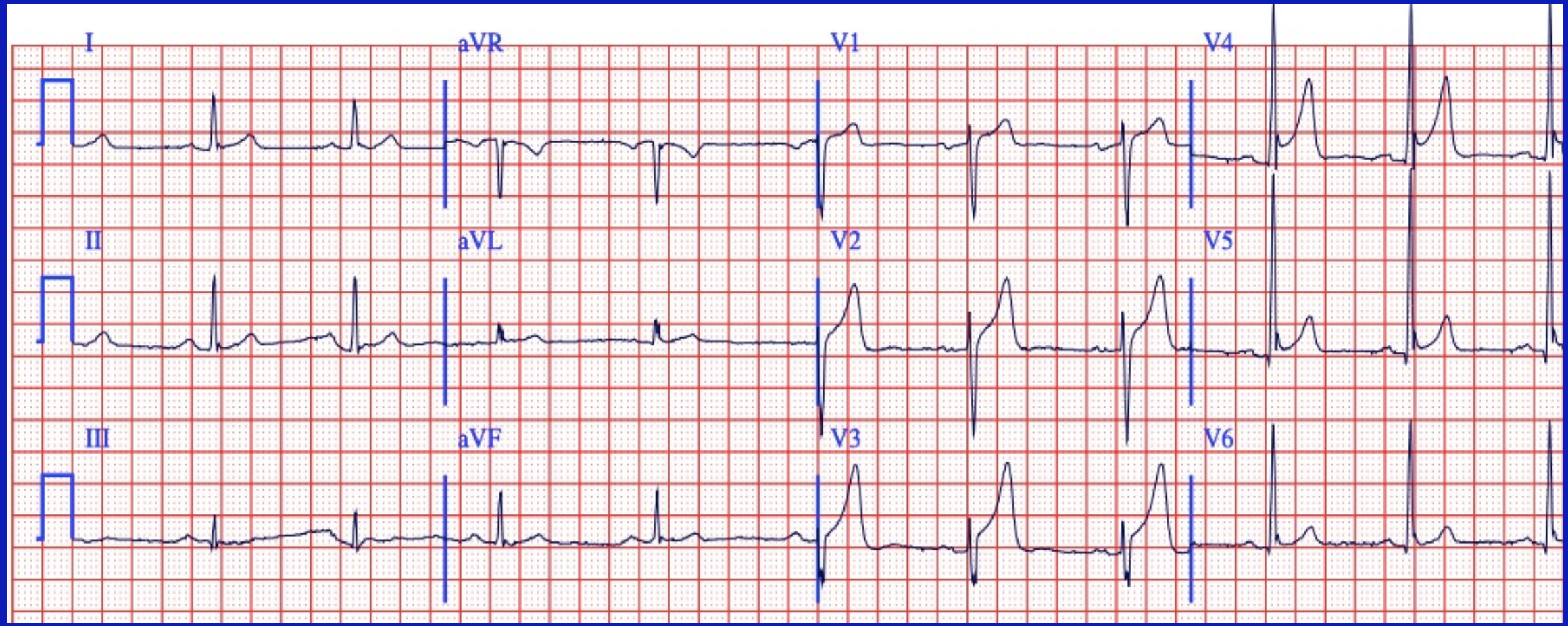
4. Measure the base.
If greater than 3.5 mm, then meets criteria (this is equivalent to a 35 degree beta angle)

Bayés de Luna A, et al . J Electrocardiol 2012; 45:433

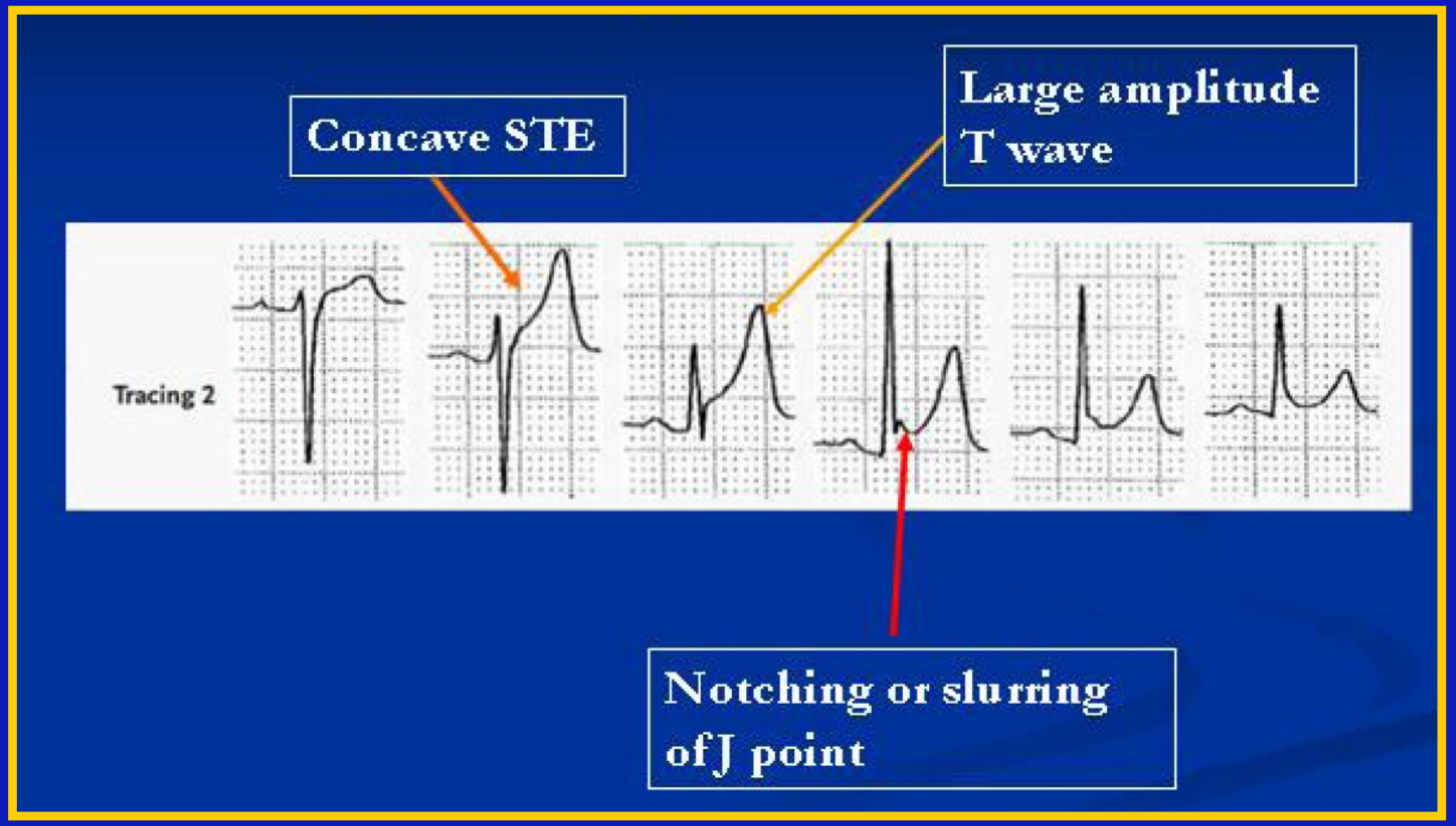
52 y.o. chef at a popular Thai restaurant
Any concerns?



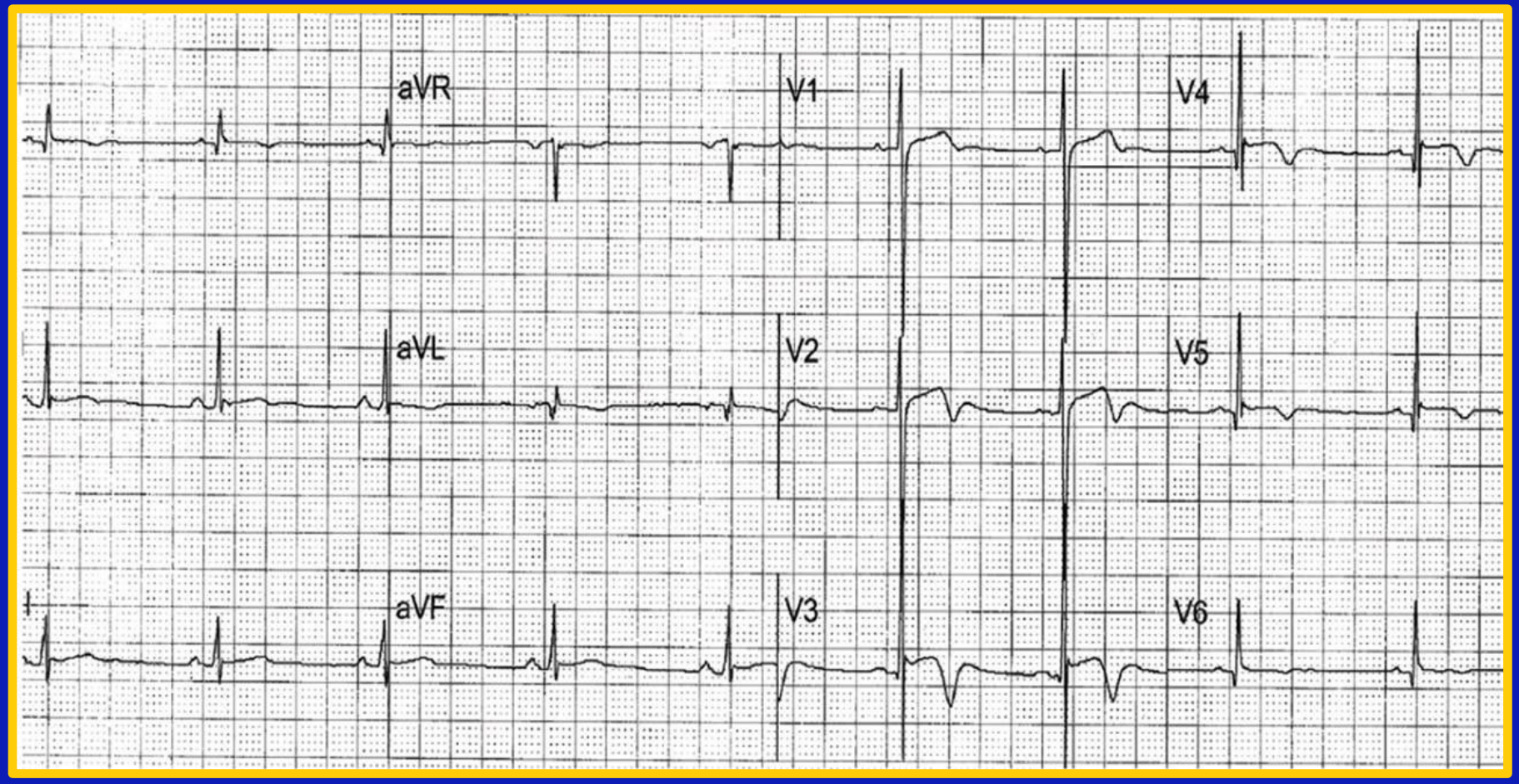
29 y.o. son of your company's CEO
Ok for Everest expedition?



Classic Early Repolarization



36 y.o. asym. male college basketball coach
Silent ischemia?

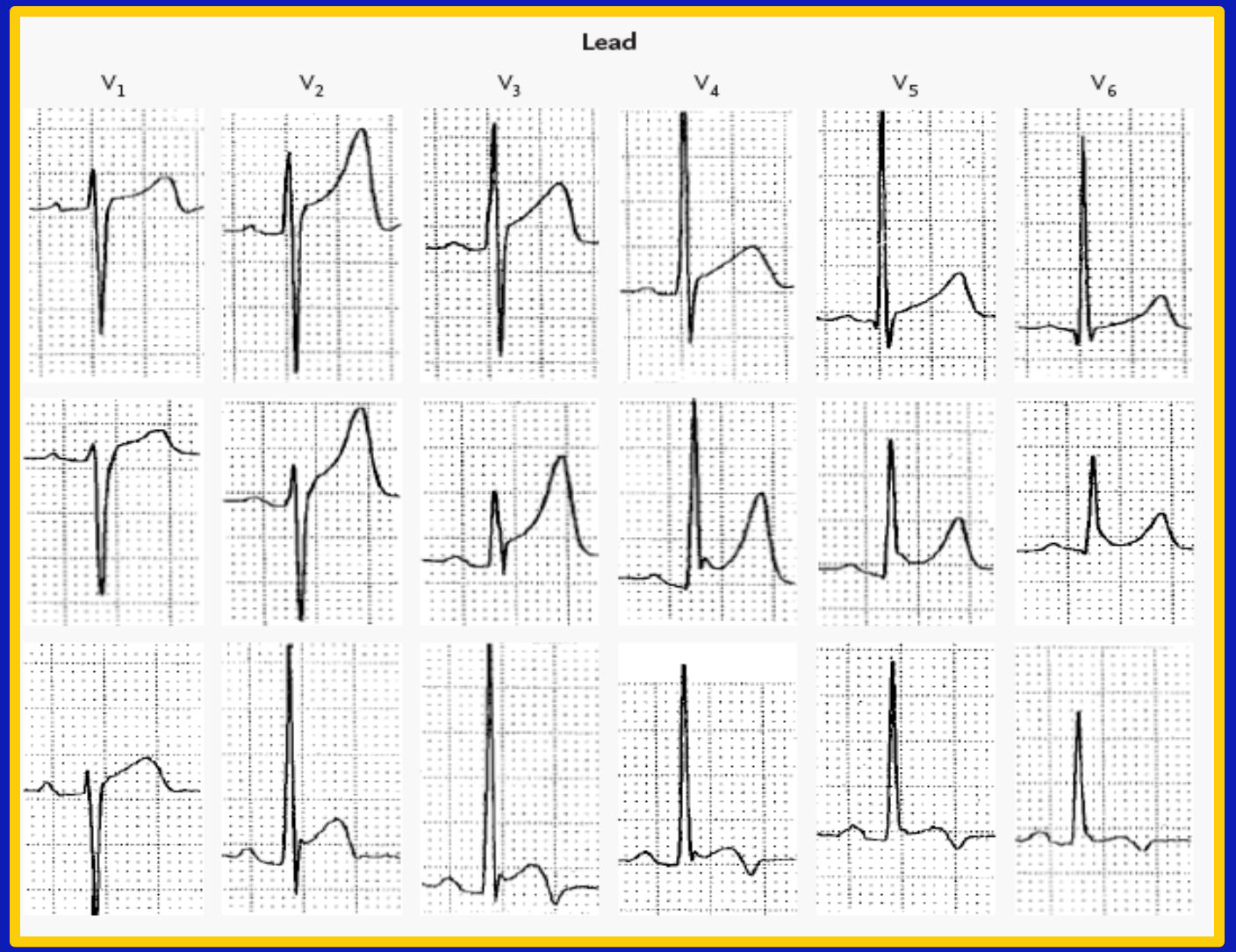


Normal Precordial ST Segment Elevation

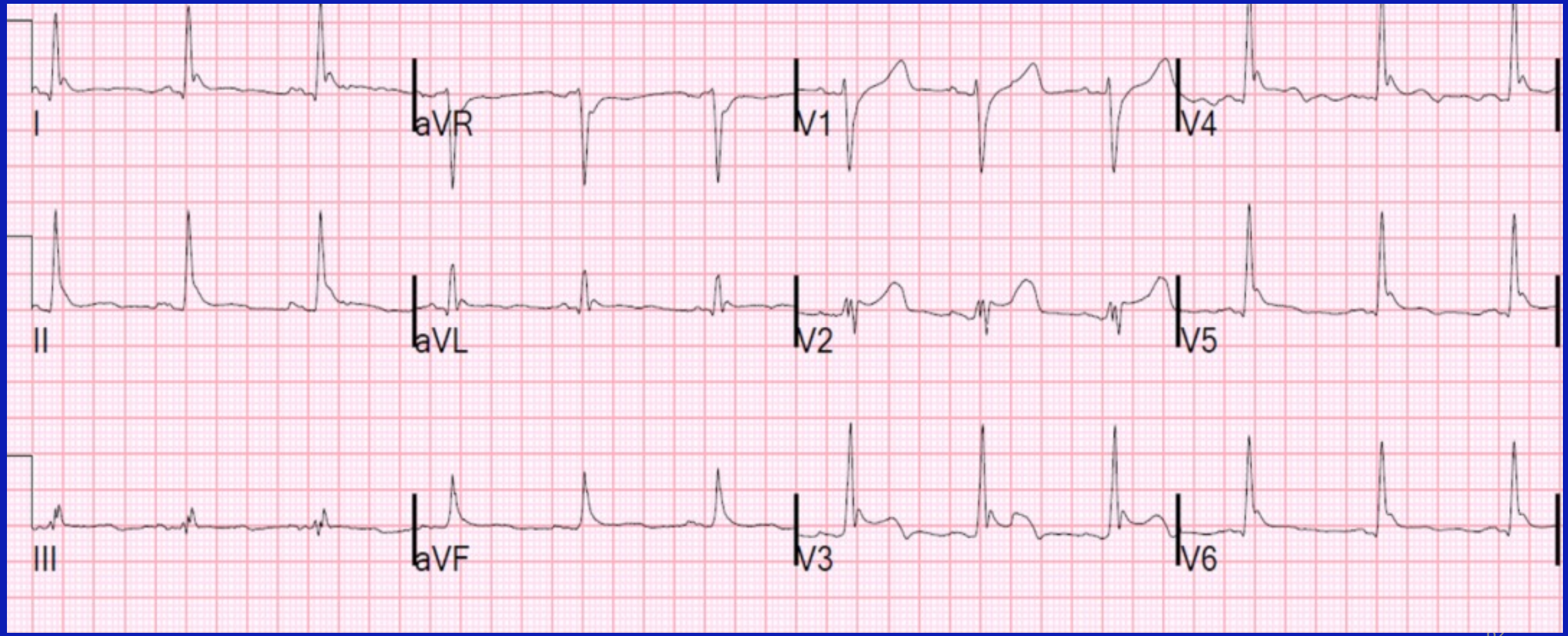
Normal Male Pattern

Classic ERP

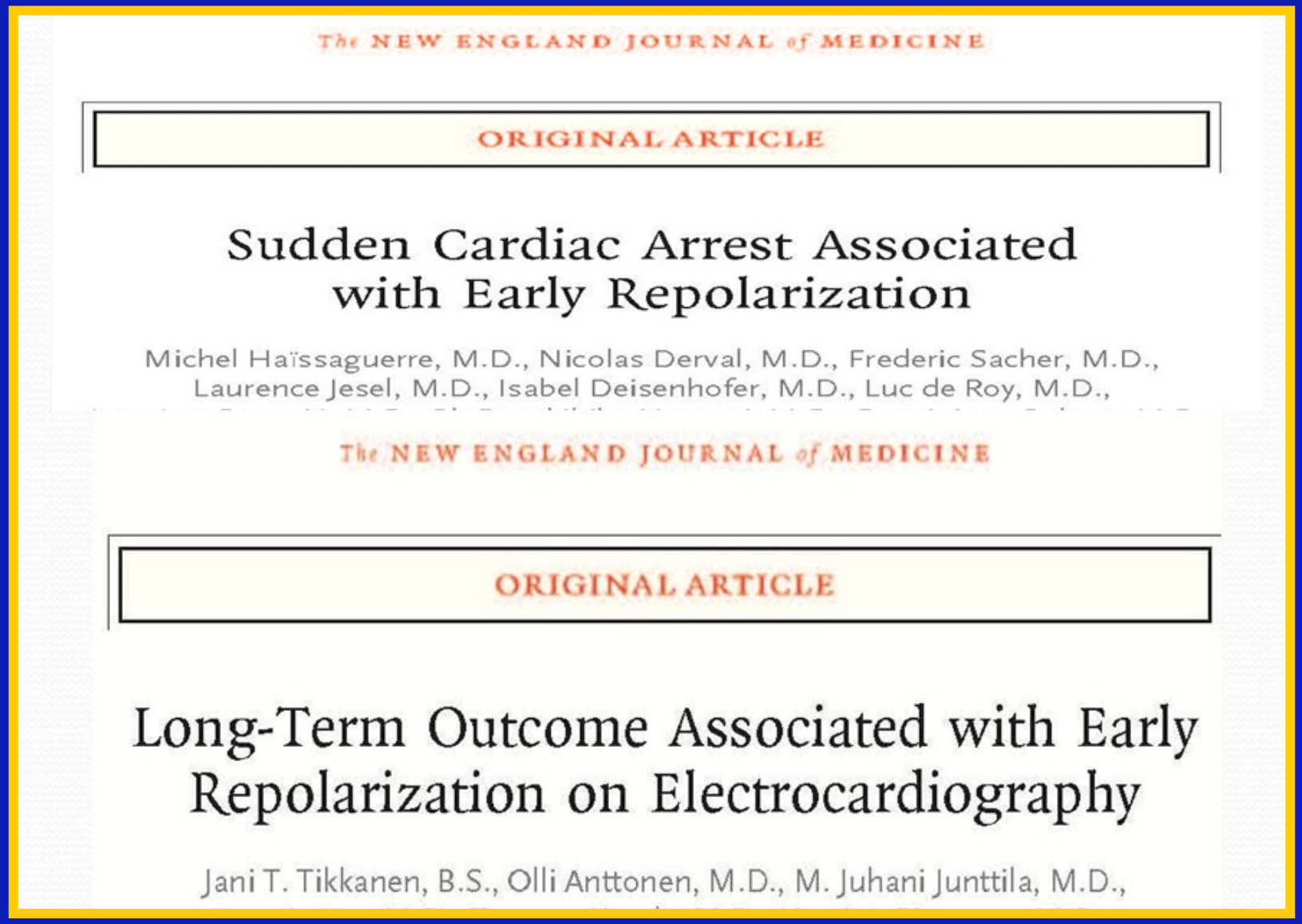
Normal Variant Negative T



29 y.o. male – screening EKG for Everest attempt
It's your CEO's son – still good to go?



Is early repolarization always benign?



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Sudden Cardiac Arrest Associated with Early Repolarization

Michel Haïssaguerre, M.D., Nicolas Derval, M.D., Frederic Sacher, M.D., Laurence Jesel, M.D., Isabel Deisenhofer, M.D., Luc de Roy, M.D.,

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Long-Term Outcome Associated with Early Repolarization on Electrocardiography

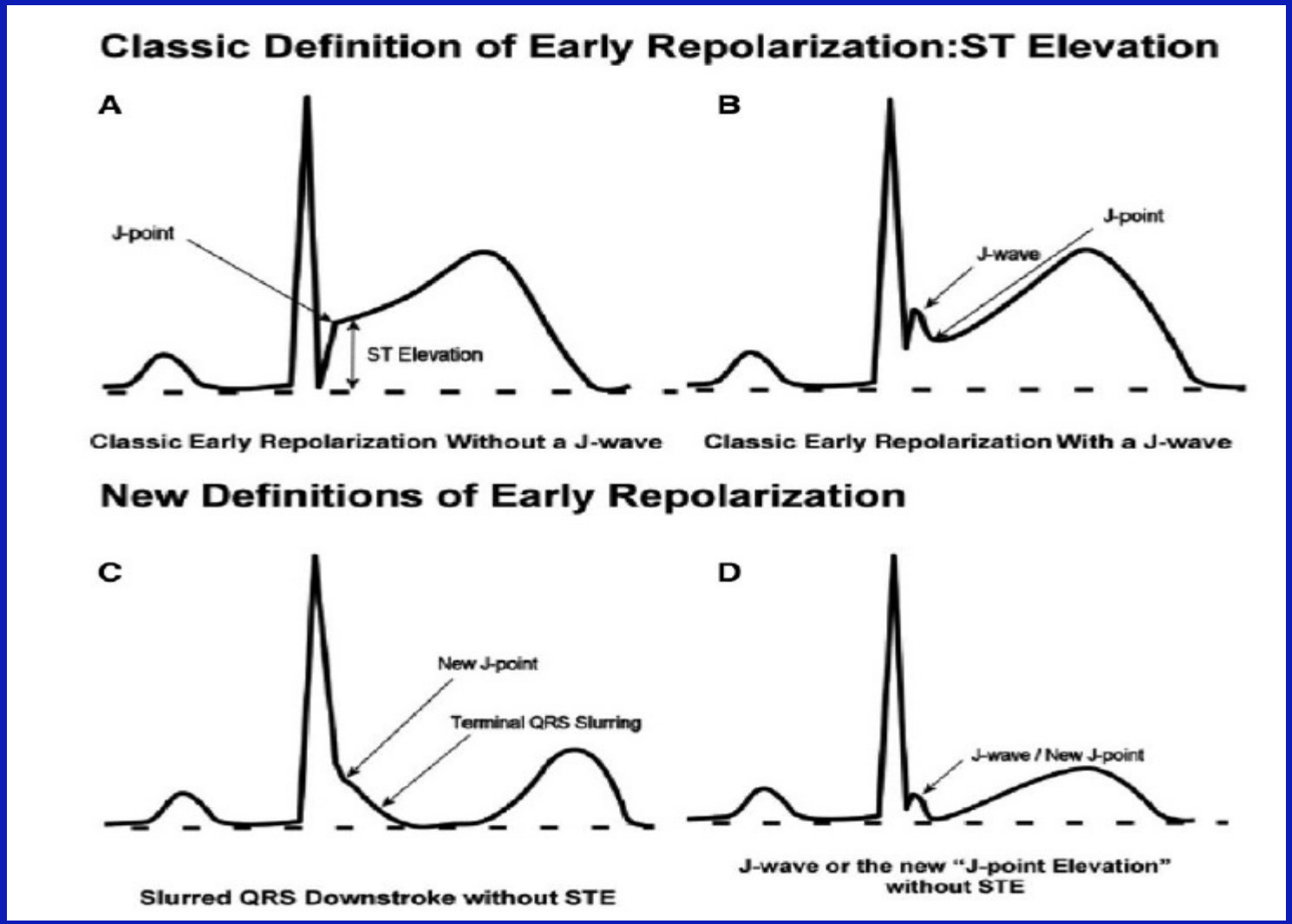
Jani T. Tikkanen, B.S., Olli Anttonen, M.D., M. Juhani Junttila, M.D.,

Results

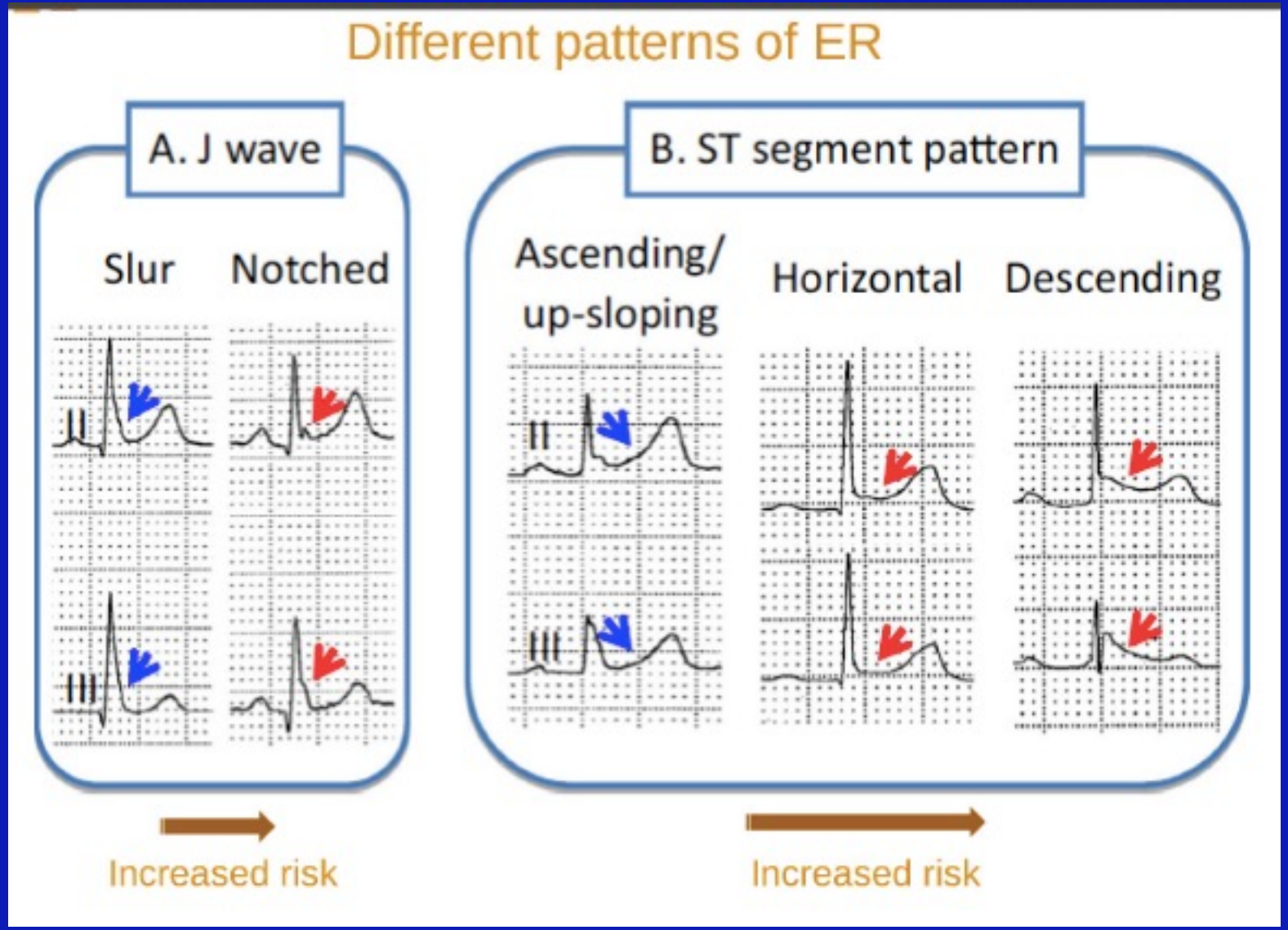
- The prevalence of ER was higher in group of subjects with idiopathic VF with respect to the control group (31% vs. 5%; $p<0.001$).
- Localization:
  - ✓ 47% inferior leads
  - ✓ 44% inferior and lateral leads
  - ✓ 9% lateral leads.

Haïssaguerre M et al. NEJM 2008; 358: 2016-23

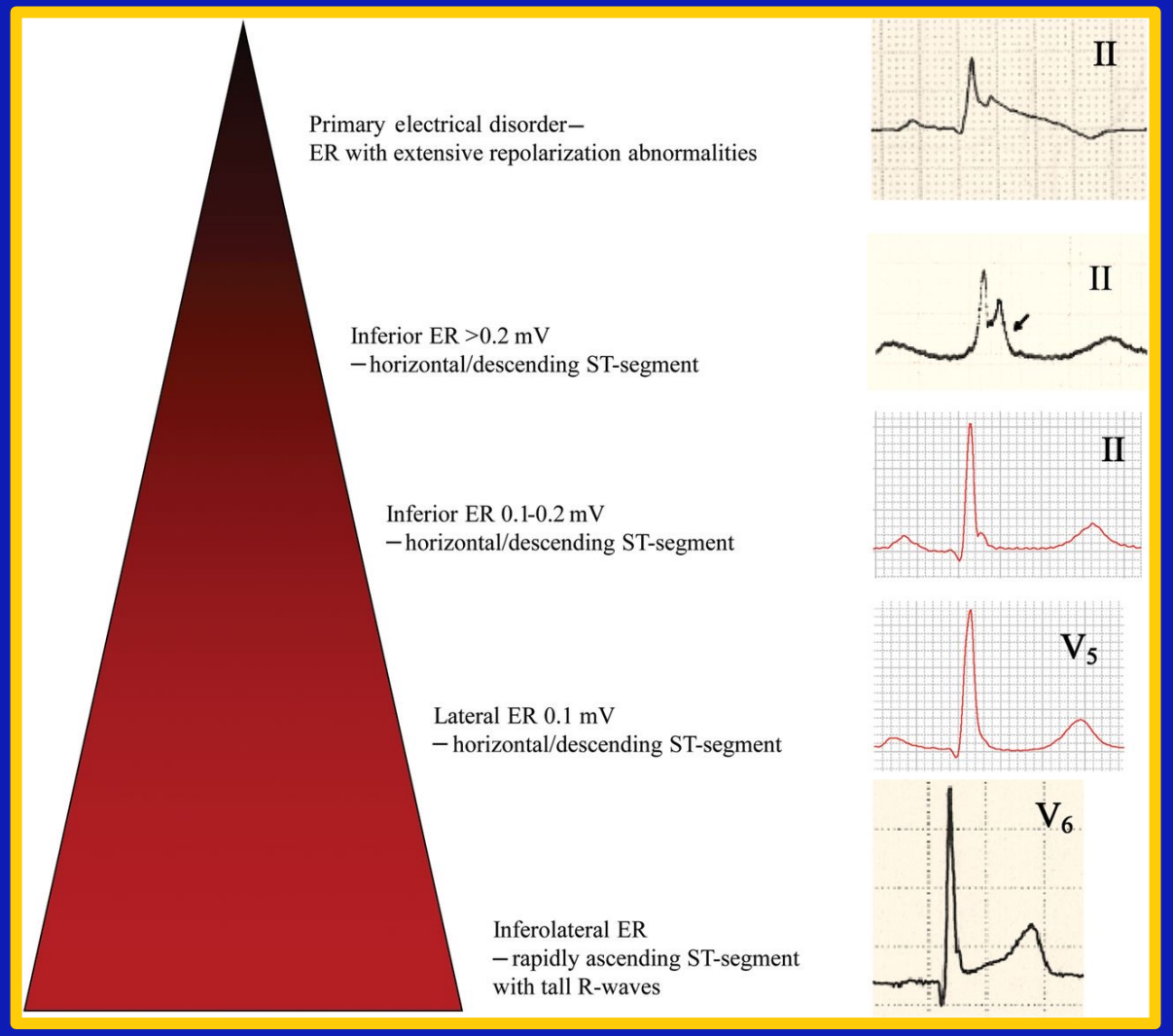
Changing Definitions of Early Repolarization



Perez MV,. *Am J Med*. 2012;125:843

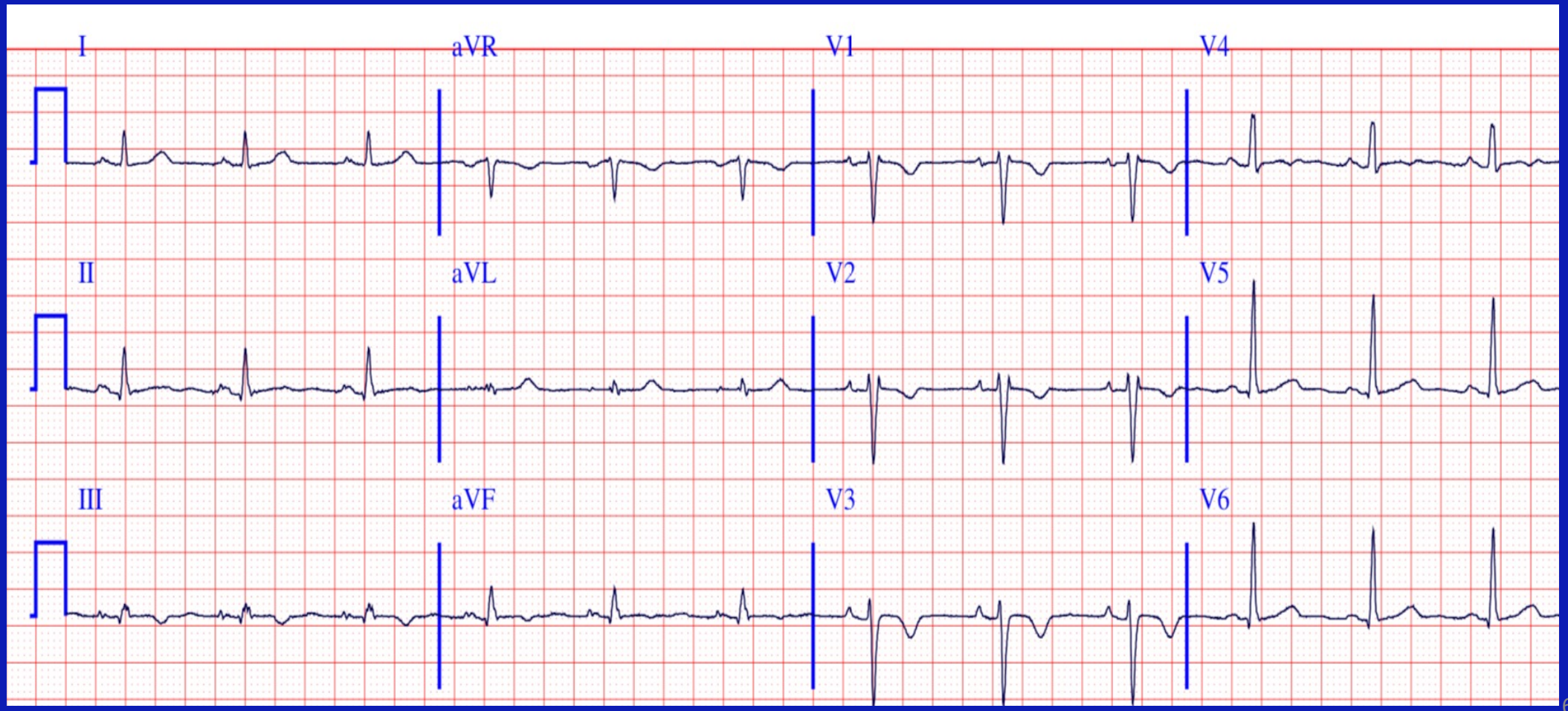

Different patterns of ER
A. J wave
Slur
Notched
II
III
Increased risk
B. ST segment pattern
Ascending/
up-sloping
Horizontal
Descending
II
III
Increased risk

Inferolateral early repolarization patterns and magnitude of sudden cardiac death risk



Junttila M J et al. Eur Heart J 2012;33:2639-2643

35 y.o. male applicant
Persistent juvenile T wave pattern?



Prevalence of T wave Inversion Beyond V_1 and V_2

In ages 19-45

< 4% in women

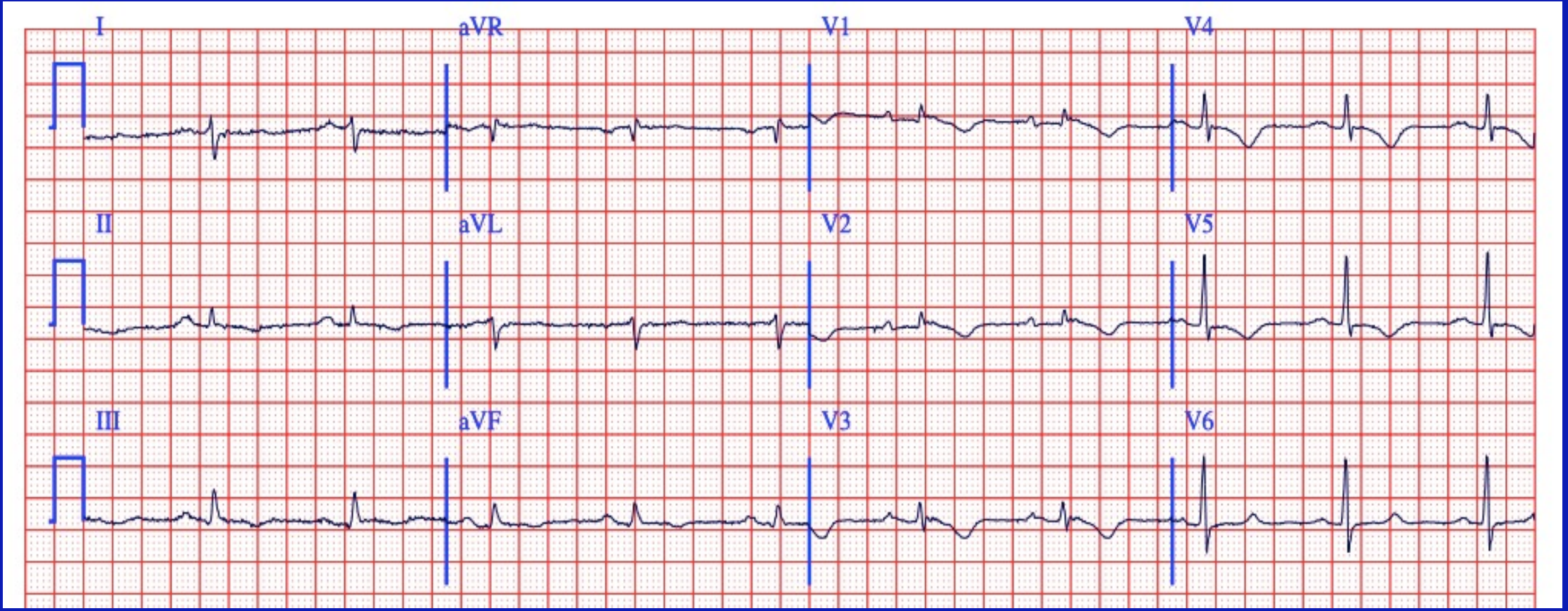
< 1% in men

In middle-aged subjects 36-50

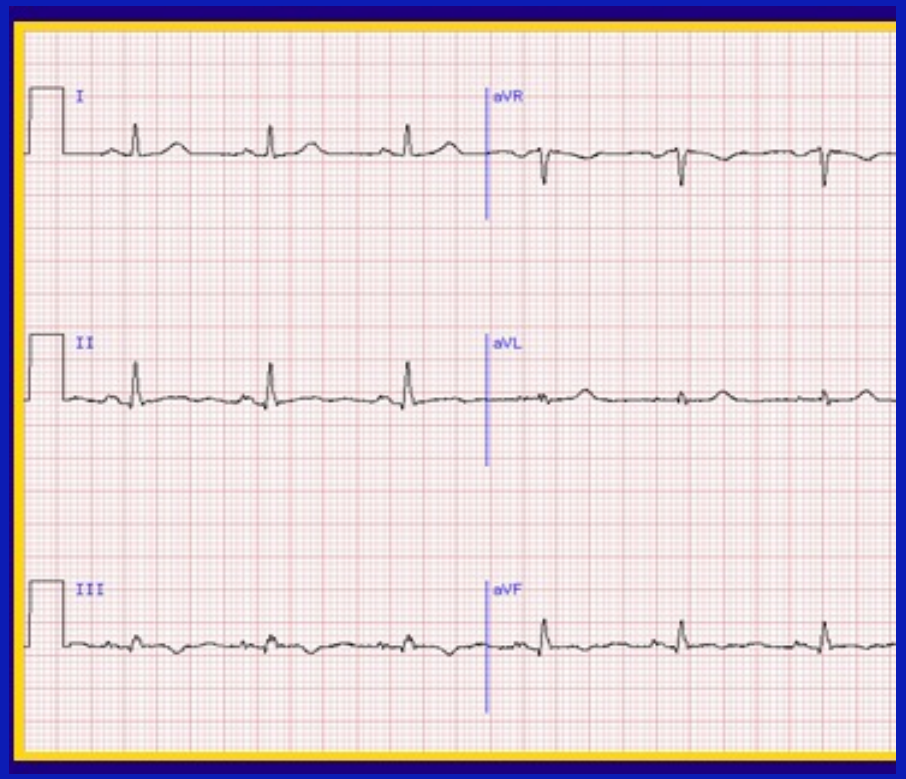
< 0.7%

Marcus F. Am J Cardiol 2005; 95:1070
Aro AL. Circulation 2012; 125:1272

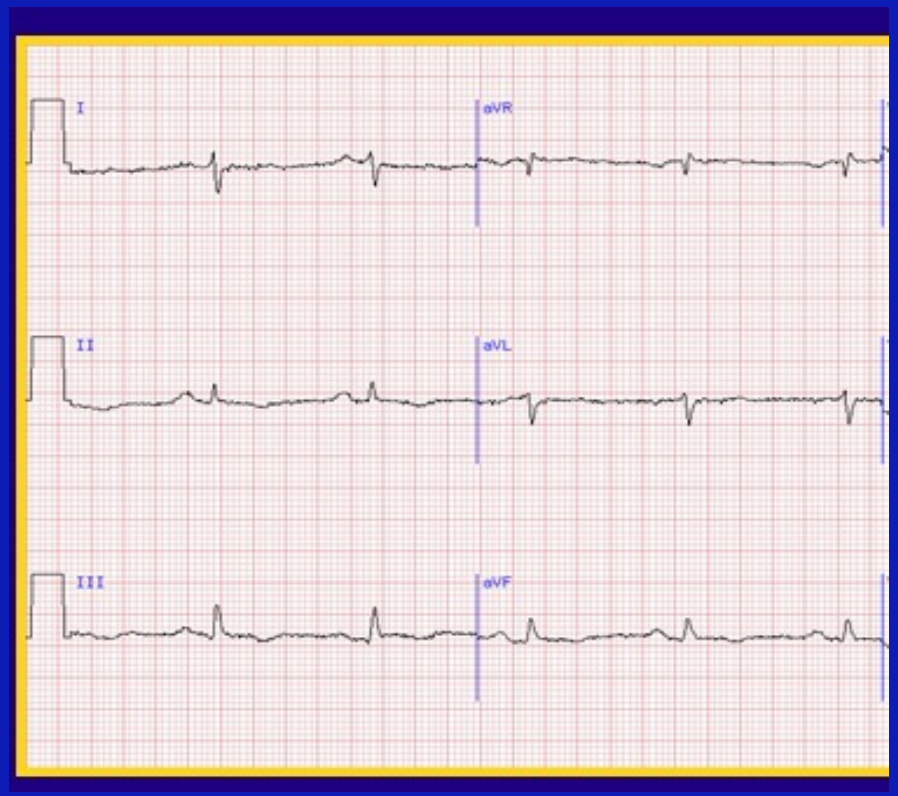
40 y.o. male applicant
Persistent juvenile T wave pattern?



Evolution of ECG Changes in Limb Leads

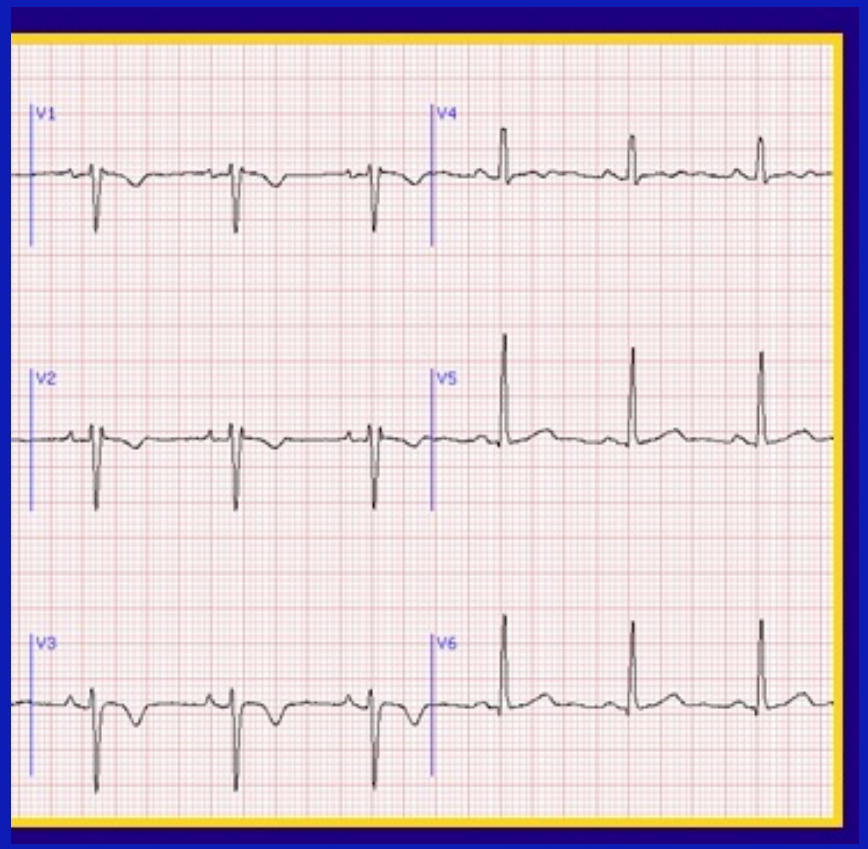


Age 35

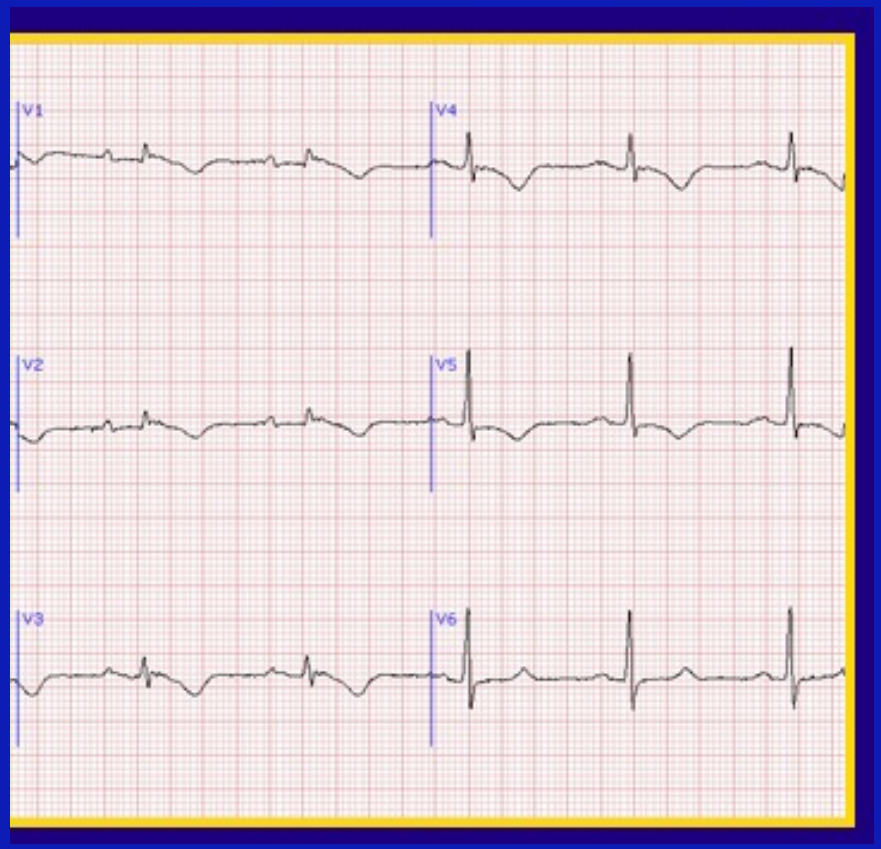


Age 40

Evolution of ECG Changes in the Chest Leads

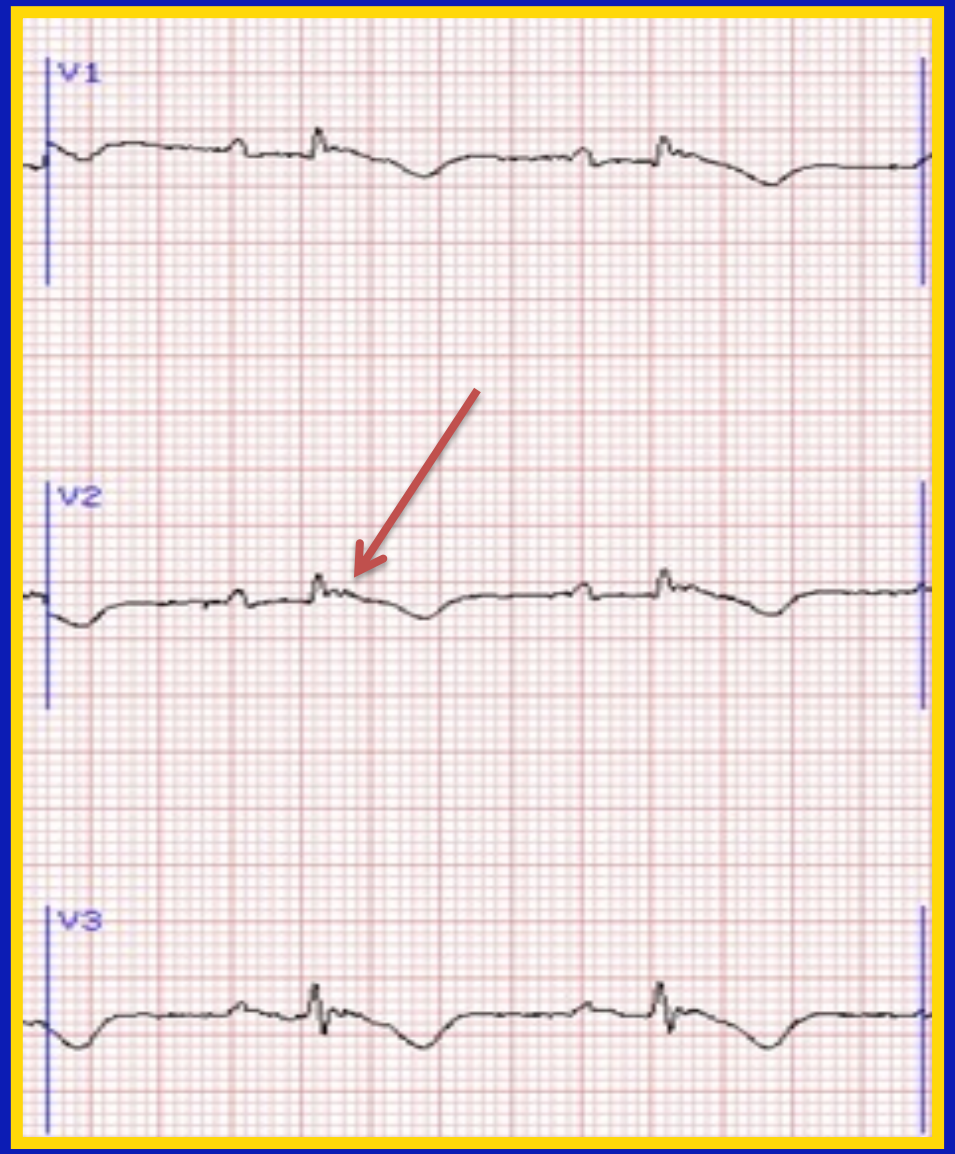


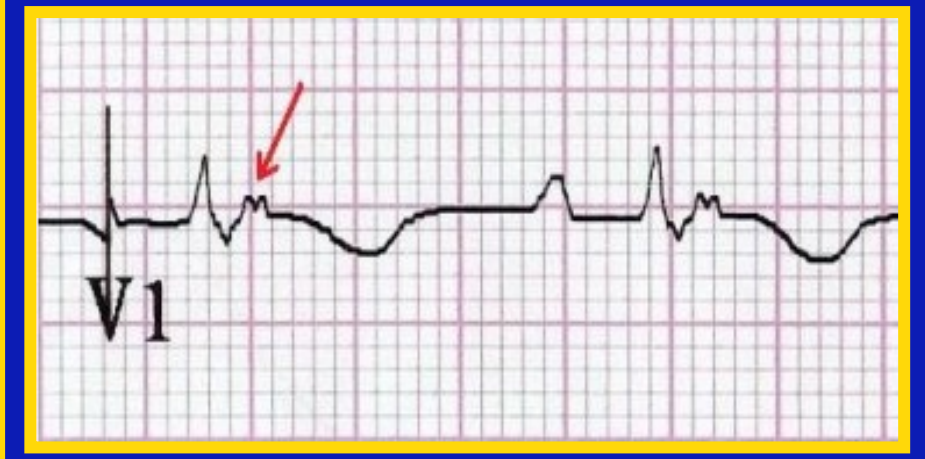
Age 35



Age 40

Epsilon Wave





Arrhythmogenic RV Dysplasia/Cardiomyopathy

- Genetically determined c'myopathy
- Young adult males
- Mutations in cell adhesion proteins
- Fibrofatty repl't of RV +/- LV
- Prone to arrhythmia, heart failure, SCD

How to Choose a New Dog

The Dalmatian Dilemma

Sudden Death in Dalmatians

Normal QT

Long QT

ECG Challenges During Risk Assessment

Thank You