

ECG telemetry workshop

David Newman MD



International Winter arrhythmia School
Collingwood ON
February 10,2017

disclosures

Honoraria from Boehringer, Bayer, astra zenica
BOD cardiocom

Will talk about off label use of all devices
(where labels exist)

The mandate from EC:

Focus on ECG

Looking for patterns

QT measurement and error

Noise

Examples

PT: [REDACTED] AMV

ID: 1068318-1

MA SCANHEAD

7.50 MHZ

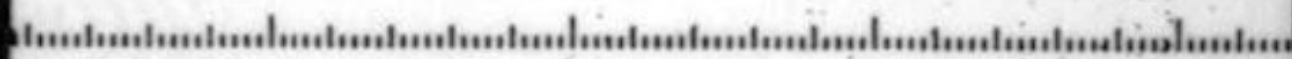
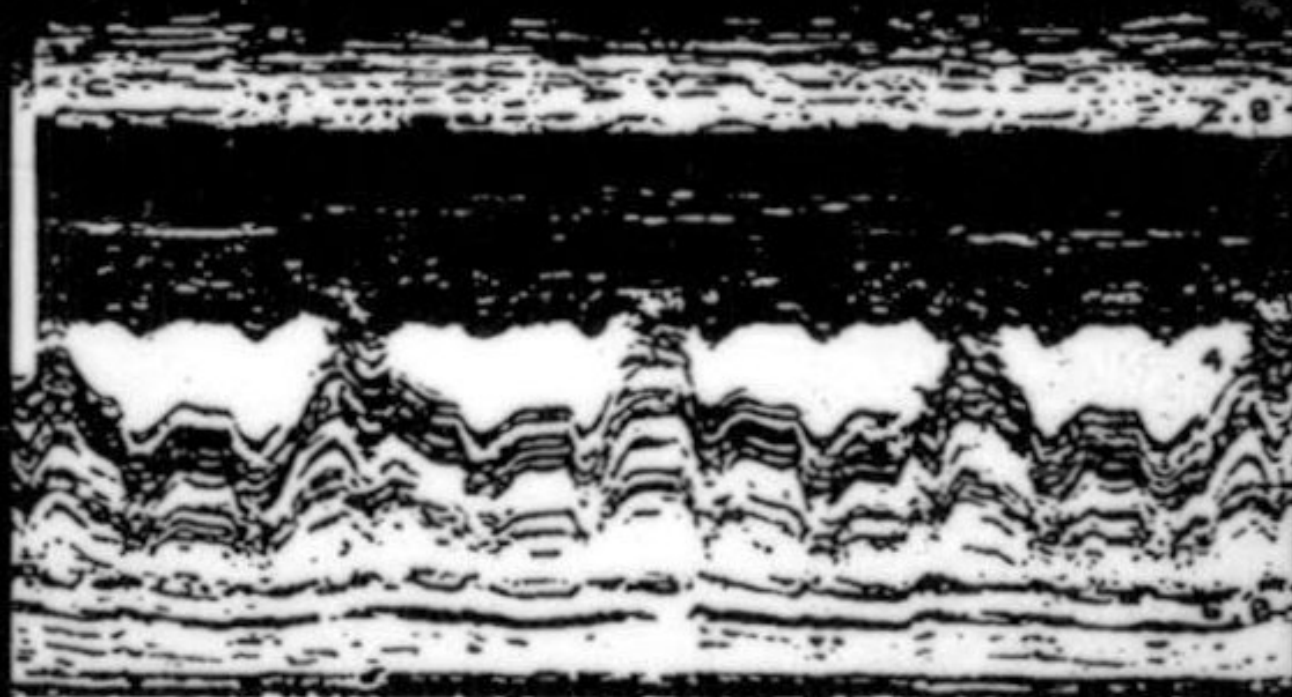
2.0 'CH

28 SEP 88

10:10 AM

POWER

100 %



The urgent call:

78, HT, DM, past MI, sinus brady in past

HB 80 chronic gastric and colonic angiodysplasia

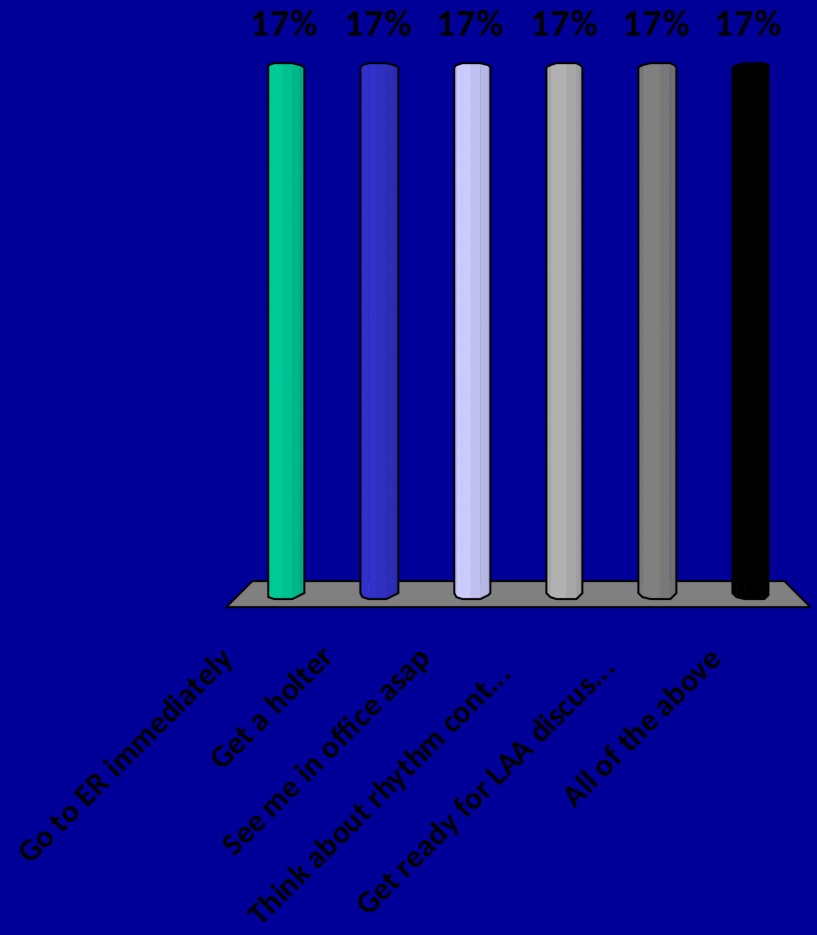
Feels weak, presyncopal

In atrial fibrillation

What should I do....

?

- A. Go to ER immediately
- B. Get a holter
- C. See me in office asap
- D. Think about rhythm control +/- pacing amio + TEE DCS
- E. Get ready for LAA discussions
- F. All of the above



19-Dec-2016 11:13:16

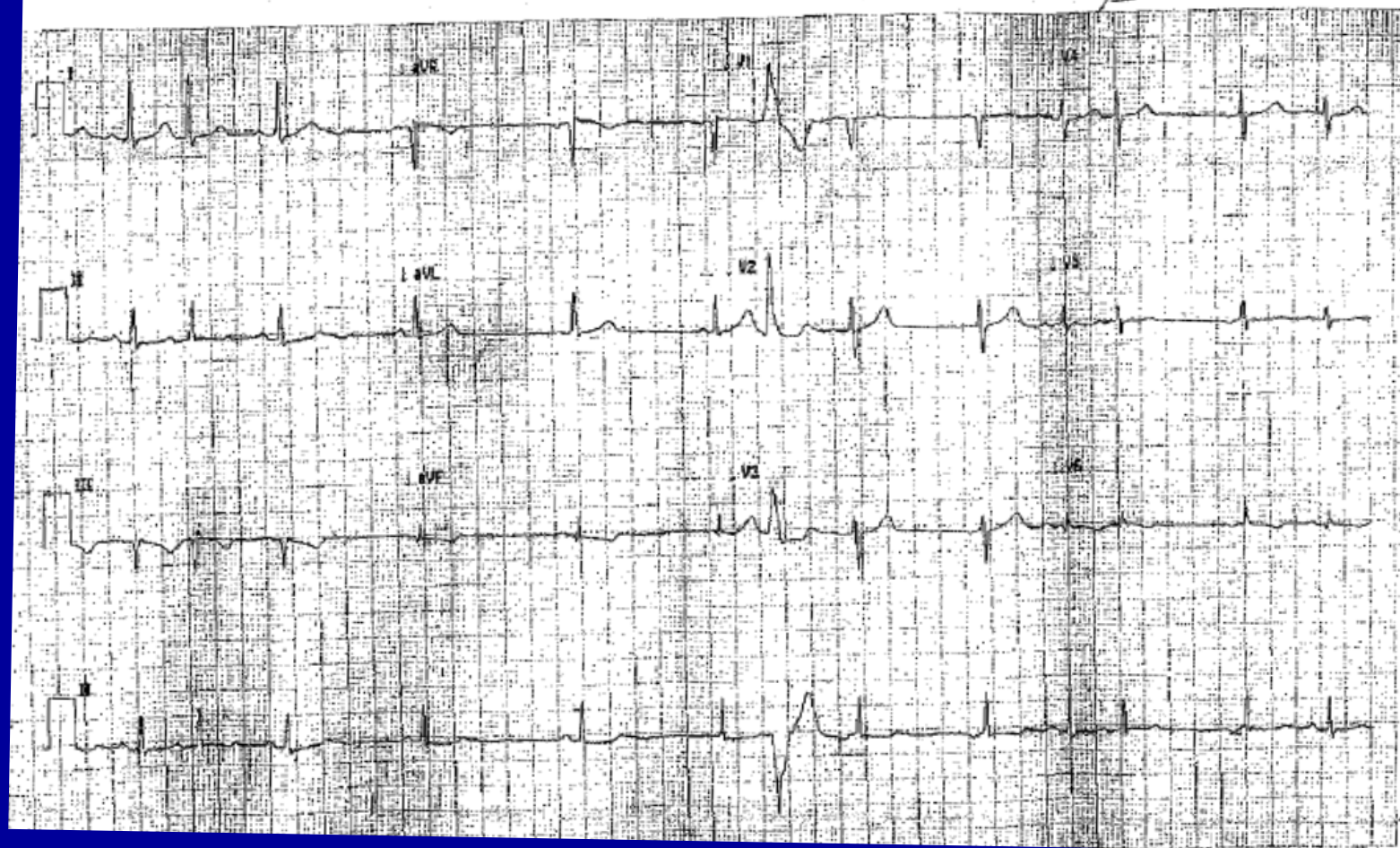
Heart rate 76 BPM
PR int 8 ms
QRS dur 82 ms
QT/QTc 375/408 ms
P-R-T axes 3 4 -27

ATRIAL FIBRILLATION WITH ABERRANT CONDUCTION OR VENTRICULAR PREMATURE COMPLEXES
MODERATE ST DEPRESSION (0.05+ mV ST DEPRESSION)
ABNORMAL ECG

UNCONFIRMED REPORT

Age: 60yr
Sex: Male
Dr.: Del Rizzo

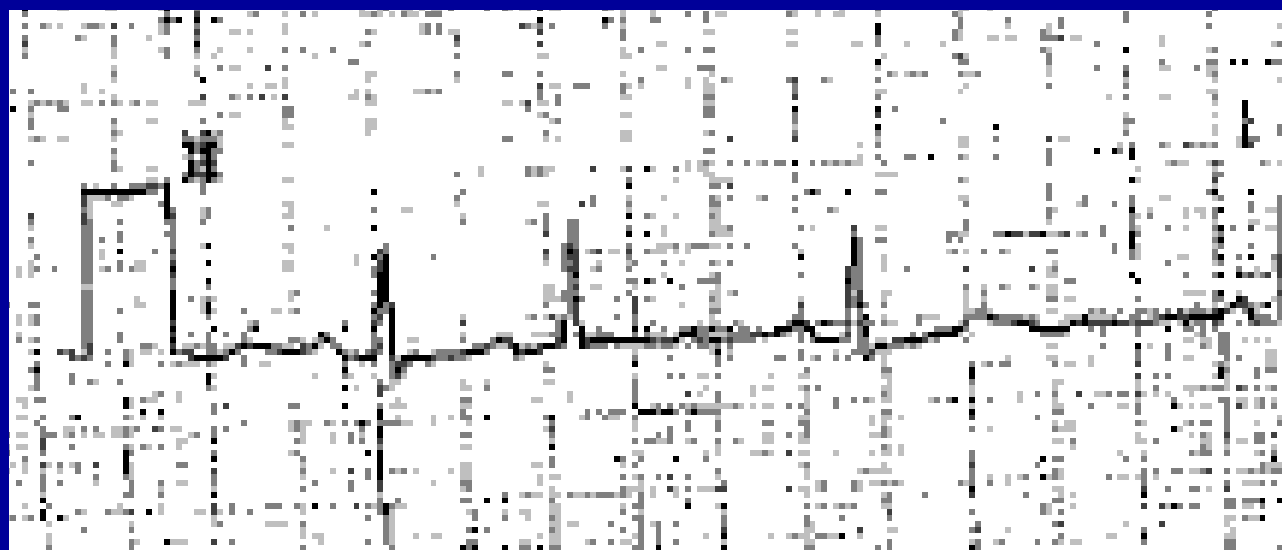
RECEIVED
DEC 19 2016

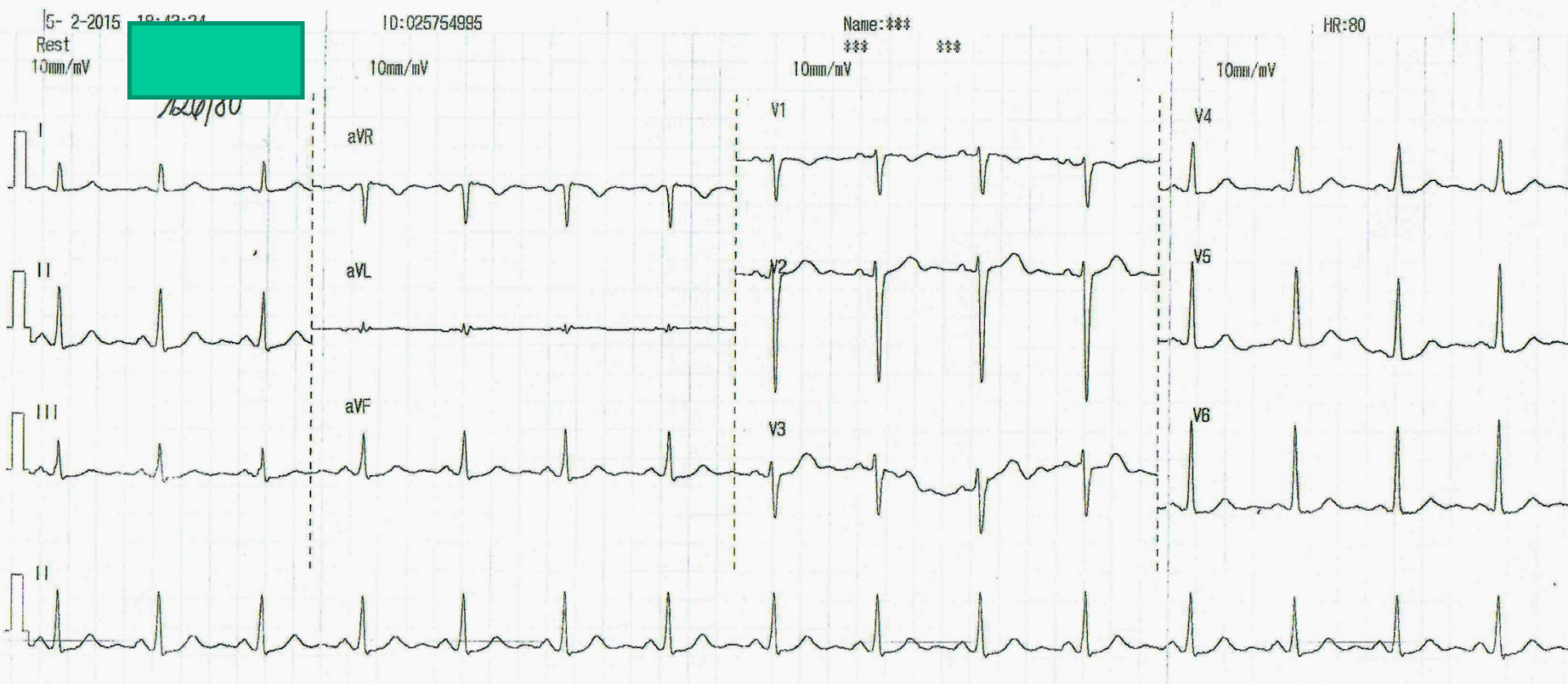


ATRIAL FIBRILLATION WITH ABERRANT CONDUCTION OR VENTRICULAR PREMATURE COMPLEXES
MODERATE ST DEPRESSION (0.5+ mv ST DEPRESSION)
ABNORMAL ECG

UNCONFIRMED REPORT

RECEIVED





43F former athlete. Asymptomatic. Routine stress test for work.

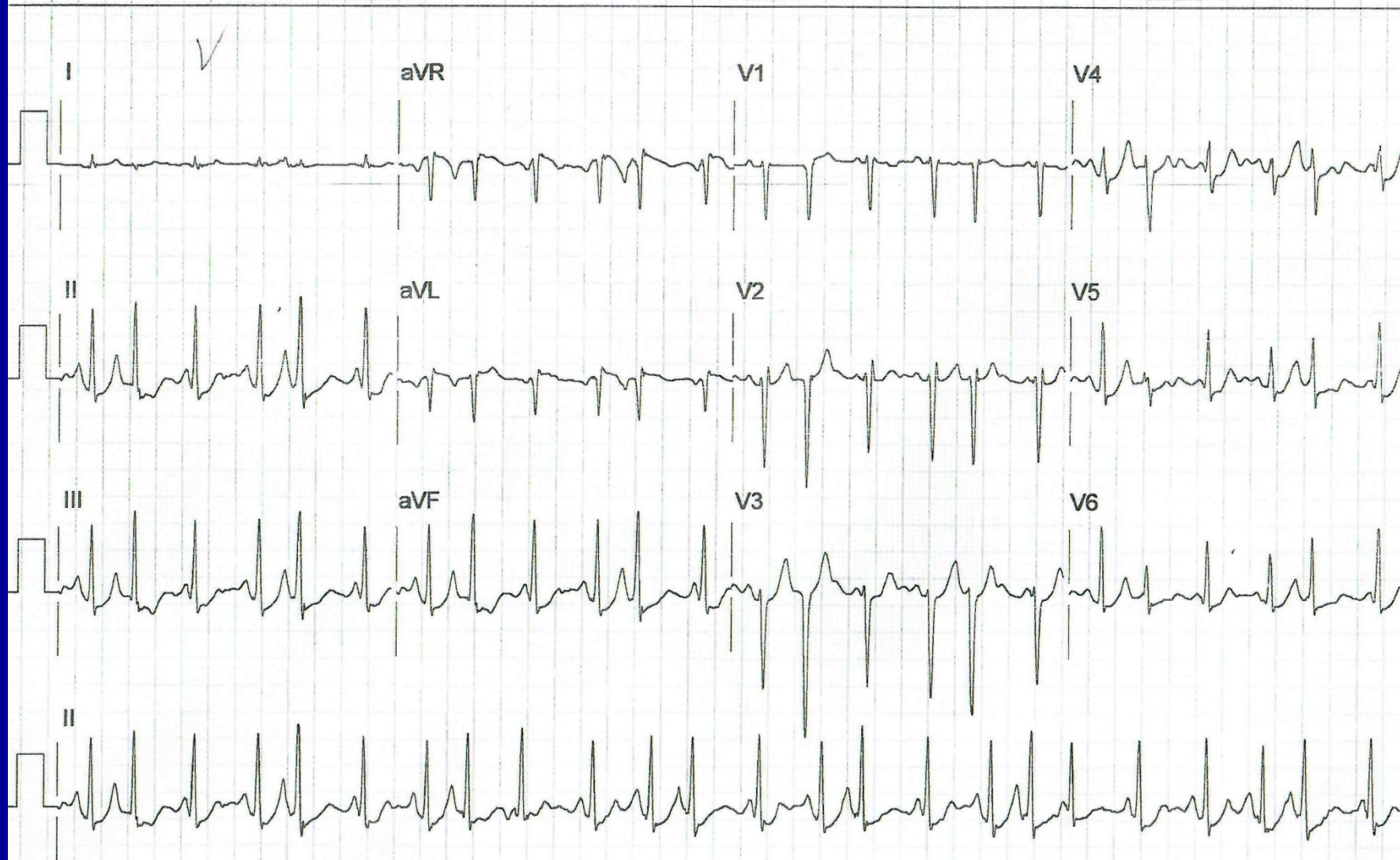
Mother died during sleep at age of 60. Morbide obese- 180 KG, otherwise no family history.

No meds.

01/01/1973
12-Lead(simultaneous)

Protocol Bruce
Stage 2 02:50 05:50
Spd/Grd 2.5 mph 12.0%

RPE	—	HR	146						
METs(a)	7.0	Target HR	177	II	LVL	-1.4	SLP	25	
BP	130/80	Max HR	149	V2	LVL	0.3	SLP	16	
Previous BP	120/80	HRxBP	18980	V5	LVL	-0.4	SLP	34	



01/01/1973
10 second Rhythm Manual

Protocol

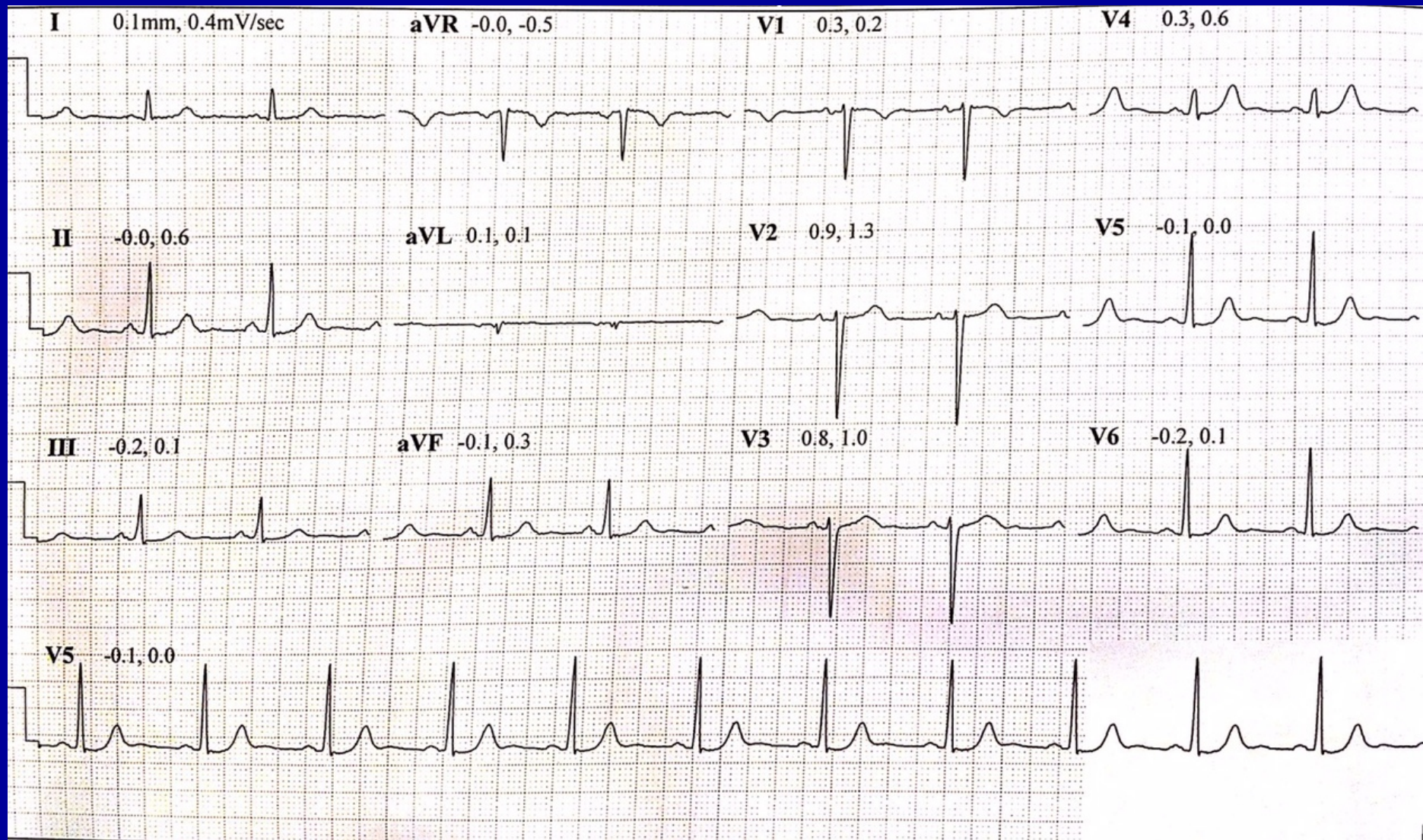
Bruce
Stage
Spd/Grd

3 01:01 07:01
3.4 mph 14.0%

METs(a)	10.1	Target HR	177	II	LVL	-1.8	SLP	28
BP	—/—	Max HR	166	V2	LVL	0.2	SLP	18
Previous BP	130/80	HRxBP	—	V5	LVL	-0.8	SLP	36



Supine, HR 68 bpm

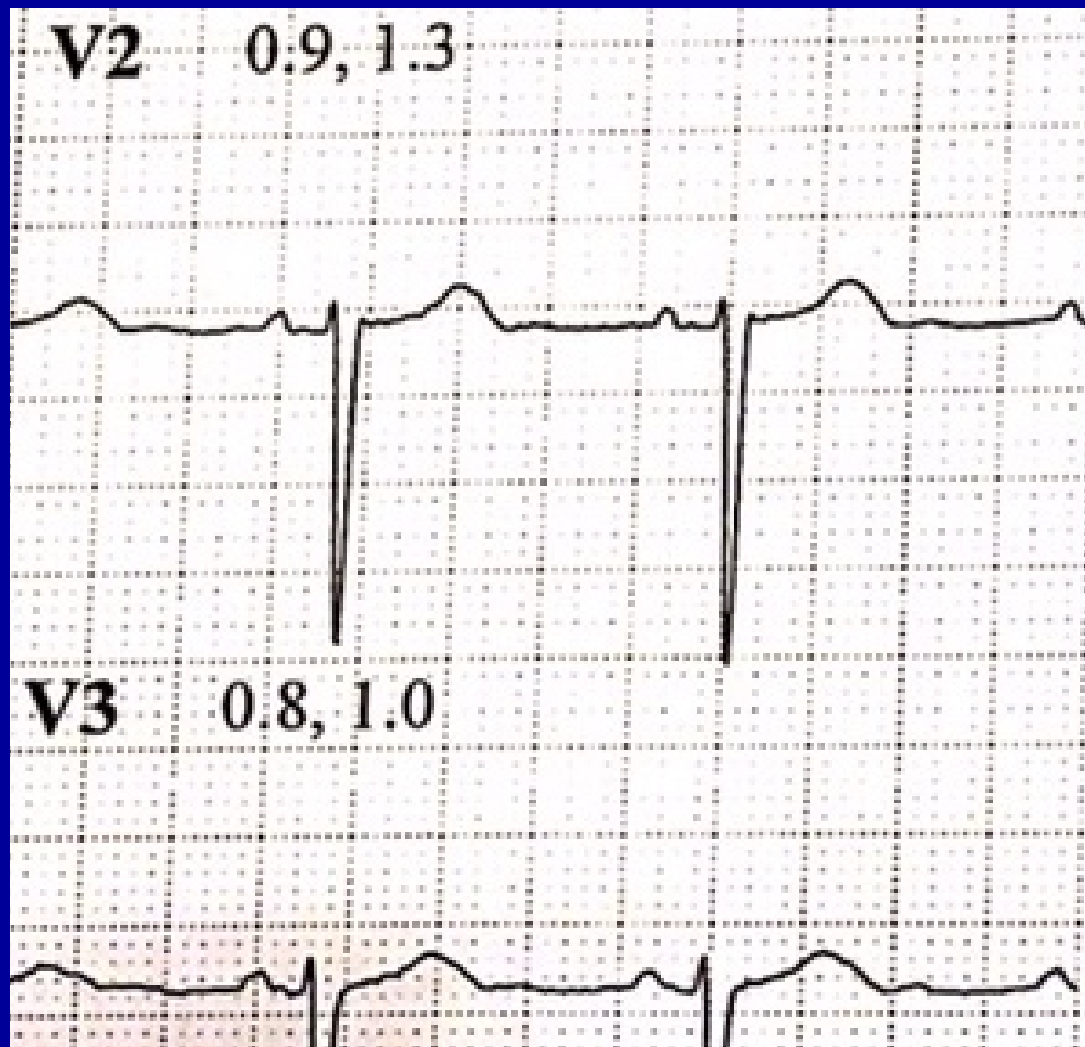


RR 880 msec

QT 400 msec

QTc 450 msec

Supine, HR 68 bpm

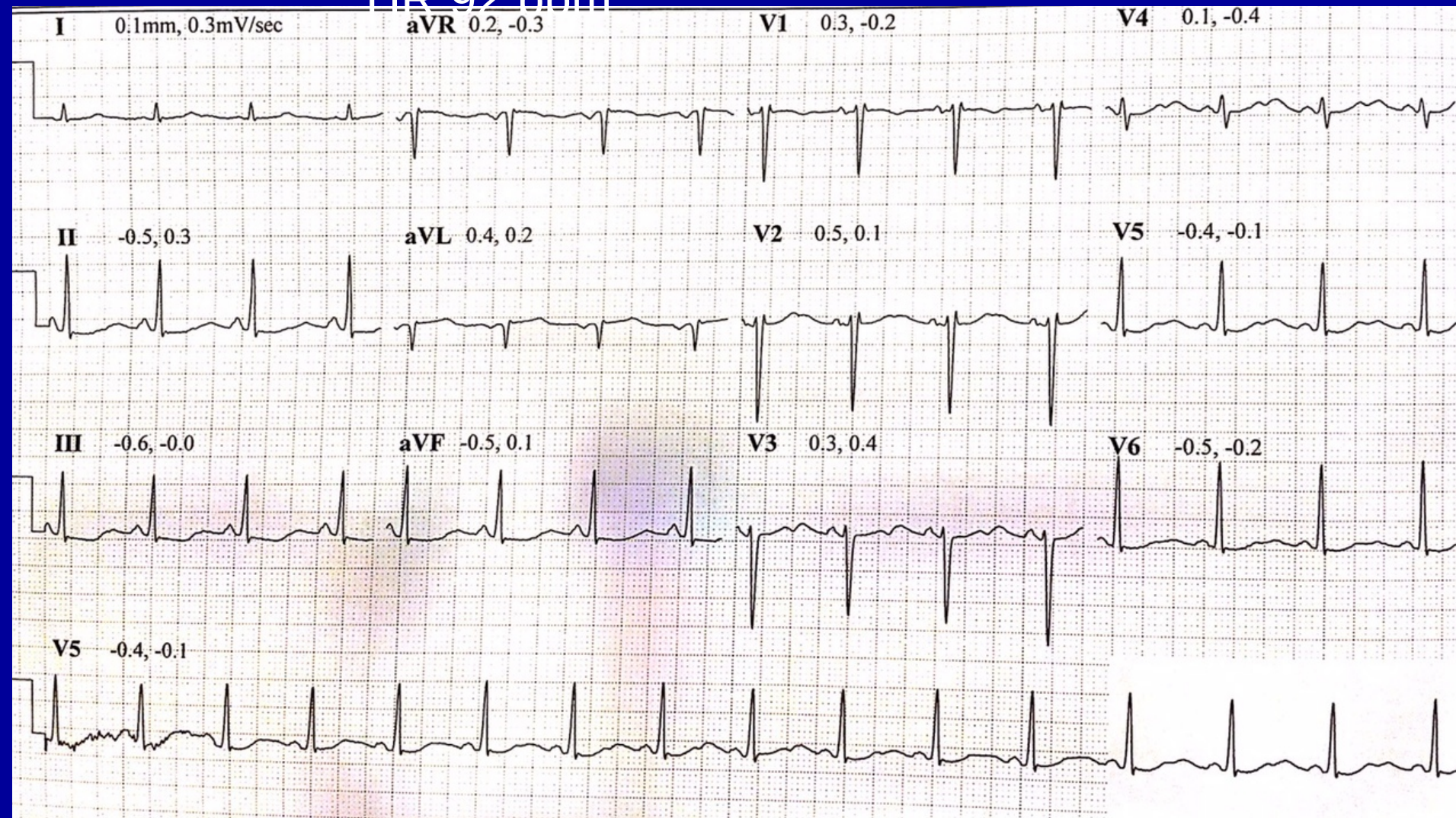


RR 880 msec

QT 400 msec

QTc 450 msec

Standing- maximal tachycardia, HR 92 bpm



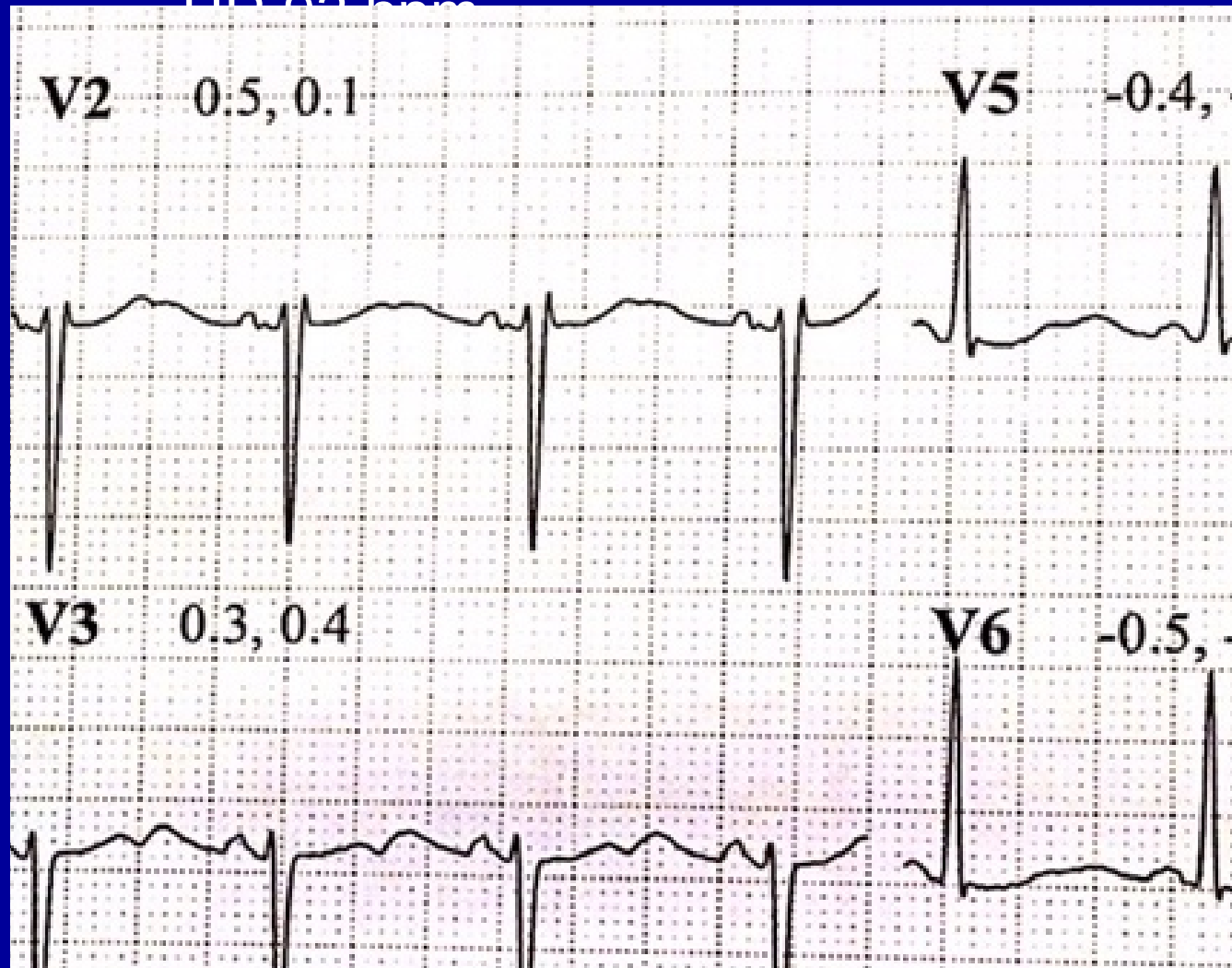
RR 670 msec

QT 520 msec

QTc 630 msec

Standing- maximal tachycardia,

HR 22 bpm



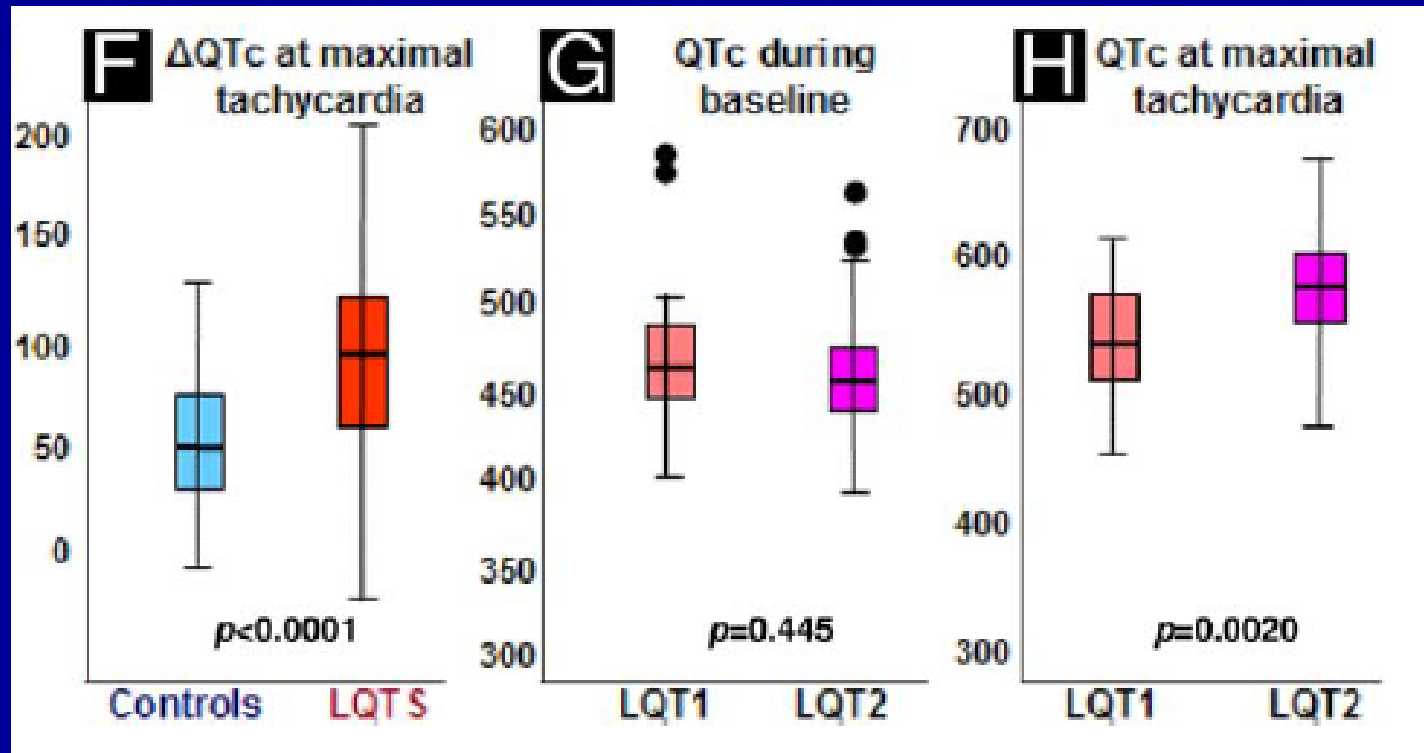
RR 670 msec

QT 520 msec

QTc 630 msec

The Response of the QT Interval to the Brief Tachycardia Provoked by Standing

A Bedside Test for Diagnosing Long QT Syndrome



Viskin JACC 2010;55:1955

12 Lead ECG Report

Recorded by: CMD, Office_S
Reporting MD: CMD, Office_S
Referring MD: --
Inst. ID/Location: --
Interpretation: Sinus bradycardia
Normal morphology

Patient:
Health ID:
Date of Birth: Feb 20 1973(40yrs)
Gender: MALE

Report Date: Nov 01 2013
ECG Date/Time: Oct 30 2013 11:50:29 AM

Rate: 51bpm
QRS: 0.090 S
QTc: 0.419 S
PR: 0.138 S
QT: 0.454 S
QRS Axis: -7

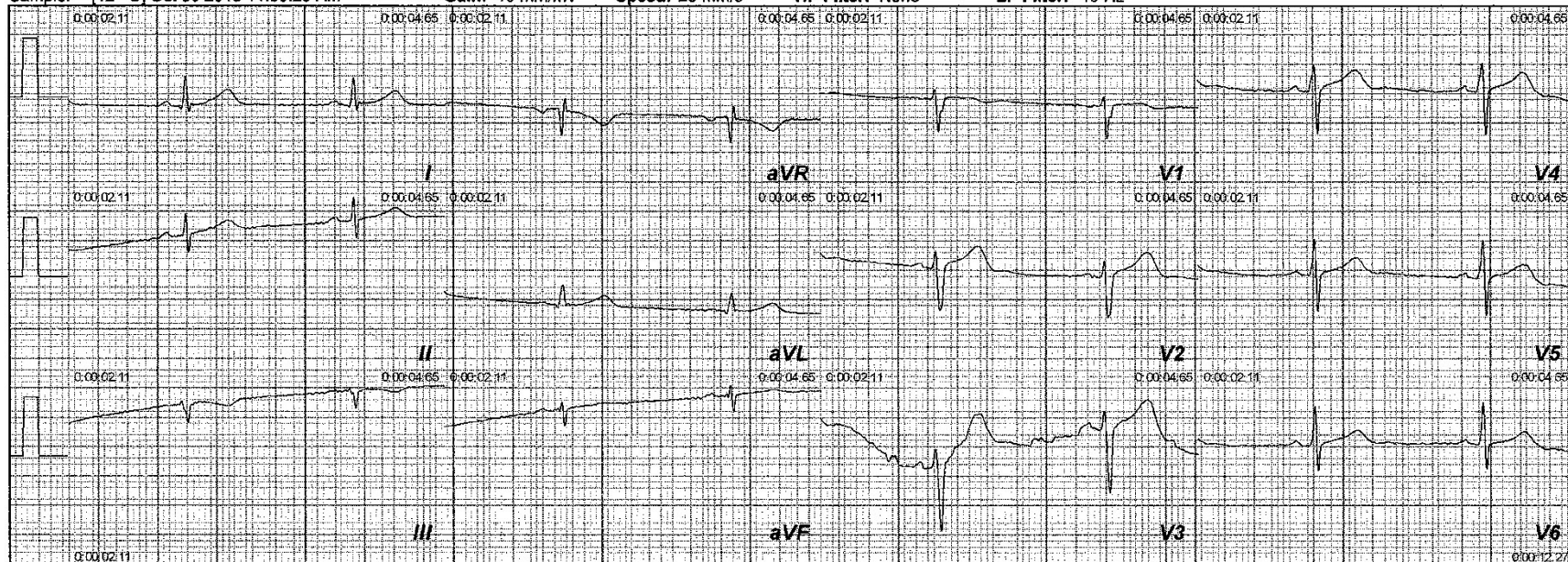
Sample: -- [12 - U] Oct 30 2013 11:50:29 AM

Gain: 10 mm/mV

Speed: 25 mm/s

HP Filter: None

LP Filter: 40 Hz



HOLTER MONITOR REPORT

Patient Name:		Physician:	David Newman
Date of Birth:		Scan Number:	2013-10-21 11:33
ID #:		Date Recorded:	10/18/2013
Age:	40 Years	Date Processed:	10/21/2013
Sex:	M	Recorder Num:	007015
Analyst:	IK	HookupTech:	MT
Interp.Physician:	David Newman	Height:	0 -- Weight: 0 -- BMI: 0
Indications:	Rhythm assessment	Medications:	

DN-S Wise, Joseph G was monitored for a total of 47:59 hours. The total time analyzed was 46:32 hours. Start time was 2:26PM1. There were a total of 172239 beats. Less than 1% were Ventricular beats, less than 1% were Supraventricular beats.

Mean Heart Rate: 62

Maximum Heart Rate: 102 at 10:50:25PM1

Minimum Heart Rate: 40 at 6:18:21AM2

Pauses: 0 (Greater than 2.5 sec.)

Ventricular Ectopy

Total: 196
 Single: 191
 Pairs: 2
 Total Runs: 0
 Beats in Runs: 0
 #beats @ rate
 Longest Run: 0 @ 2:26PM1 0
 Fastest Run: 0 @ 2:26PM1 0
 RonT: 1

Supraventricular Ectopy

Total: 338
 Single: 333
 Pairs: 1
 Total Runs: 1
 Beats in Runs: 3
 #beats @ rate
 Longest Run: 3 @ 2:43PM1 158
 Fastest Run: 3 @ 2:43PM1 158
 Aberrant: 0

RR Variability

SDNN: 180 ms
 pNN50: 25.02 %
 RMSSD: 102 ms

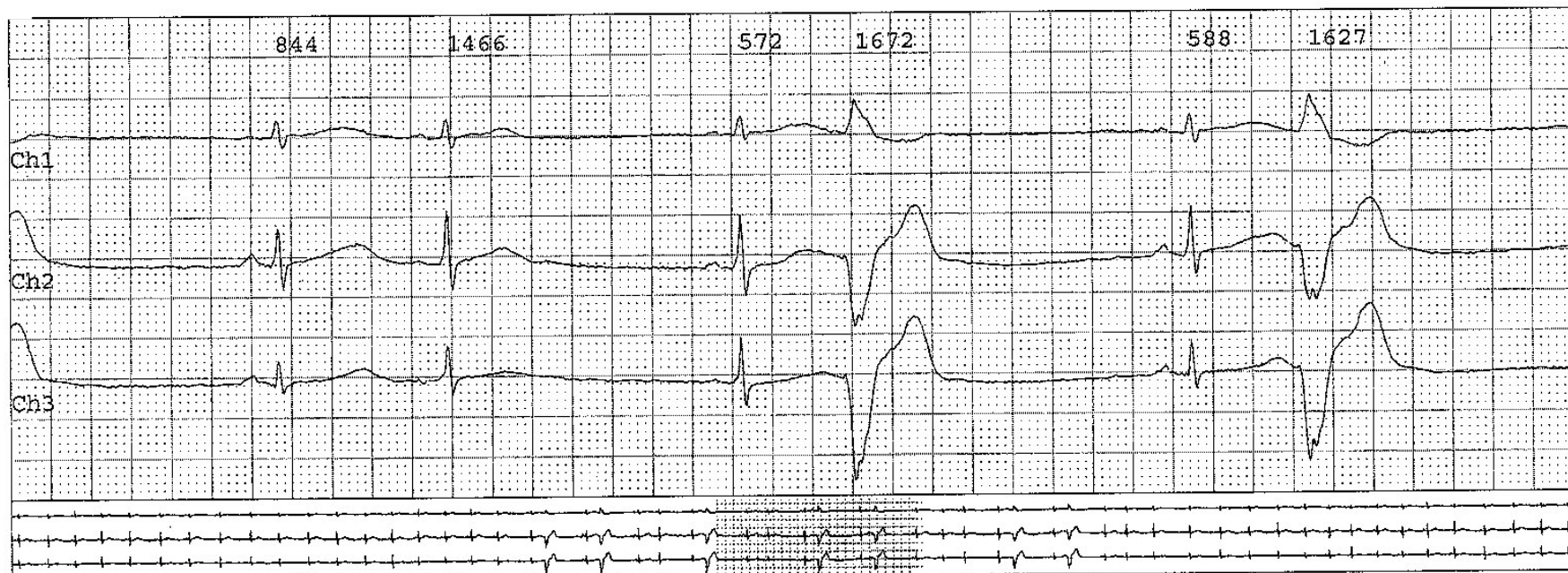
ST Absolute

Depression: *** mm
 Elevation: *** mm

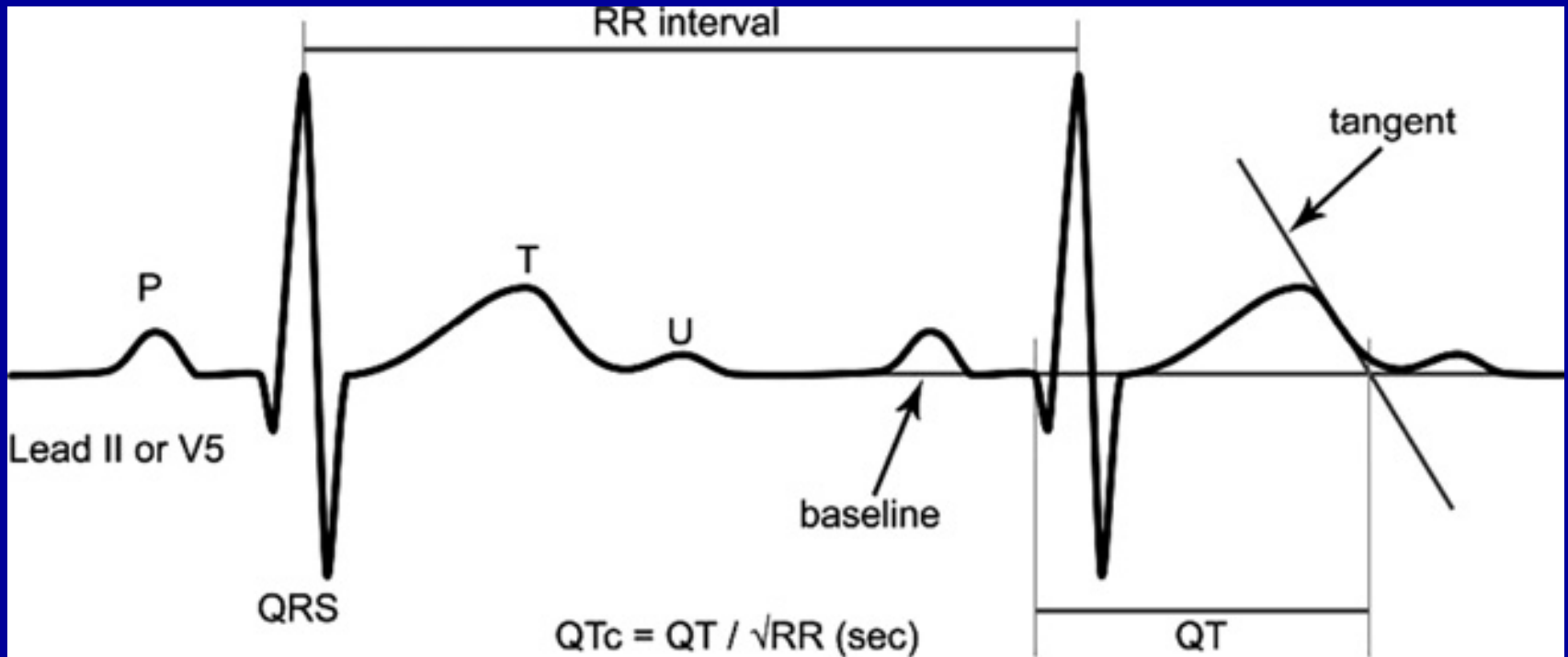
3:47:36AM3

Quadrigeminy

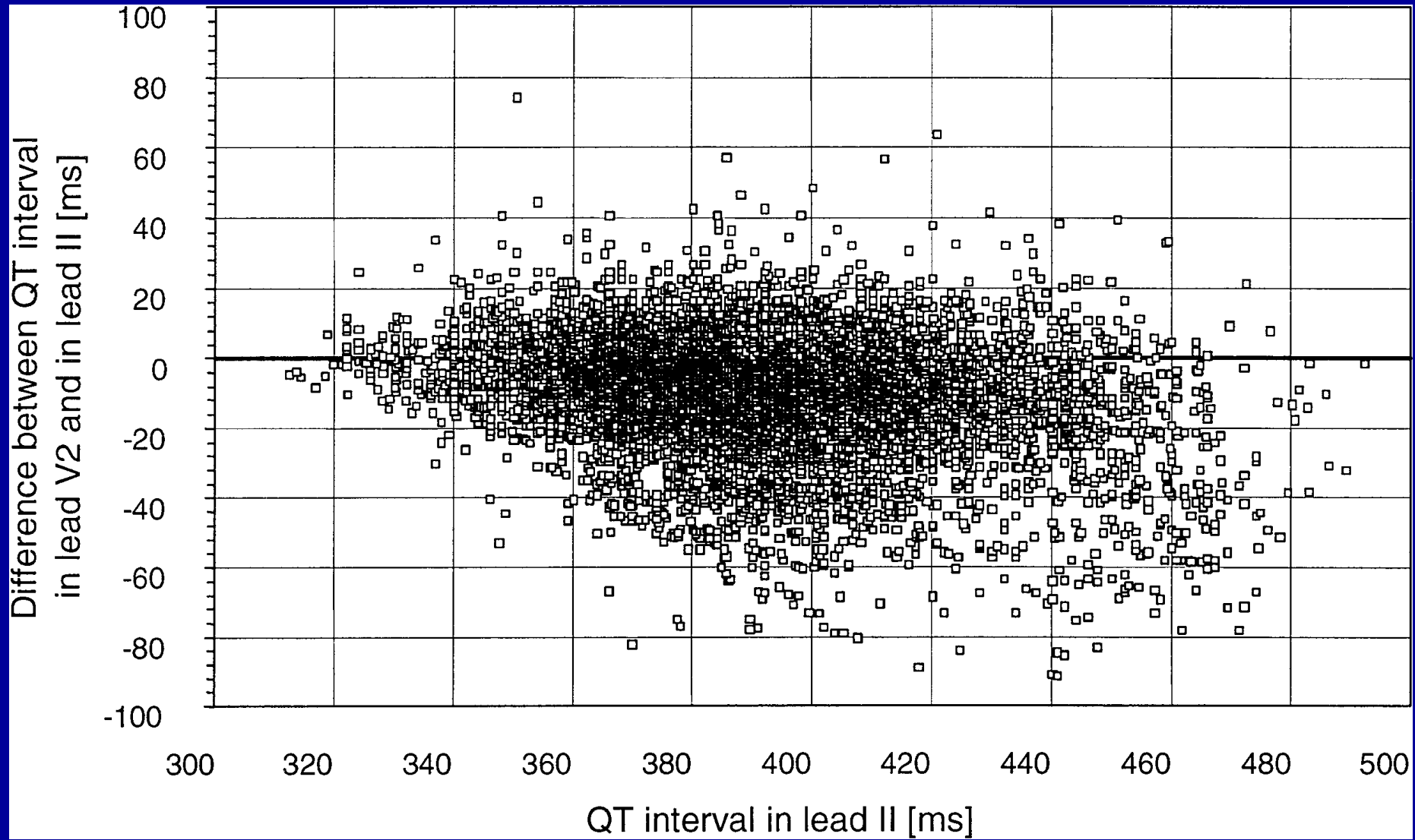
HR = 56



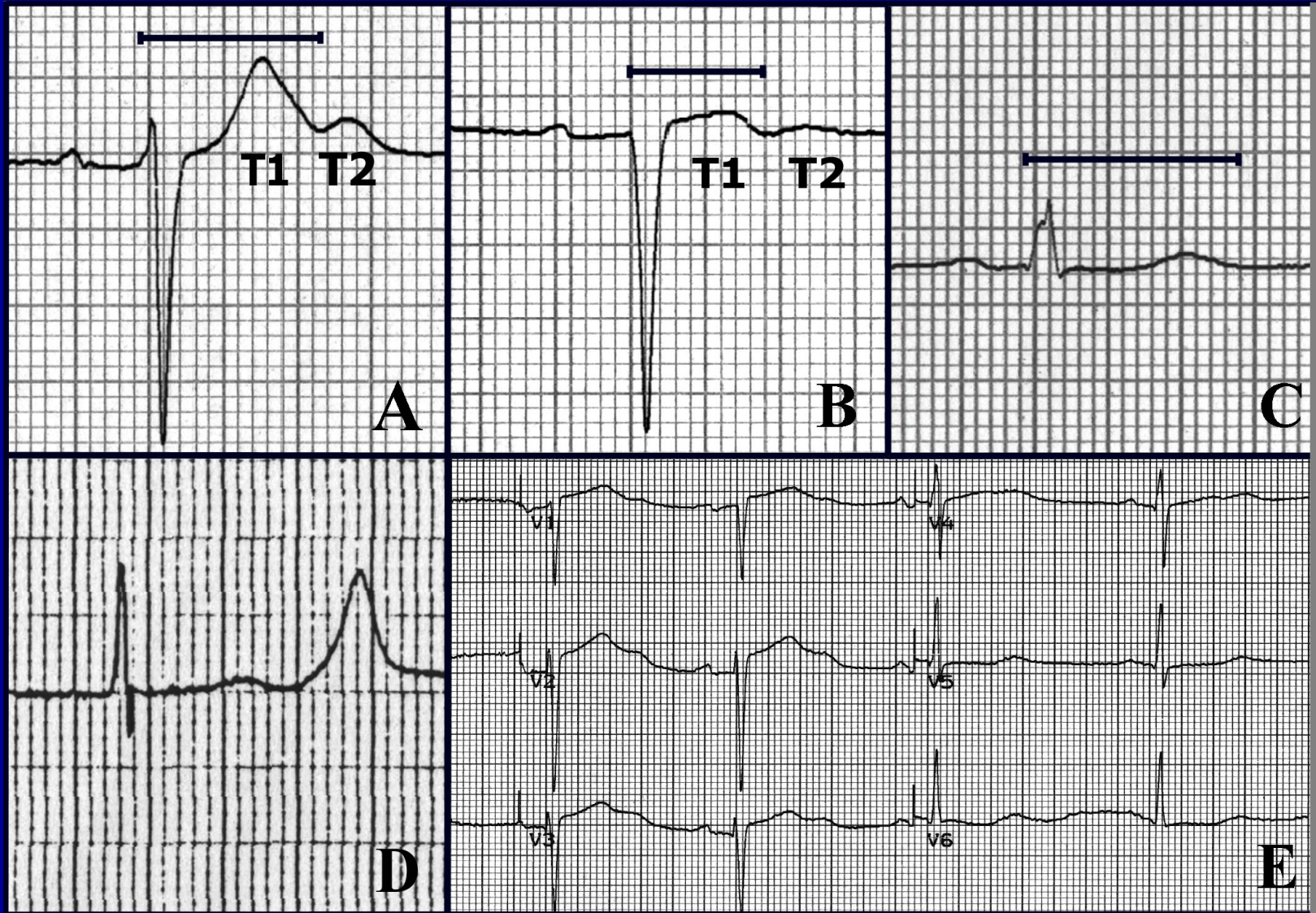
Accurate electrocardiographic assessment of the QT interval: Teach the tangent



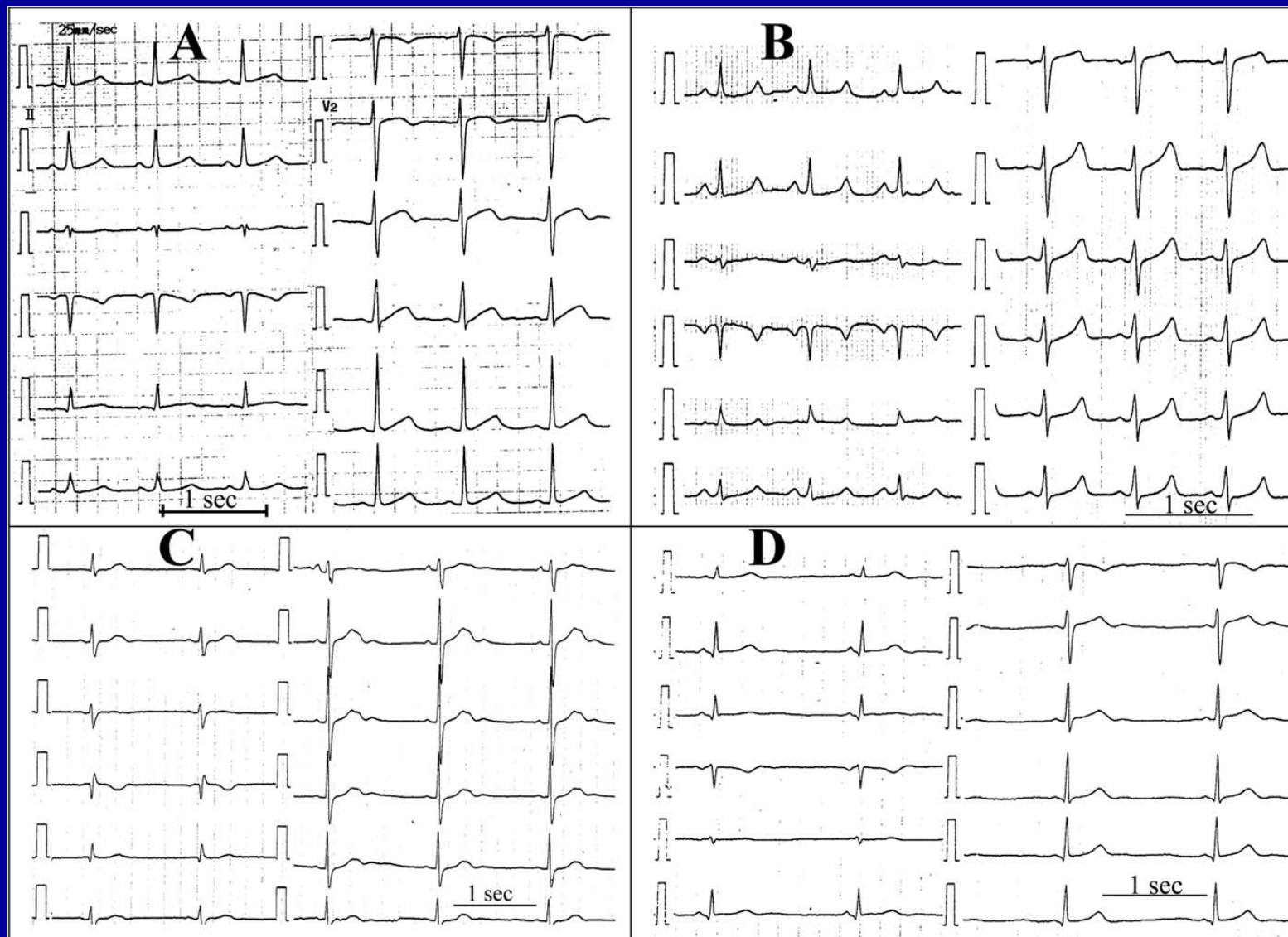
N=75, medical students, correct diagnosis 70%



Patterns of QT Prolongation



**Inaccurate electrocardiographic interpretation of long QT:
The majority of physicians cannot recognize a long QT
when they see one**

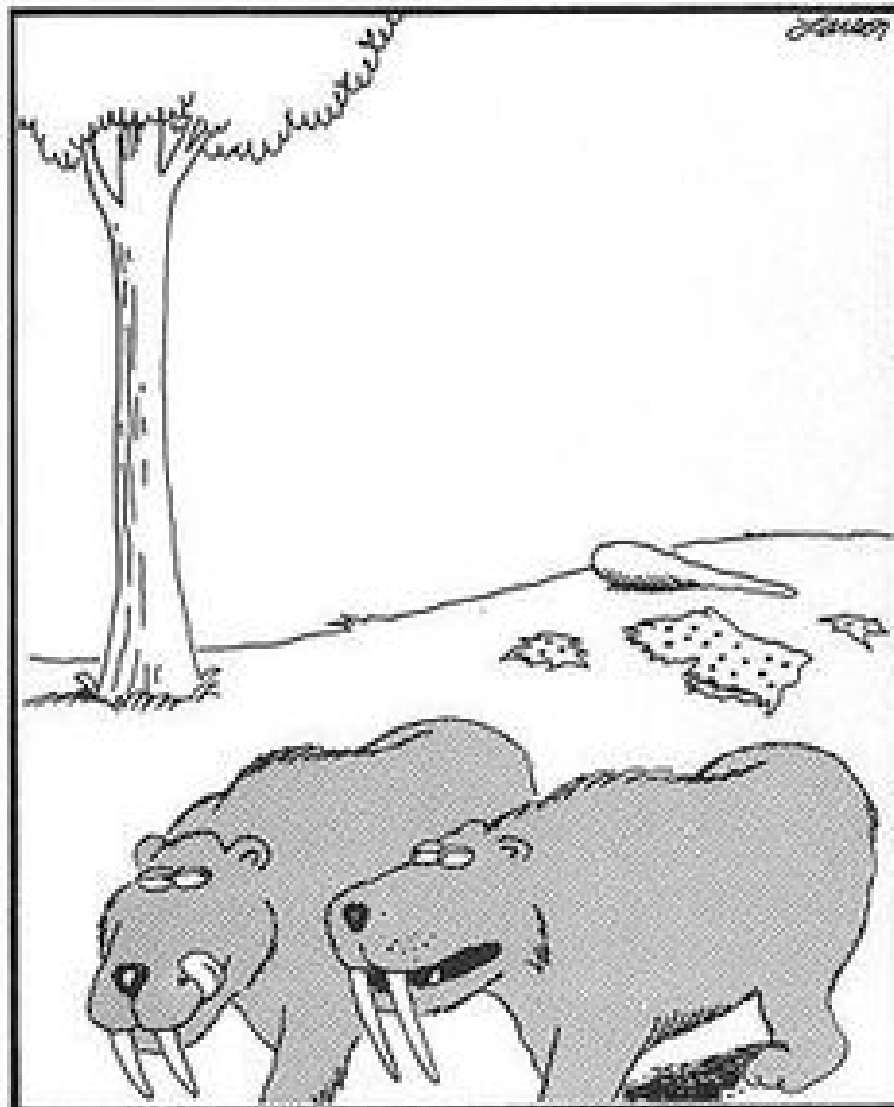


Inaccurate electrocardiographic interpretation of long QT: The majority of physicians cannot recognize a long QT when they see one

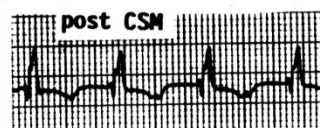
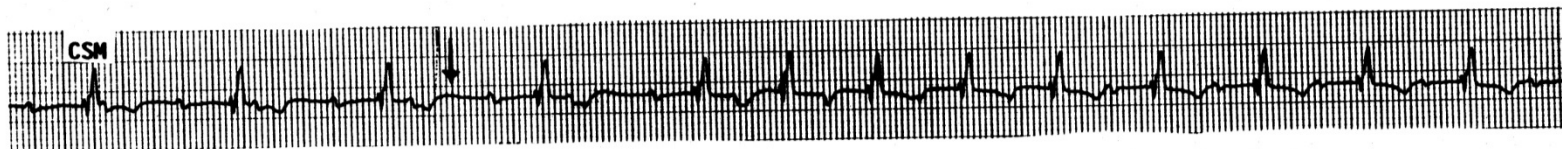
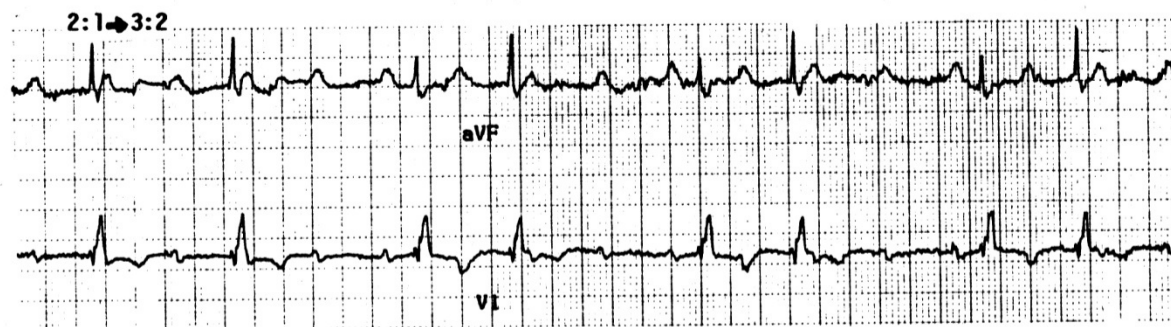
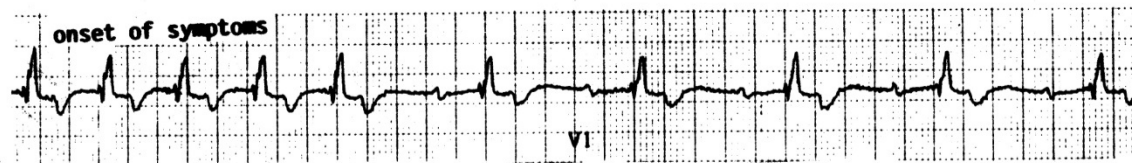
<u>N</u>	<u>category</u>	<u>correct</u>
25	expert	96%
106	EP's	62%
329	card's	<25%
442	non-card	<25%

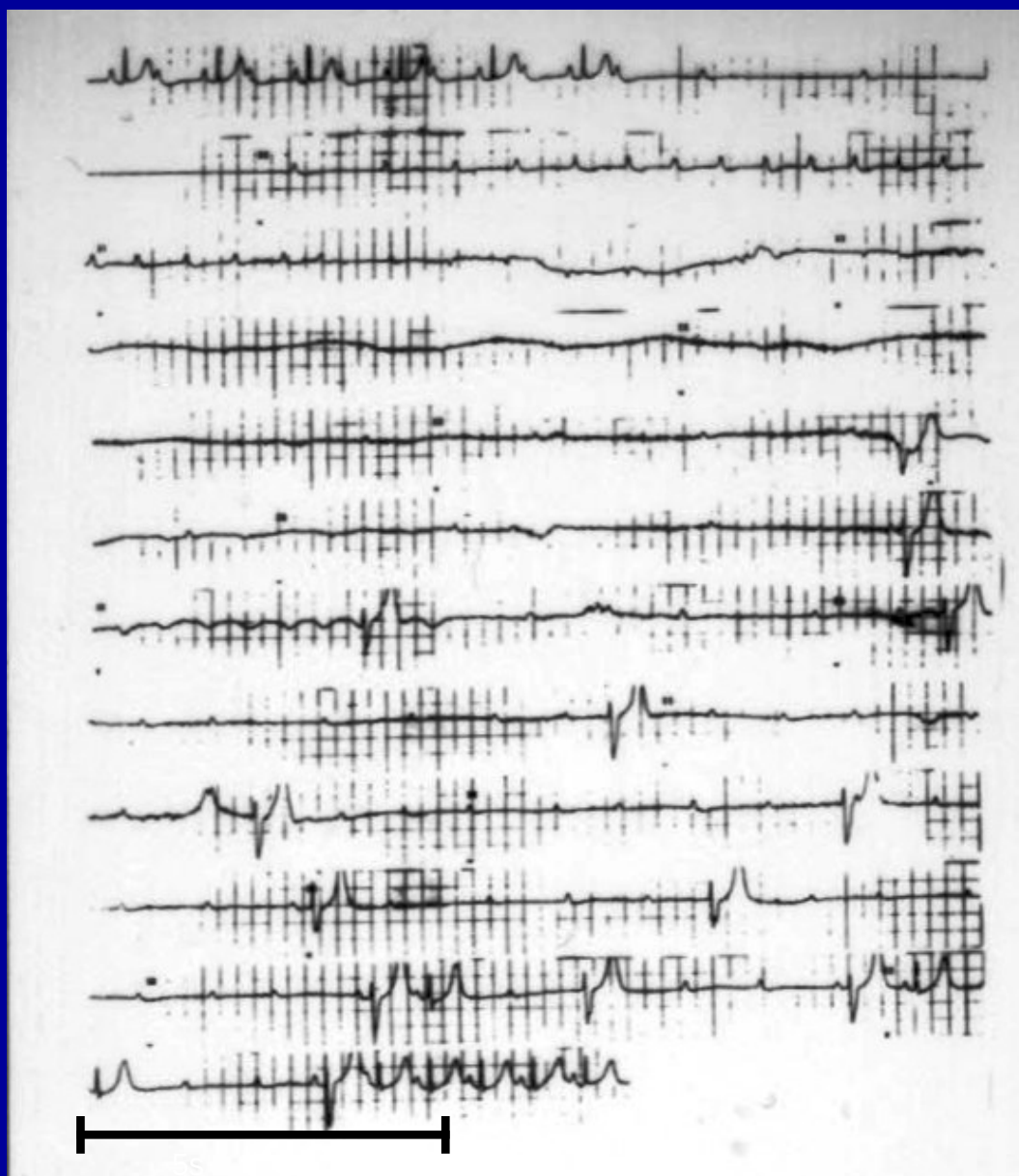
Uses and pitfalls of EKG's to predict *Torsades*:

- QT vs QTC
- correction formulae
- QT vs T morphology
- QT variability (measurement error, circadian postural, hysteresis, etc...)
- fixed, arbitrary “normal values”



"I've heard all kinds of sounds from these things, but 'yabba dabba doo' was a new one to me."





Keep to simple principles...

53, followed 15 yr

PRK-AG2 IHSS with AS AP

Ablation with delayed syncopal high grade AVB (centre #1 UK)

unipolar VVI (centre #2 UK)

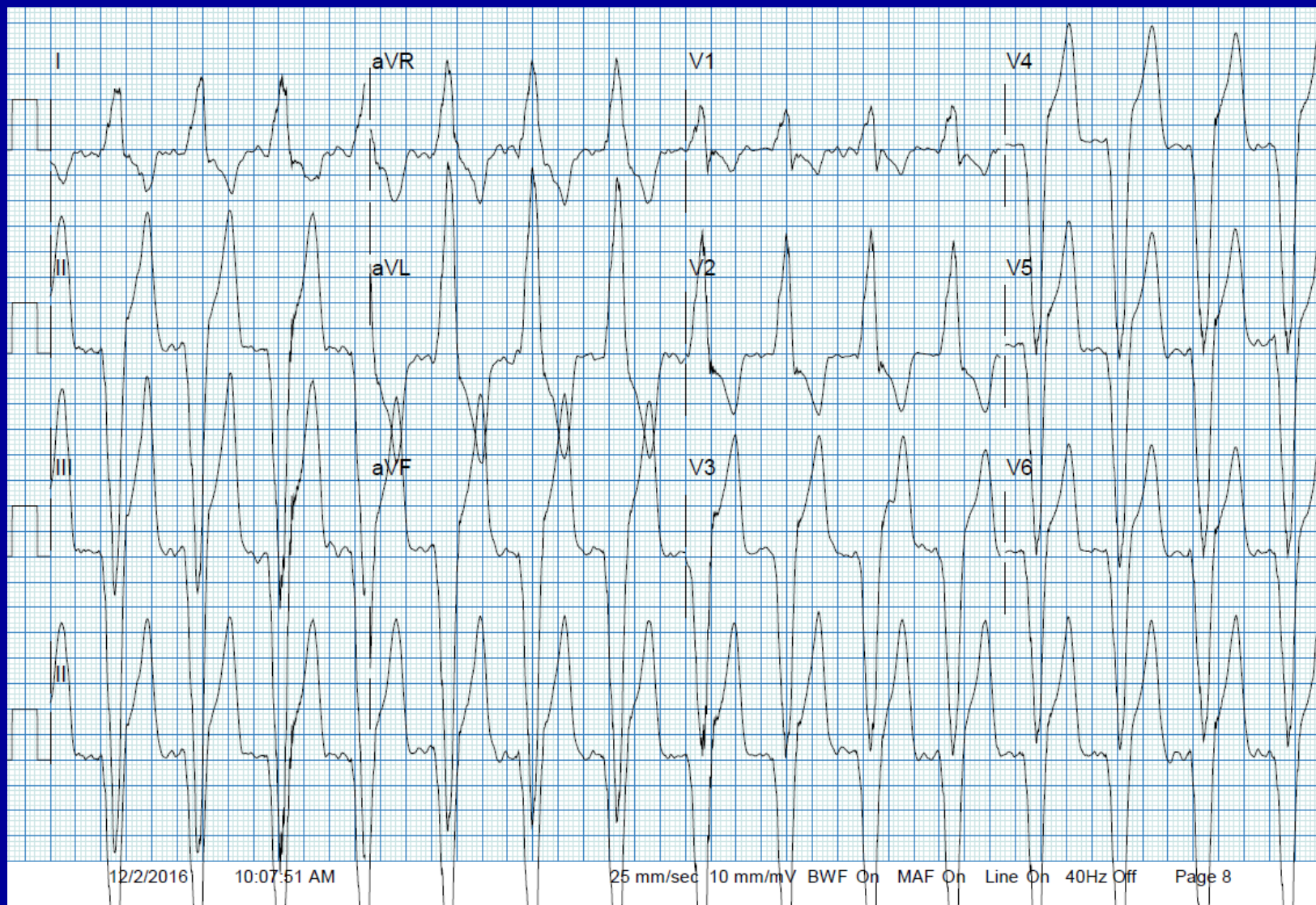
10 mo later myopotential inhibition syncope

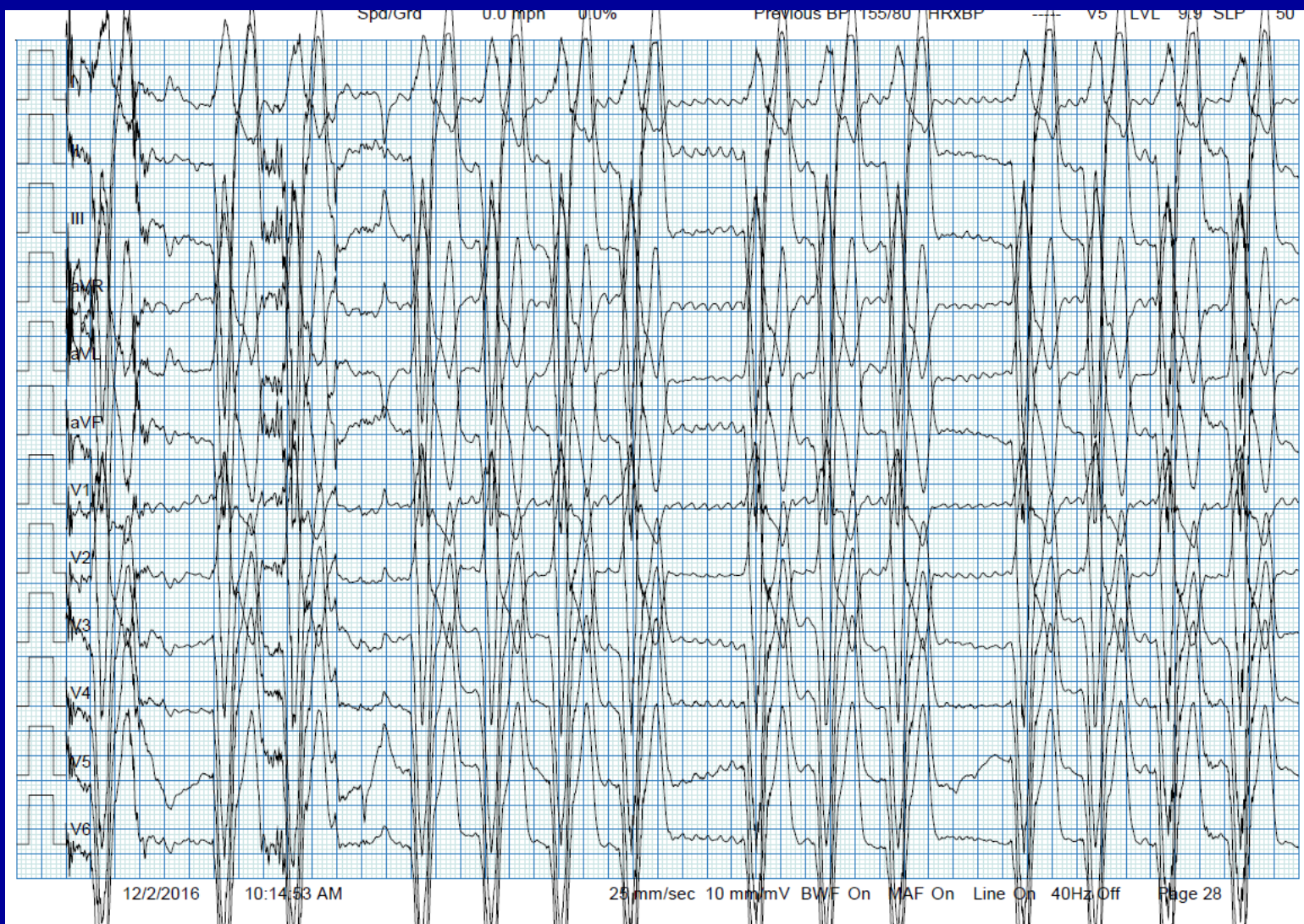
Upgrade to DDD (centre #3 Toronto)

2 yr later hyperthyroid: 2:1 flutter; onto CTI + AVJ (centre #3)

Onto asymptomatic permanent afib

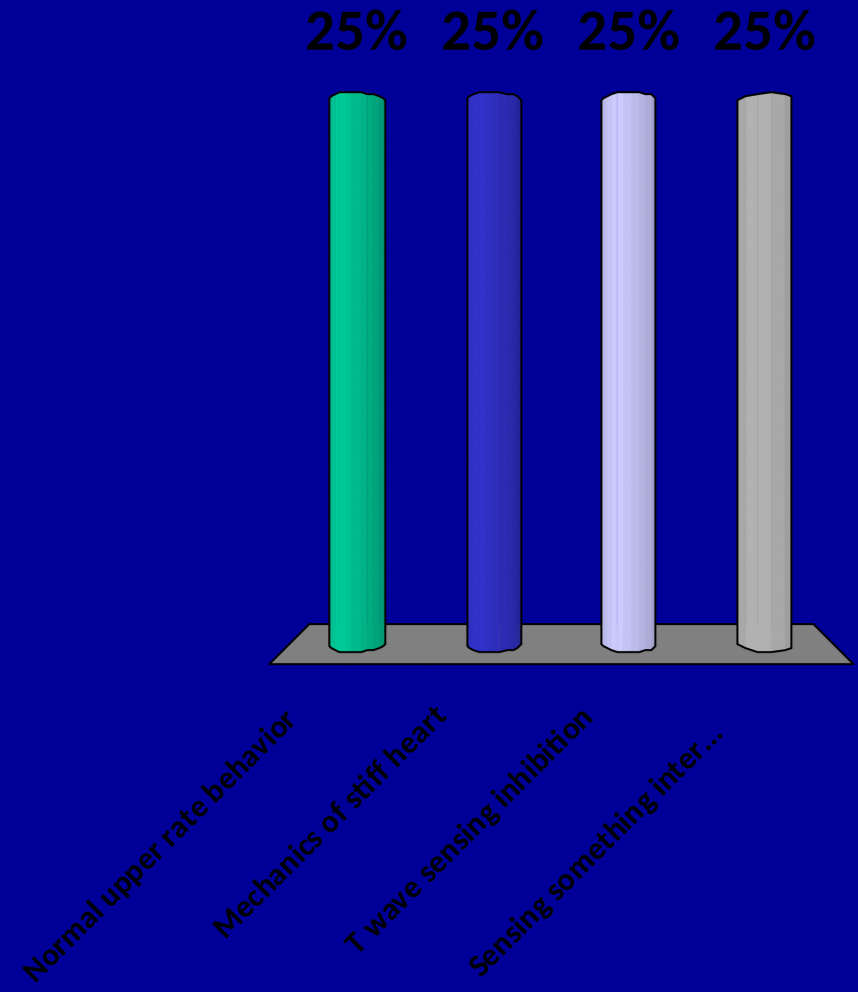
At EOL SJM VVI –R , yearly f/u





Hmmm, feels poorly...

- A. Normal upper rate behavior
- B. Mechanics of stiff heart
- C. T wave sensing inhibition
- D. Sensing something intermittently



Parameters

Page 1 of

Patient

Date of Birth 22 Mar 1963
EF % 55 %

Indications for Implant

Atrial Fibrillation (AF), AV Node Ablation, Hypertrophic Cardiomyopathy

Implant Notes

CAPPED A AND V P/S LEADS

Device	Manufacturer	Model	Serial	Implant Date
ICD	St. Jude Medical	Fortify Assura™ VR 1359-40QC	1121884	2 Sep 2014
V Lead	St. Jude Medical	Durata™ 7121Q / 58 cm	BNU017772	2 Sep 2014

Basic Operation

Mode VVIR
Magnet Response Normal
V. Noise Reversion Mode VOO
Sensor On
Threshold (Measured Avg.) Auto (+0.0) (2.0)
Slope 10
Max Sensor Rate 150 min⁻¹
Reaction Time Medium
Recovery Time Fast

Refractories & Blanking

Rate Responsive V Ref Low
Shortest V Ref 175 ms
V Pace Refractory 190 ms
V Sense Refractory 125 ms
Arrhythmia Unhiding 3 intervals

Rates

Base Rate 60 min⁻¹
Rest Rate Off
Max Sensor Rate 150 min⁻¹
Hysteresis Rate Off

Capture & Sense

AutoCapture V
On
Backup Pulse Configuration Bipolar
Search Interval 24 hours
Pulse Amplitude 1.0 V **A**
Pulse Width 0.8 ms
AutoSense On
Sensitivity Auto **A**

Leads

V
Lead Type Bipolar
Pulse Configuration Bipolar
Sense Configuration Bipolar
Lead Monitoring Monitor
Lower Limit 200 Ω
Upper Limit 2,000 Ω
HVLI Lower Limit 20 Ω
HVLI Upper Limit 125 Ω

Parameters

Page 1 of

Patient

Date of Birth 22 Mar 1963
EF % 55 %

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Atrial Fibrillation (AF), AV Node Ablation, Hypertrophic Cardiomyopathy

Implant Notes

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Device	Manufacturer	Model	Serial	Implant Date
ICD	St. Jude Medical	Fortify Assura™ VR 1359-40QC	1121884	2 Sep 2014
V Lead	St. Jude Medical	Durata™ 7121Q / 58 cm	BNU017772	2 Sep 2014

Basic Operation

Mode	VVIR	Rate Responsive V Ref	Low
Magnet Response	Normal	Shortest V Ref	175 ms
V. Noise Reversion Mode	VOO	V Pace Refractory	190 ms
Sensor	On	V Sense Refractory	125 ms
Threshold (Measured Avg.)	Auto (+0.0) (2.0)	Arrhythmia Unhiding	3 intervals
Slope	10		
Max Sensor Rate	150 min ⁻¹		
Reaction Time	Medium		
Recovery Time	Fast		

Refractories & Blanking

Rates

Base Rate	60 min ⁻¹
Rest Rate	Off
Max Sensor Rate	150 min ⁻¹
Hysteresis Rate	Off

Capture & Sense

AutoCapture	On
Backup Pulse Configuration	Bipolar
Search Interval	24 hours
Pulse Amplitude	1.0 V A
Pulse Width	0.8 ms
AutoSense	On
Sensitivity	Auto A

Leads

Lead Type	V
Pulse Configuration	Bipolar
Sense Configuration	Bipolar
Lead Monitoring	Monitor
Lower Limit	200 Ω
Upper Limit	2,000 Ω
HVLI Lower Limit	20 Ω
HVLI Upper Limit	125 Ω

Auto sensing:

Amplifies high frequency signals

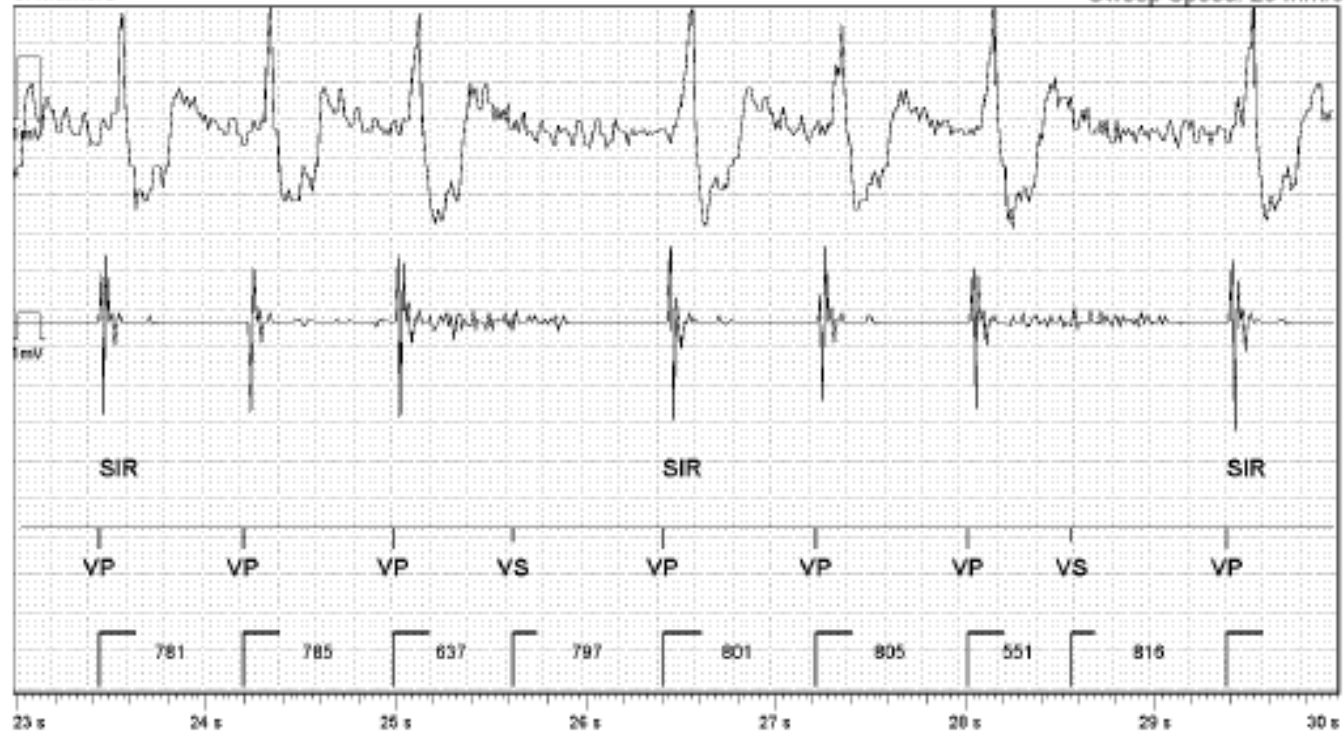
Dampens low frequency signal

1: Leadless ECG AutoGain (8.4 mm/mV)

2: V Sense Amp AutoGain (3.5 mm/mV)

3: Markers

Sweep Speed: 25 mm/s



Fortify Assura™ VR 1359-40QC ICD (1121884 pr15.02.10)

Merlin™ PCS (#22711 3330 v20.0.1.2 rev 1)

Freeze Capture Page 1 of 1

6 Jan 2017 14:44

Deep breathing in recovery

RVOT/VPB drug management

Is it benign?



RVOT/VPB drug management

Is it benign?

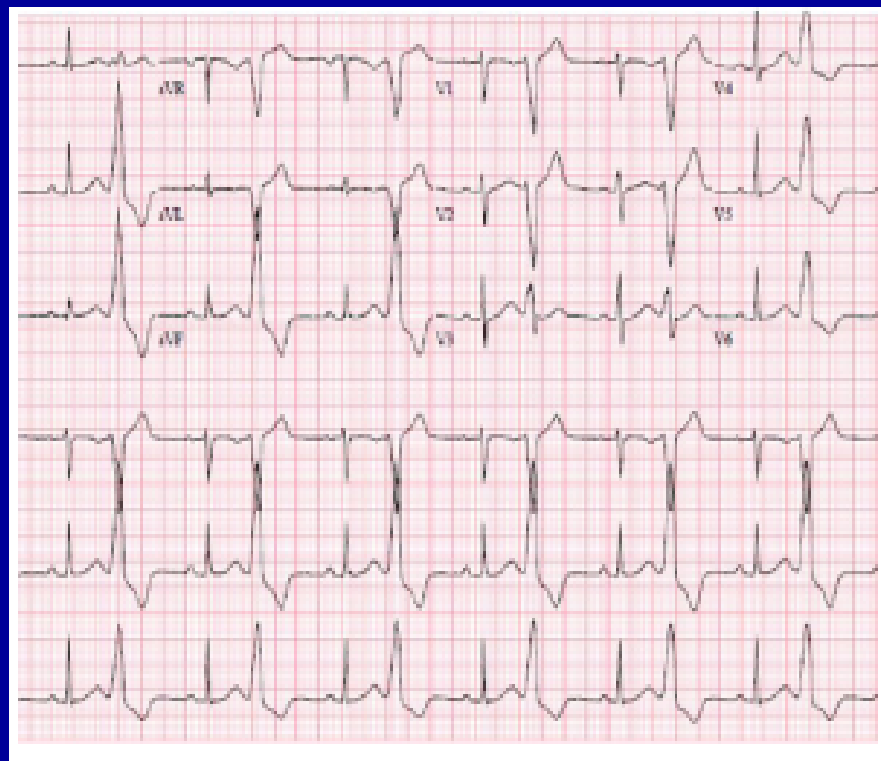
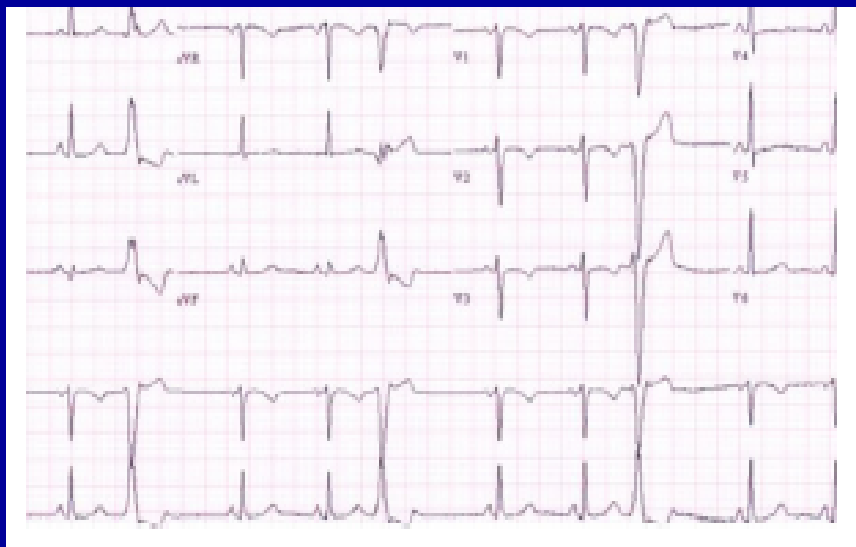


Table 1 Electrocardiographic ARVD/C risk score

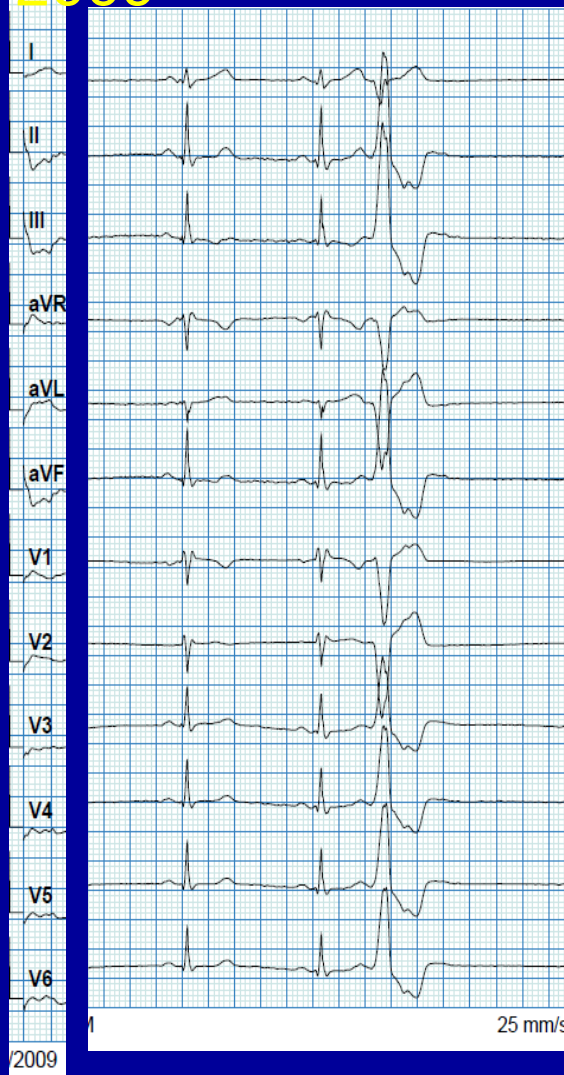
ECG characteristic	Points
Anterior T-wave inversions (V_1 - V_3) in sinus rhythm	3
VT/PVC	
Lead I QRS duration ≥ 120 ms	2
QRS notching (multiple leads)	2
V_5 transition or later	1
Maximum total	8

>5/8 pts

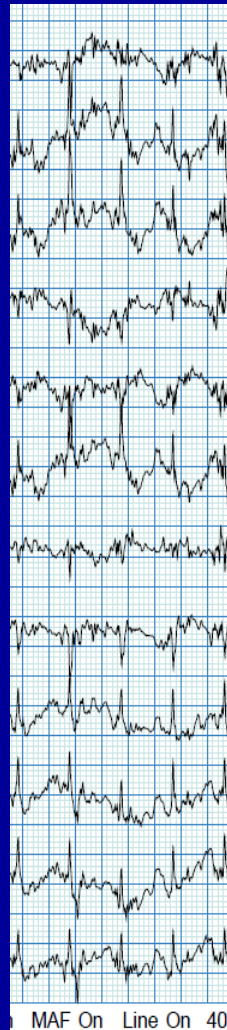
+ve PV 100% -ve PV 91%

Hoffmayer .Heart Rhythm 10:477,2013

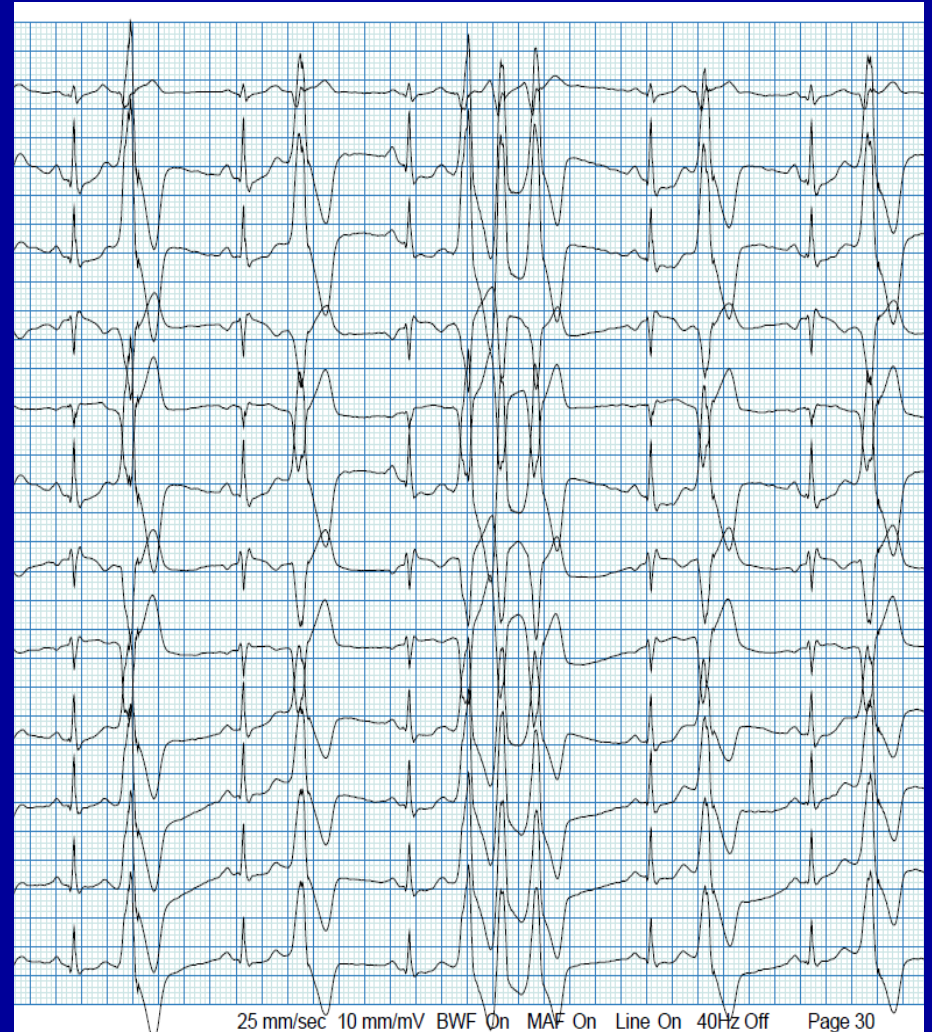
2009 Rest



exercise

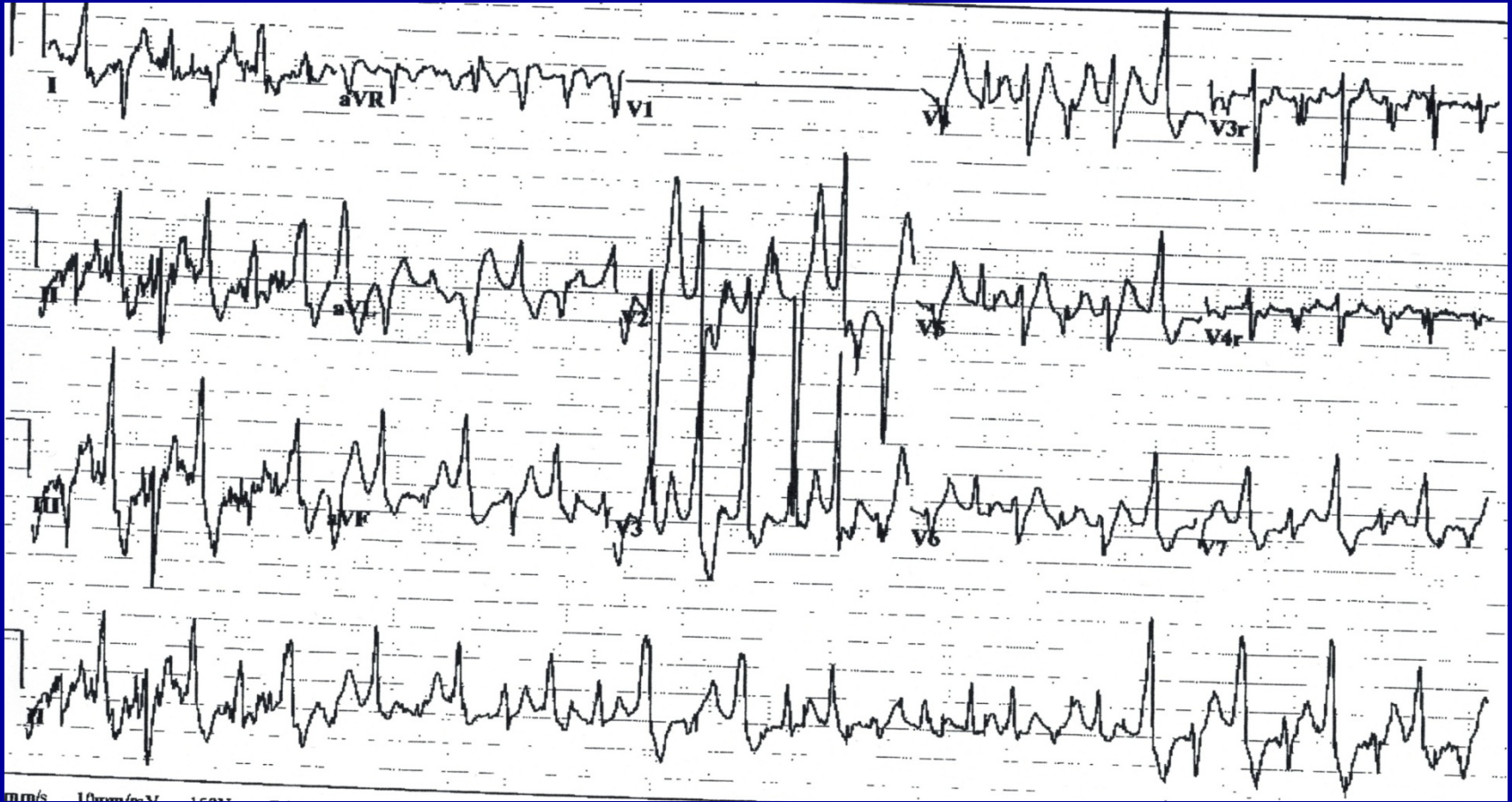


recovery



35 yr, atypical c/p, no symptoms, 20% ectopy, normal echo

CPMVT drug management



Tanya's daughter , age 10, 2011

07/20/14 10:44:11

10/23/1937

10-second Write Screen Manual

Protocol

Bruce

Stage

Spd/Grd

Recov 00:31

0.0 mph 0.0%

RPE

HR

0/

METs(a)

4.6

Target HR

144

II

LVL

-1.4

SLP

9

BP

Max HR

128

V2

LVL

0.4

SLP

-5

Previous BP 170/80

HRxBP

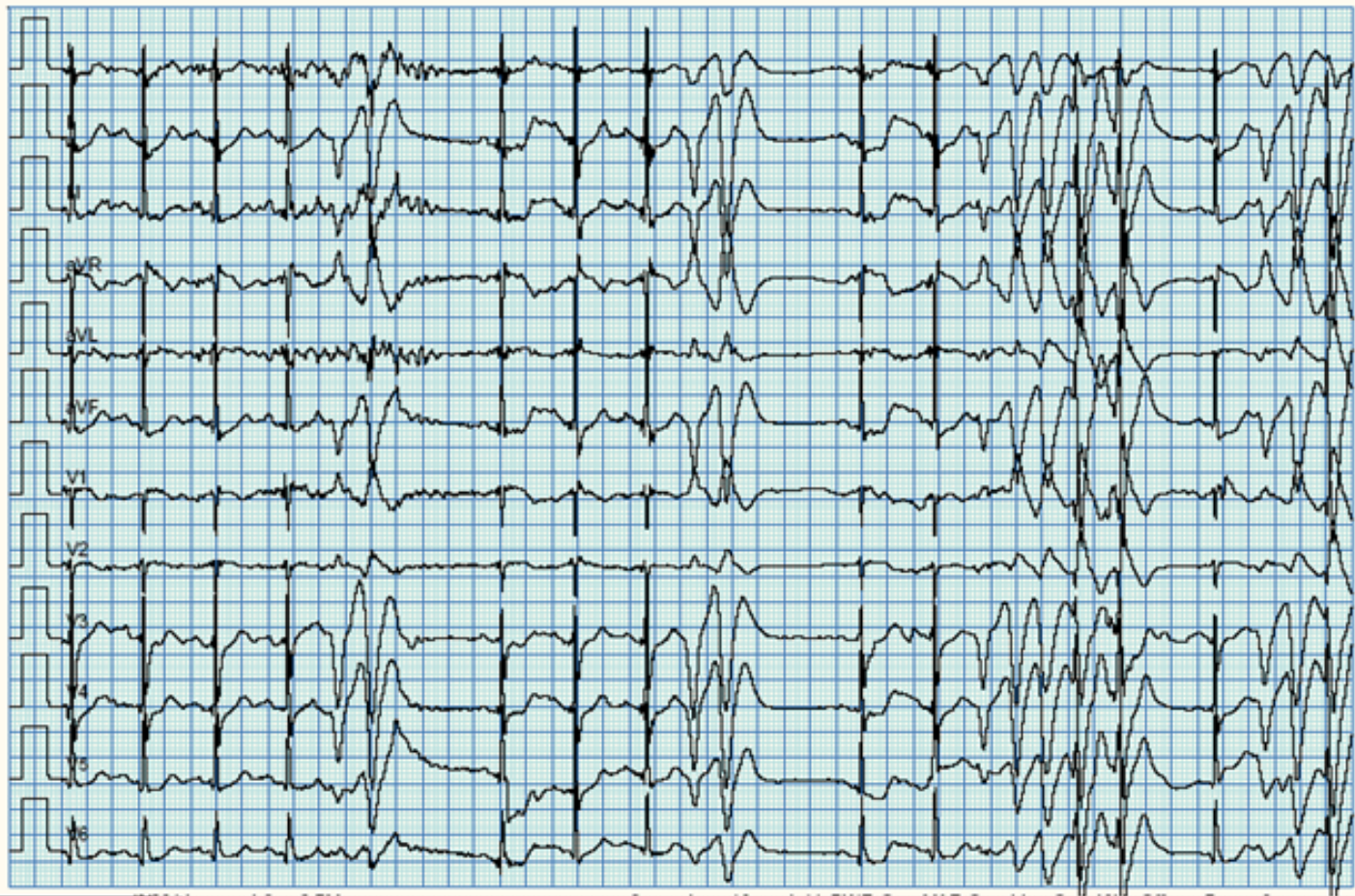
V5

LVL

-1.3

SLP

5



An approach to drug Tx of Idiopathic 'benign' VT

VPB

INDEX OF SUSPICION for LQT,CPMVT,ARVD

- 10 k /d (over 10%)
- Exclude structural heart
- Stress test
- Decide if it has concerning features :
 - CI < 360 ms
 - wide > 130 ms
 - inf ST shift on stress
 - notching
 - ant T inv

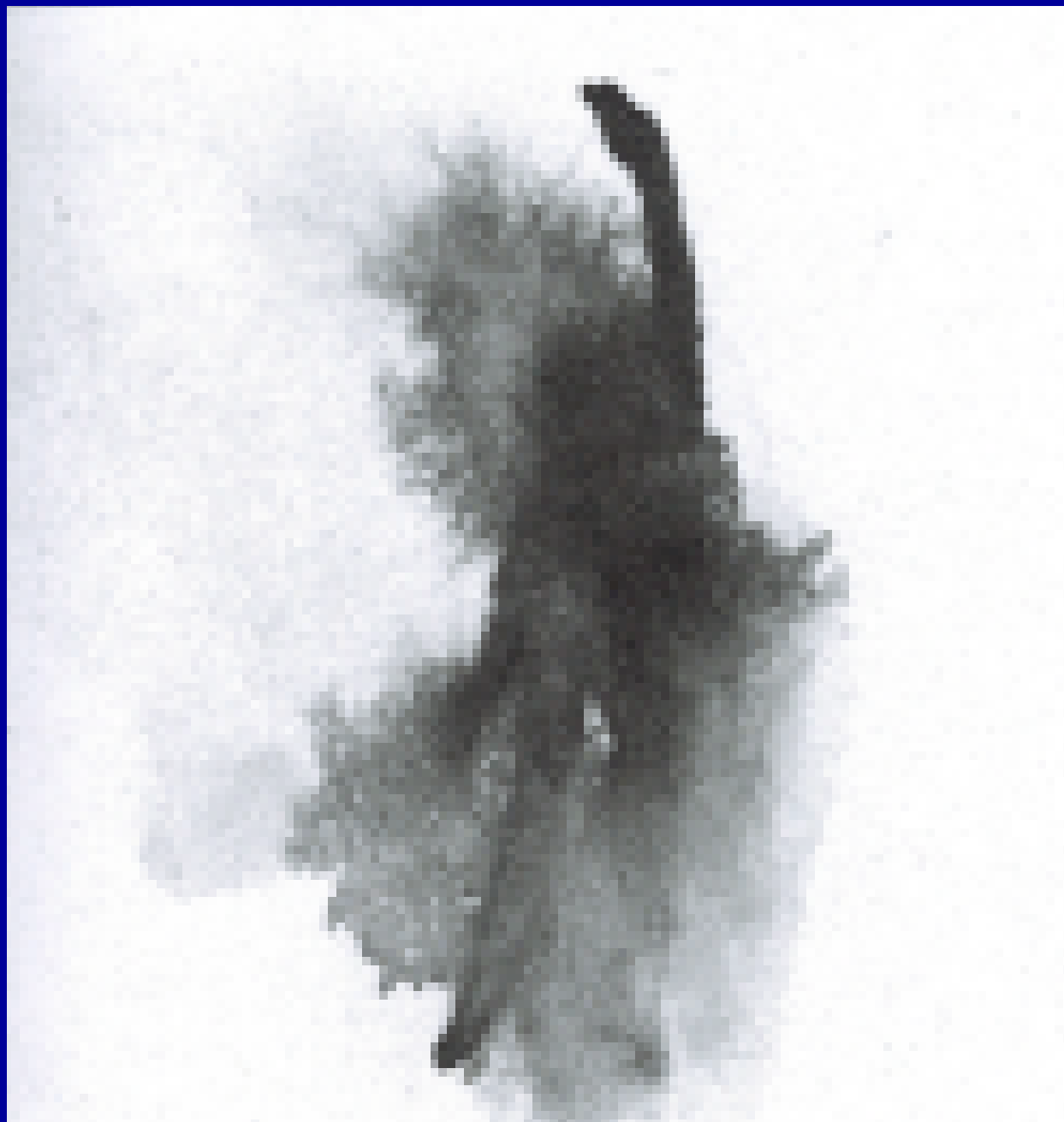
Monitor frequently and prolonged , ideally 12 lead holter

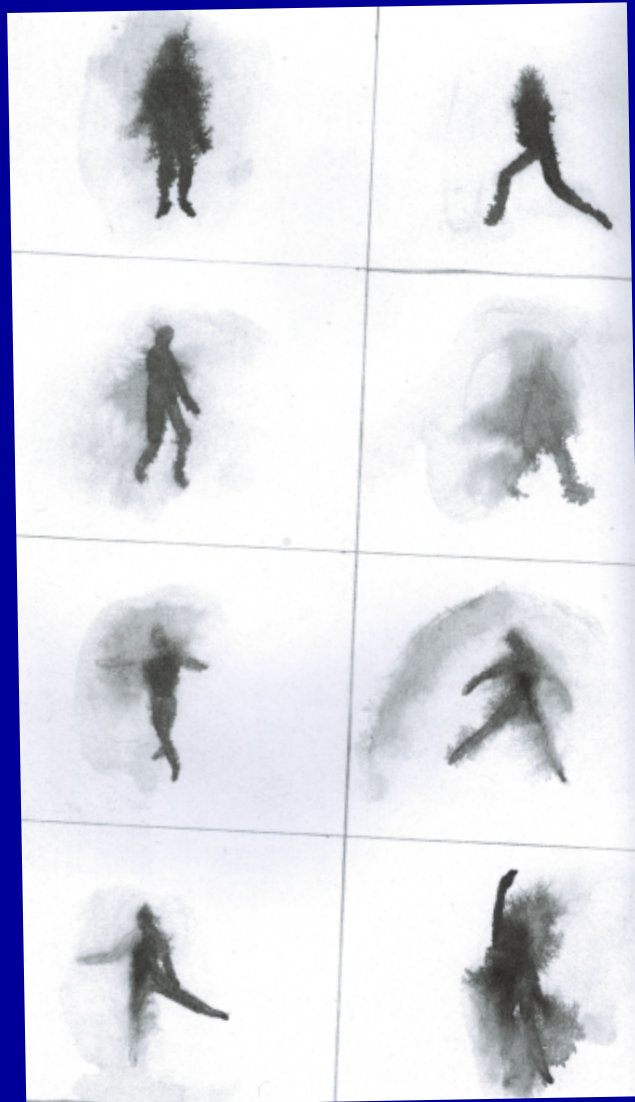
Symptoms rhythm correlation on monitor and stress

Metabolic screen

A word on noise....



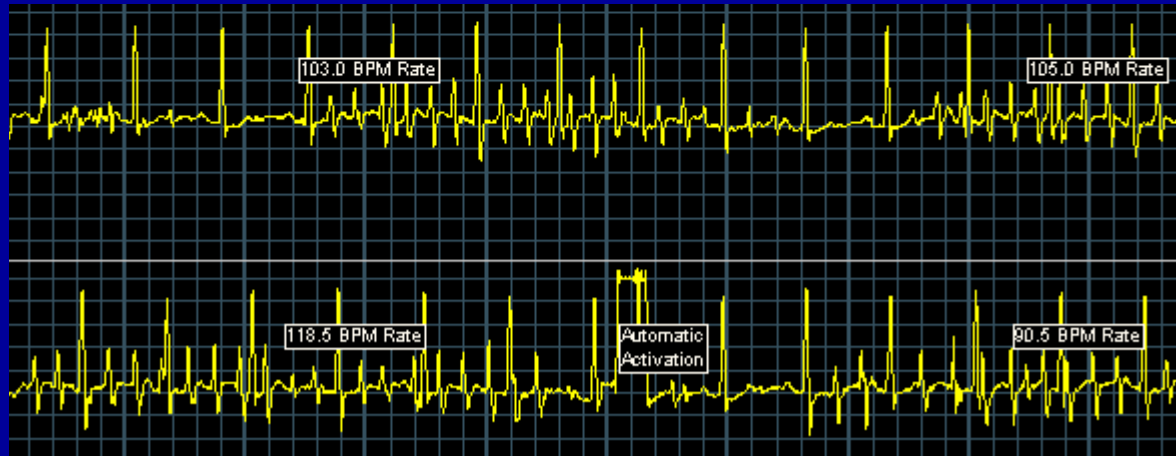




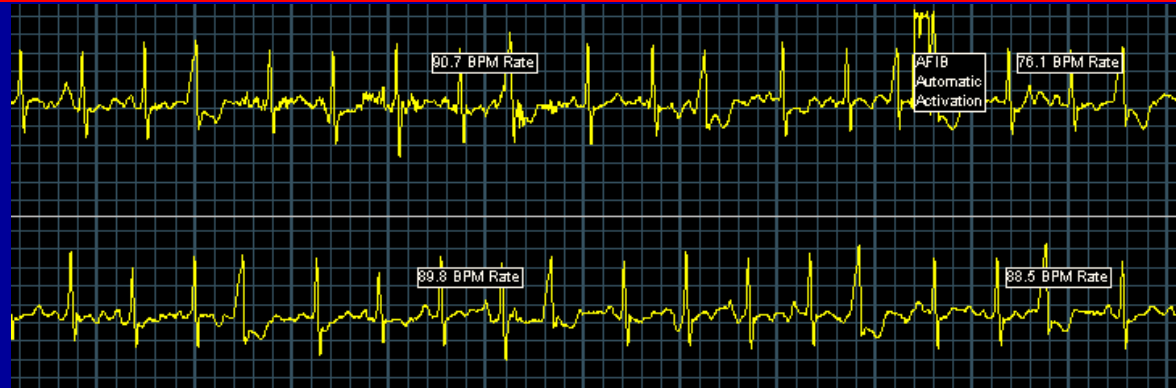
Aiden Koch, the dancer at midnight, 2012

signal: noise with ELR auto detecting

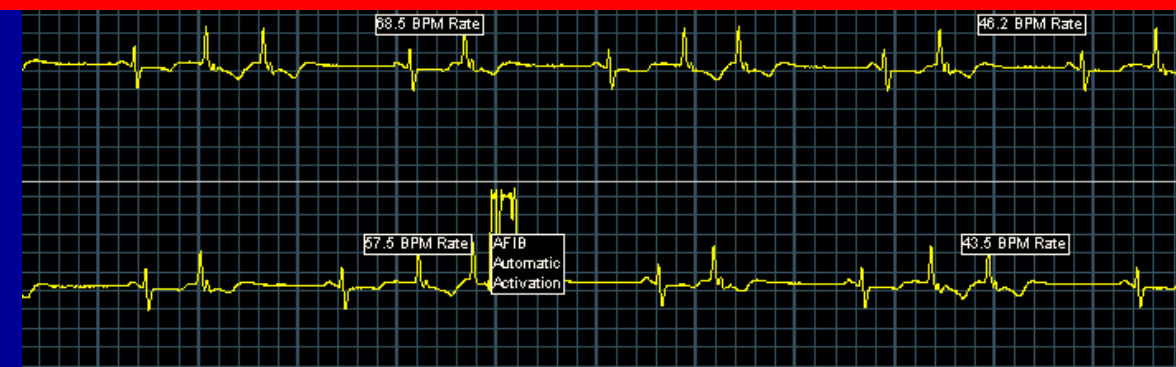
Case 1



Case 2



Case 3

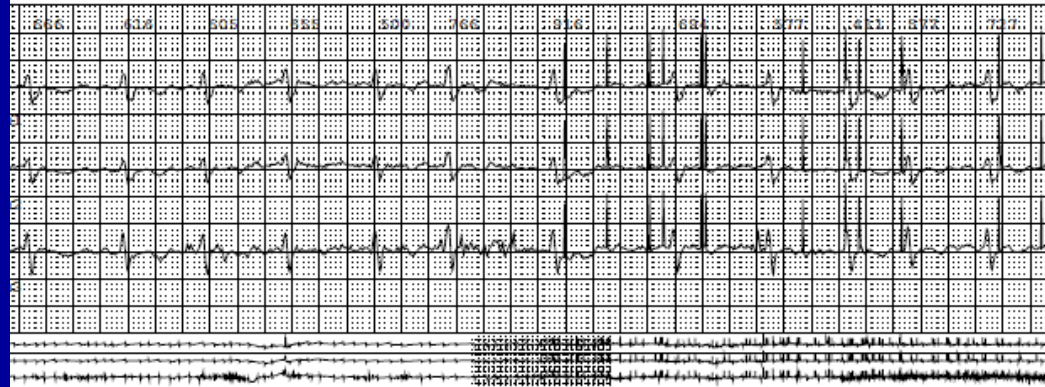


Gain[1.0] ECG 25 mm/sec

9:05:20pm-1

Sense failure

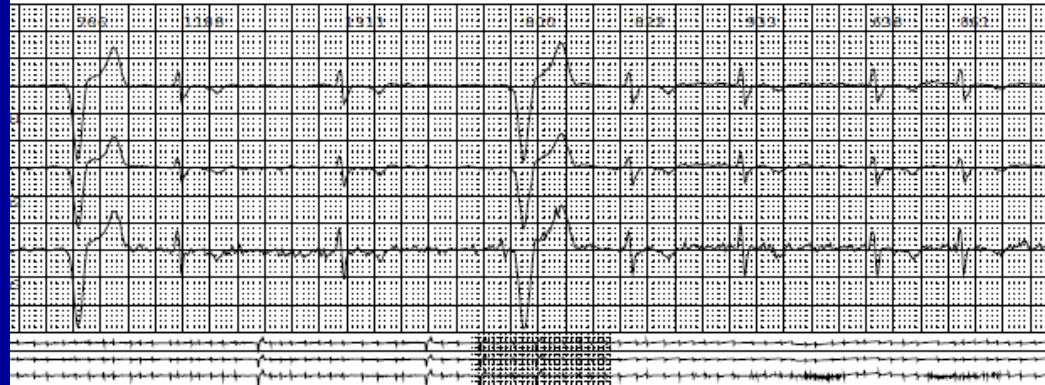
HR = 97



3:51:05pm-2

Trigeminy

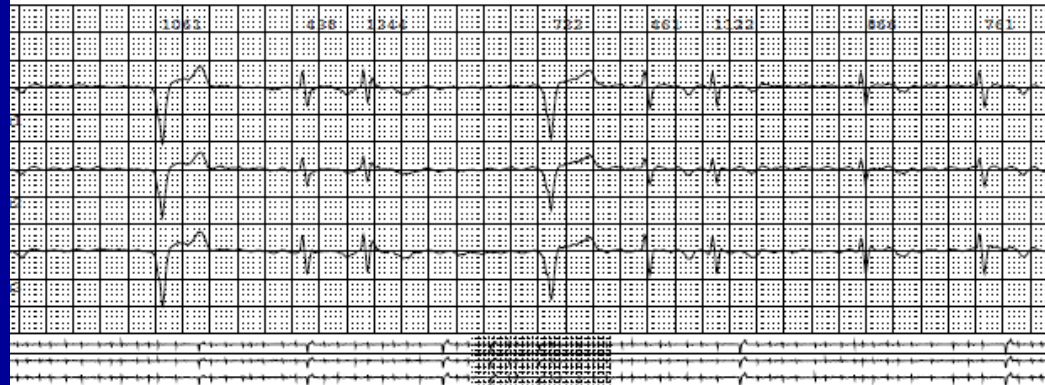
HR = 70



5:24:27am-3

Trigeminy

HR = 69



VVI-R

Asymptomatic

TA

Medical Record Number: 792000

Strip Report 25/03/2014 02:25:59

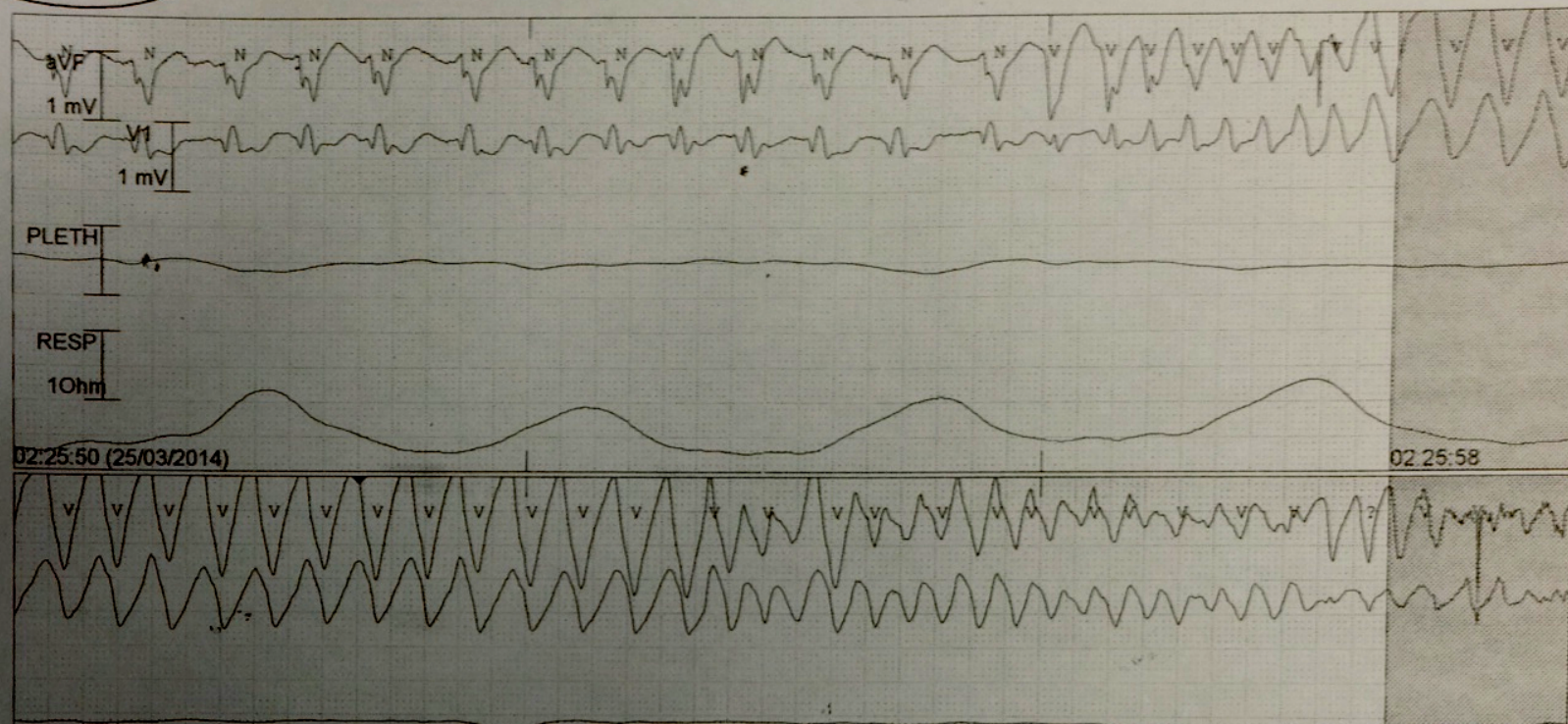
HR 156

%SpO2 92

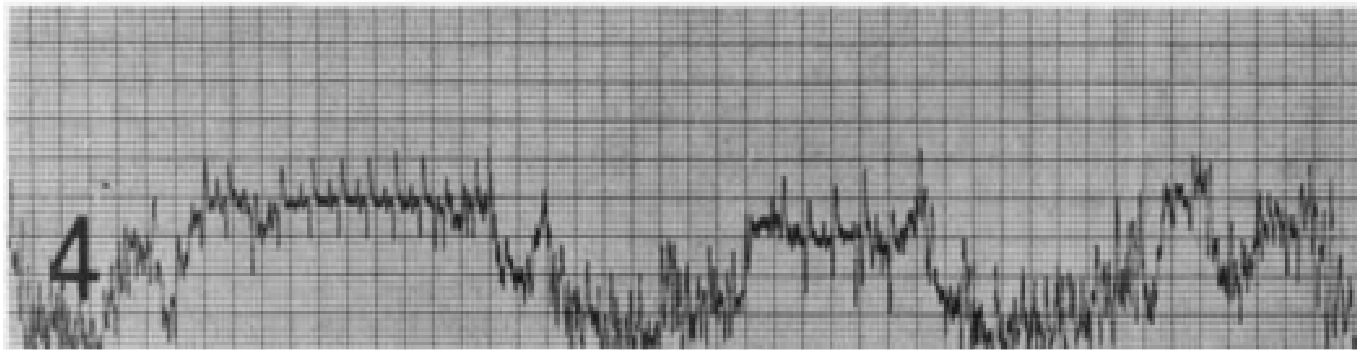
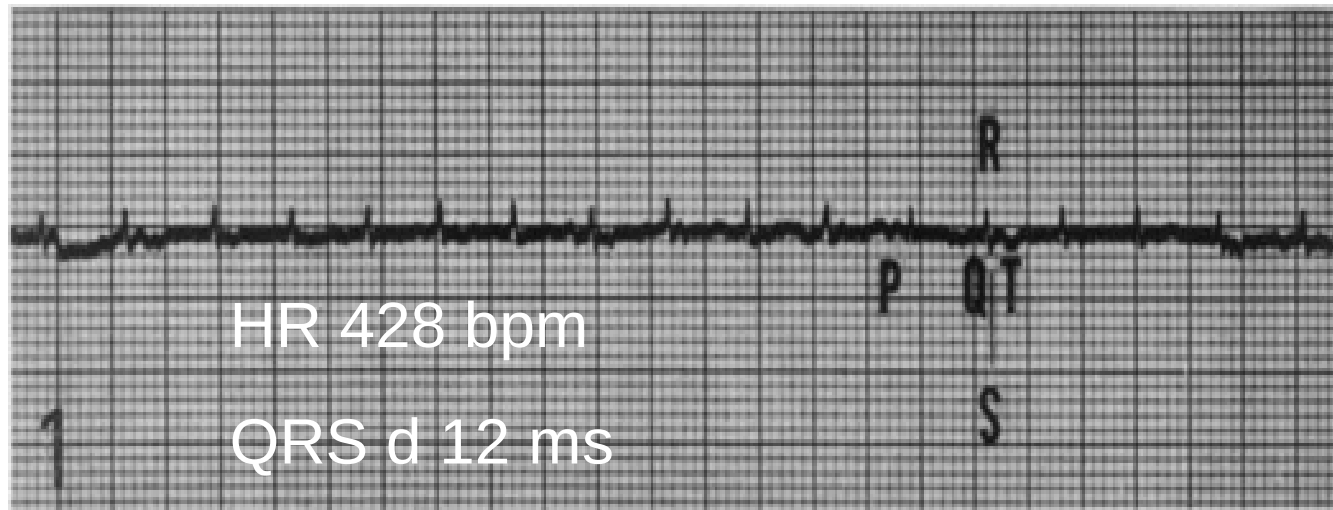
PVC 61

PULSE 151

RESP 26



50 mm/s



Myocardial Ultrastructure and Electrocardiograms of the Hummingbird under Normal and Experimental Conditions ¹

LIBERATO J. A. DIDIO ²

*Department of Anatomy, Medical School, Northwestern University,
Chicago, Illinois*

J. Anat. Rec., **1967**.
159(4):335-52.

The mandate from EC:

Focus on ECG

Looking for patterns

QT measurement and error

Noise