aapa 2021

Which Patients Should Be Referred to Cardiac Electrophysiology?

AMERICAN ACADEMY OF PHYSICIAN ASSISTANTS

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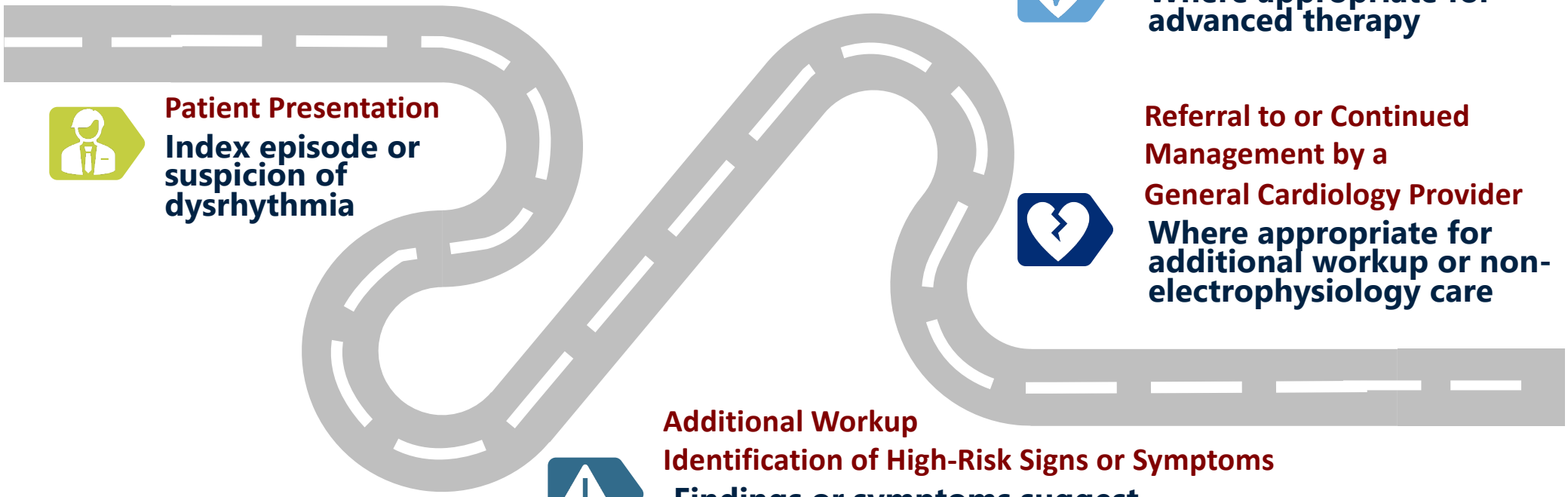
Disclosures

- No relevant commercial relationships to disclose

Learning Objectives

- Identify patients who may benefit from advanced electrophysiology care due to highly symptomatic dysrhythmias, drug-refractory dysrhythmia, or whom are at high risk for sudden death and would benefit from an ICD.
- Discuss the role for antiarrhythmic drug therapy for treatment of atrial and ventricular dysrhythmia.
- Discuss the role for catheter ablation for treatment of atrial and ventricular dysrhythmia.
- Identify ECG features of diagnoses associated with sudden death syndrome.
- Identify patients suitable for general cardiology referral and importance of general cardiology follow up.

Topic Importance



Patient Presentation

Index episode or suspicion of dysrhythmia

Additional Workup

Identification of High-Risk Signs or Symptoms

Findings or symptoms suggest advance care is warranted

Referral to Electrophysiology Provider

Where appropriate for advanced therapy

Referral to or Continued Management by a General Cardiology Provider

Where appropriate for additional workup or non-electrophysiology care

Diagnostics

Ambulatory ECG Monitoring

Longer-term and longitudinal rhythm monitoring

Exercise Testing

Evaluate exercise-induced dysrhythmias

Signal Averaged ECG

Detect “early afterdepolarizations” or “late potentials”

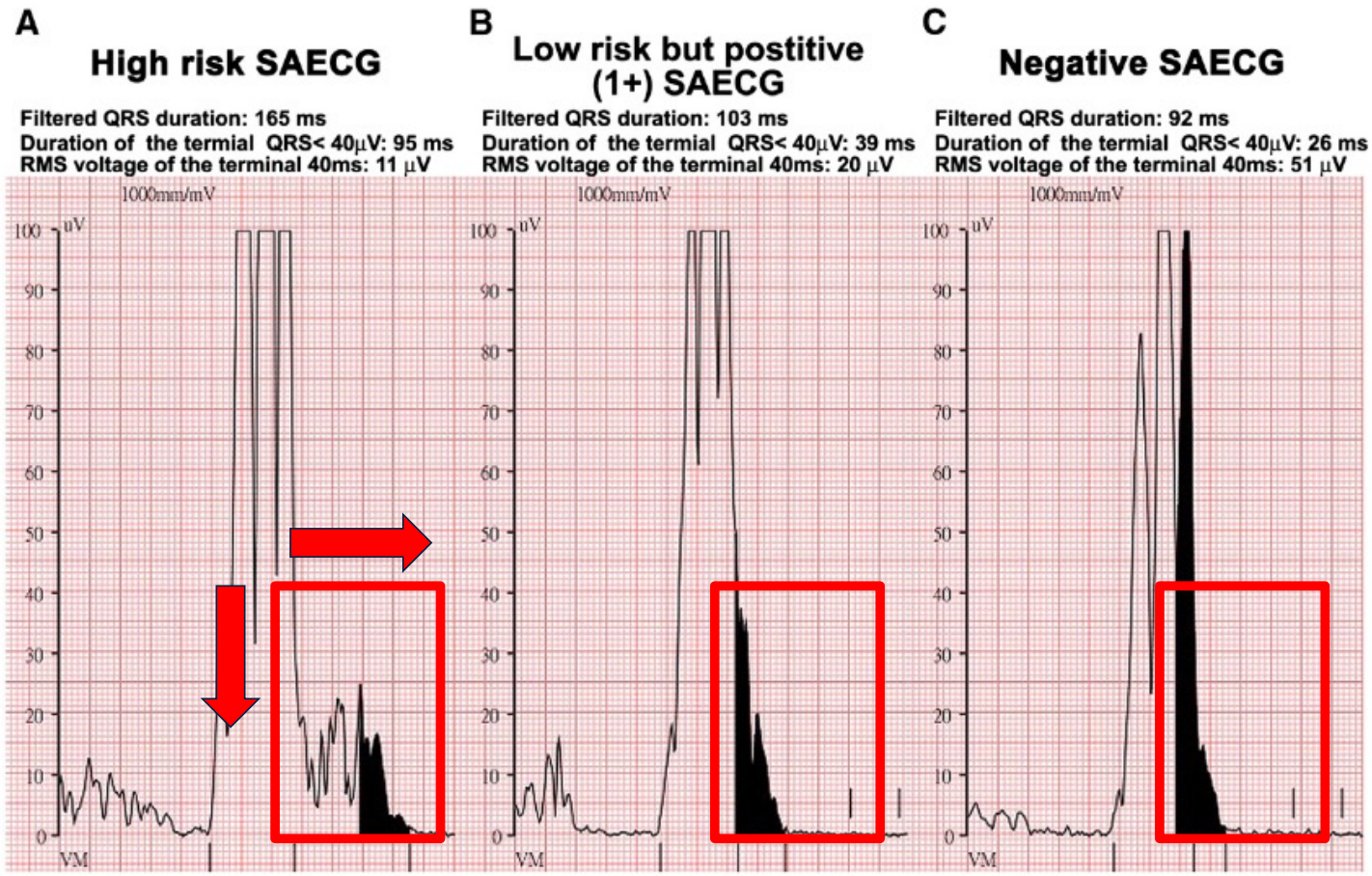


Fig. 1. Example of high risk and low risk SAECG in this study. (A). A sample of a SAECG fulfilling all 3 criteria of the Task Force consensus. A late activation signal is prominent. (B). An example of a positive SAECG fulfilling one criterion. It is a low risk pattern in this study. (C). An example of a negative SAECG fulfilling none of the criterion. It was also a low risk SAECG in this study.

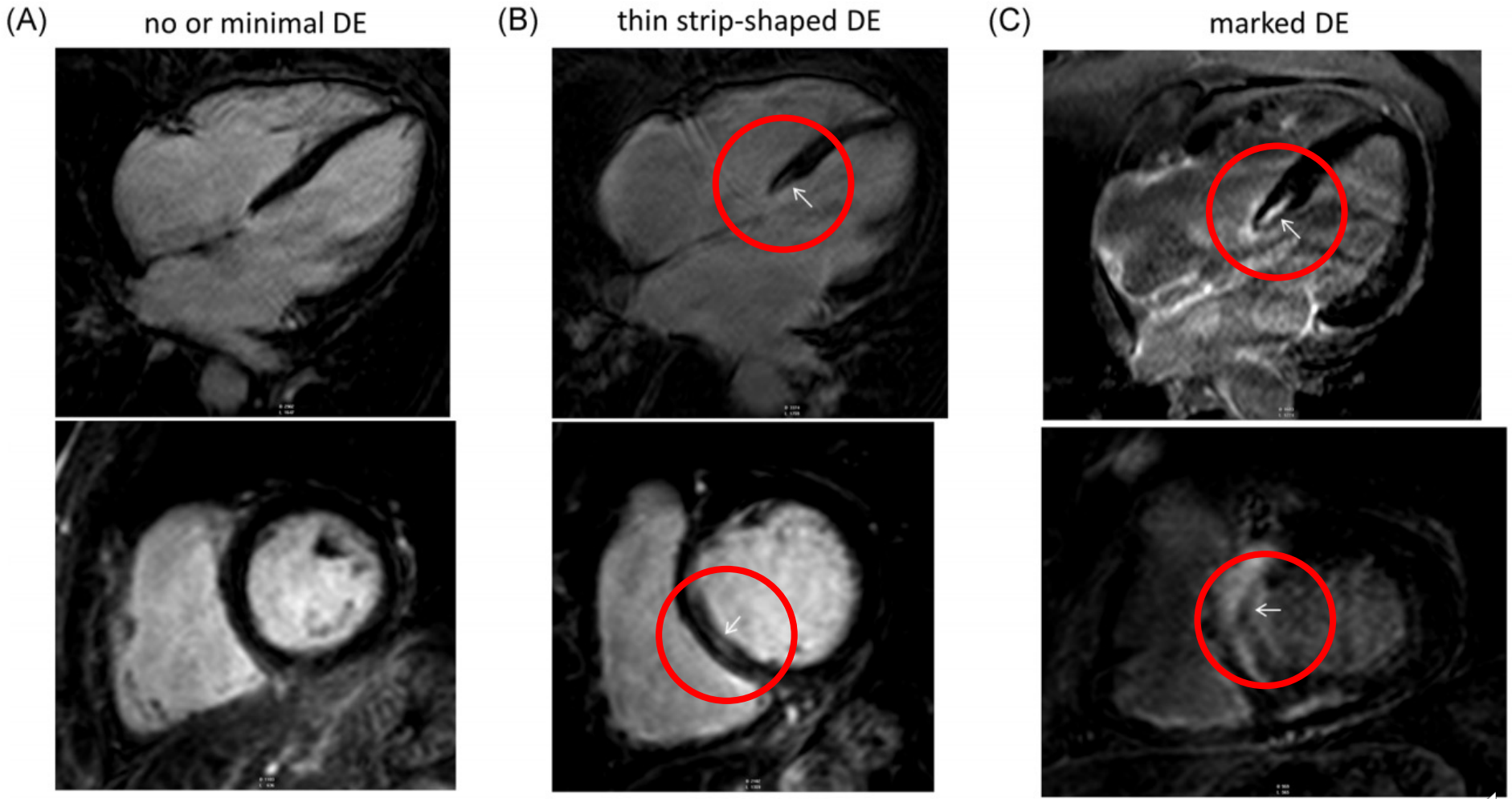
(Cho, 2011)

Diagnostics

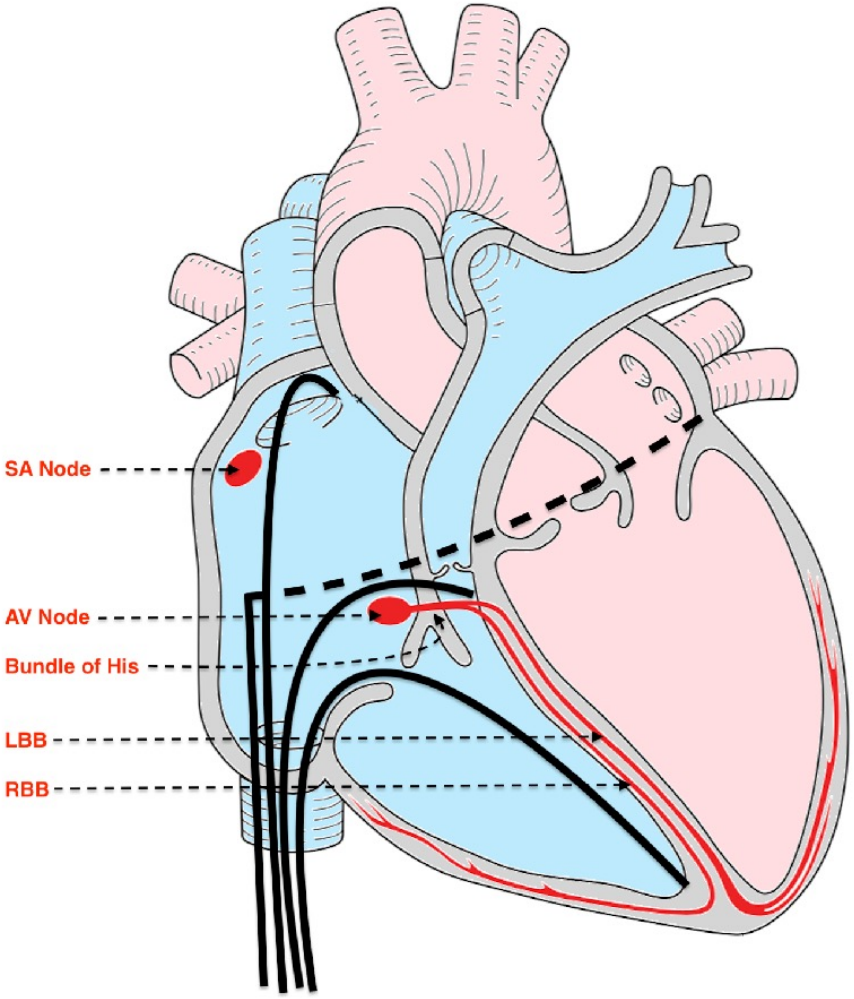
Cardiac MRI
Detect presence of late gadolinium enhancement for the present an extent of scar

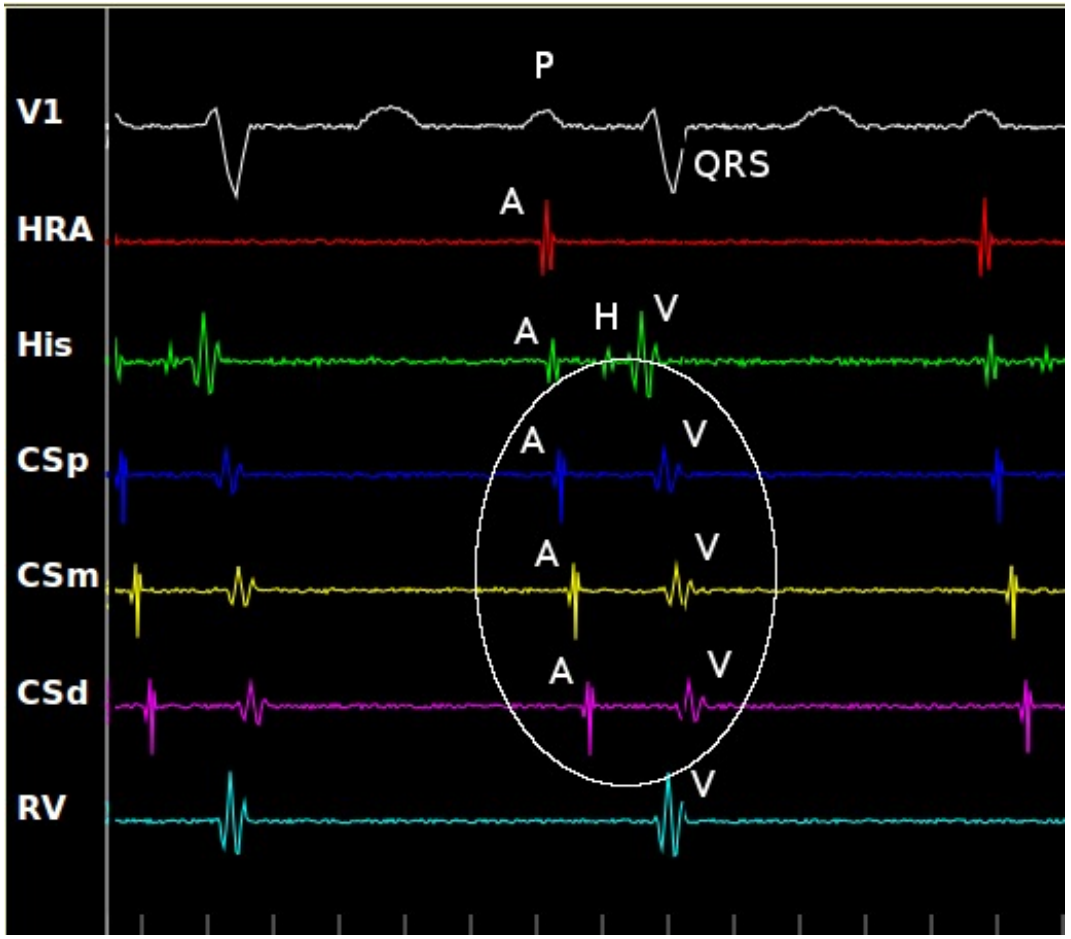
Electrophysiology Study
Local intracardiac ECG recordings at baseline and with provocation

Voltage Map & Programmed Stimulation
- Identify electrical potentials and direction of activation
- Assess dysrhythmia inducibility



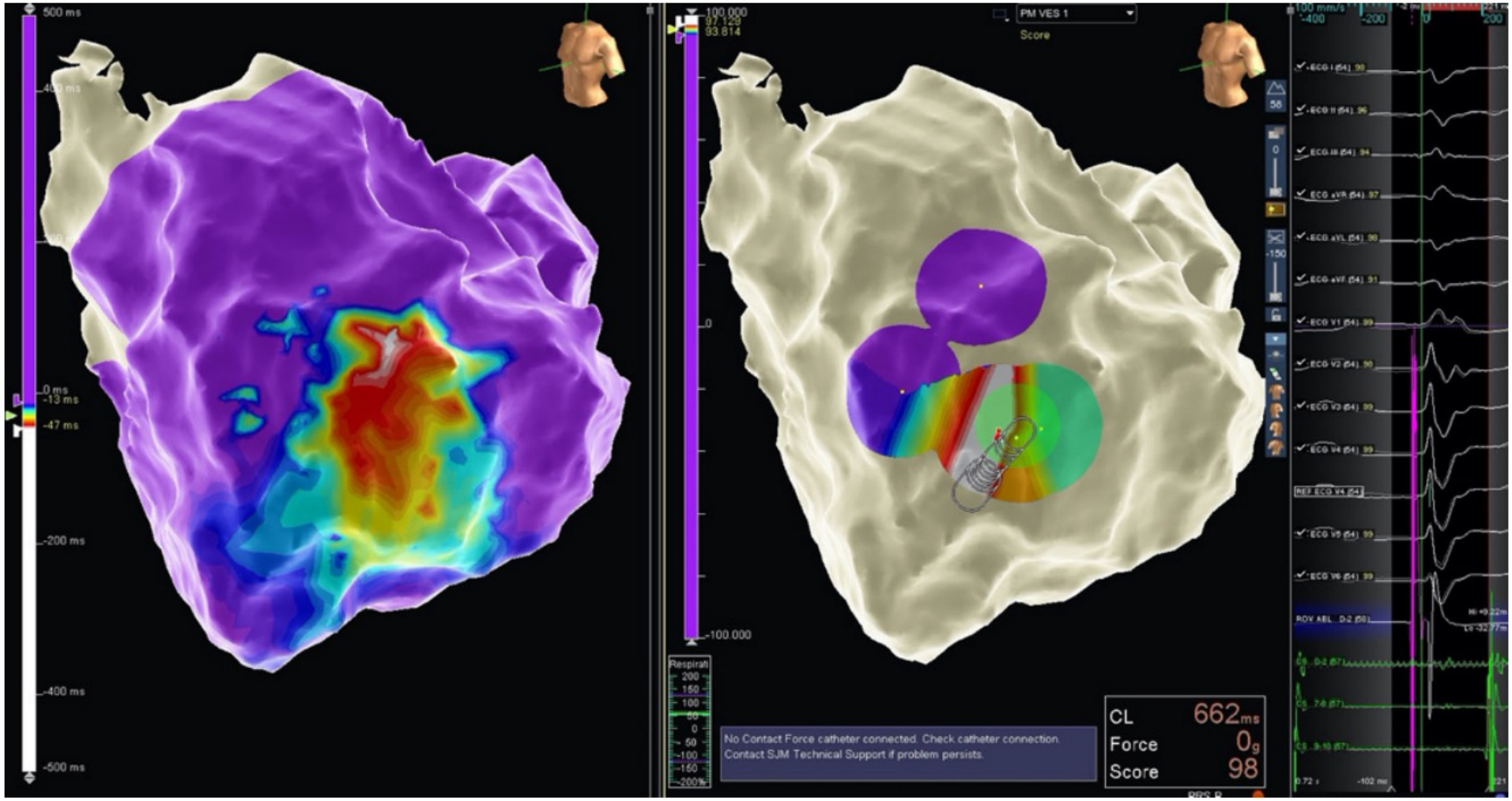
(Reithmann et al., 2019, p. 1048)





(Kevadiya, n.d.)

(Shahriar Iravanian, 2011)



(Dittrich et al., 2021, p. 29)

(Zaman et al., 2019, p. 61)

Treatment

Antiarrhythmic Drug Therapy

Membrane active agents which modify cardiac action potential components

Catheter Ablation and Radioablation

Direct focal application of radiofrequency or cryothermal energy

Cardiac Implantable Electronic Devices

Implantable pacemakers or cardioverter-defibrillators

Overview of Content

- Supraventricular Dysrhythmias
  - Regular SVT on antiarrhythmic drugs
  - Recurrent regular SVT
  - AF with suboptimal ventricular rate control
  - AF with ineffective with treatment on class IC antiarrhythmics
- Ventricular Dysrhythmias
  - Highly symptomatic ventricular ectopic activity
  - Candidates for prophylactic ICD implantation
  - Symptomatic VT with or without prophylactic ICD indication
  - Patients suspected of having a “sudden cardiac death syndrome”

- Abnormal ECGs
  - Prolonged Long QT
  - Brugada Pattern
  - Arrhythmogenic right ventricular cardiomyopathy
- Syncope
  - Structural heart disease
  - Abnormal electrocardiogram
- Any patient
  - Dysrhythmia mechanism is uncertain
  - Unacceptable side effects from antiarrhythmic drugs
- Who not to refer?

Supraventricular Dysrhythmias

Patients with:

- Regular SVT on antiarrhythmic drugs
- Recurrent regular SVT
- AF with suboptimal ventricular rate control
- AF with ineffective with treatment on class IC antiarrhythmics

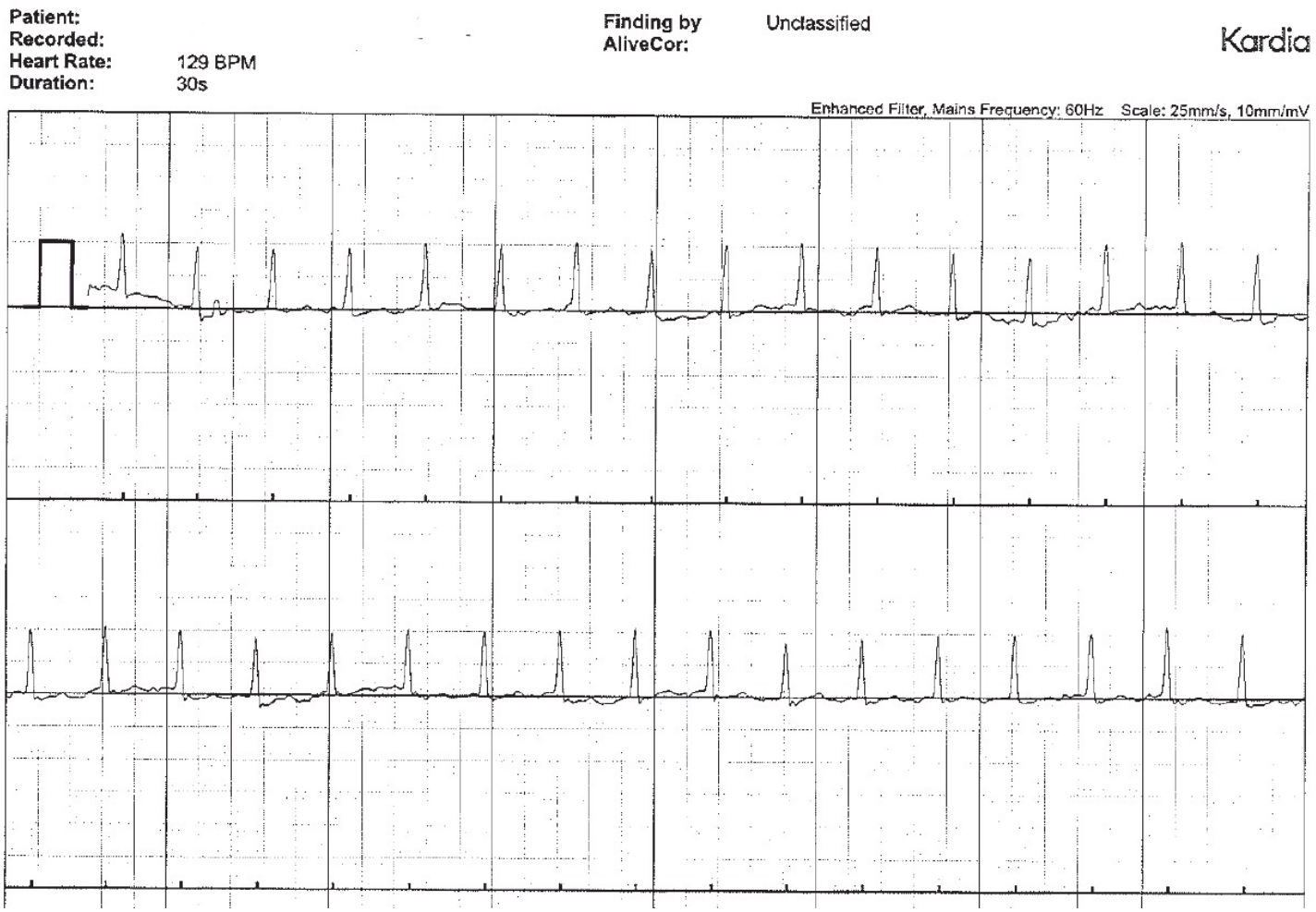
(Cottonbro, 2020)

Regular SVT on Antiarrhythmic Drugs

60 F with palpitations

S Subjective

- Atrial tachycardia
- Atrial flutter
- CHA2DS2-VASc1 (Female) on Eliquis
- Mild aortic regurgitation
- Moderate mitral regurgitation
- **Medications/ AAD history:**
  - Drodedarone (ineffective - prior)
  - Flecainide (ineffective - current)
  - Metoprolol tartrate 25mg BID (current)


Patient:
Recorded:
Heart Rate: 129 BPM
Duration: 30s
Finding by AliveCor: Unclassified
Kardia
Enhanced Filter, Mains Frequency: 60Hz Scale: 25mm/s, 10mm/mV

Strip Summary

Date: 11/23/2017 | 17:10:42 EST

Findings: Sinus Rhythm with PSVT Onset 12 beats, Rate 170 BPM

Symptom Automatic Trigger

Activities None Indicated

HR: 81

Date: 11/23/2017 | 17:10:48 EST

Findings: PSVT 12 beats, Rate 170 BPM Offset into Sinus Rhythm

Symptom Automatic Trigger

Activities None Indicated

HR: 75


(Cottonbro, 2020)

Regular SVT on Antiarrhythmic Drugs

O **Objective**

- TTE: LVEF 65, Normal left atrial size
- MCOT: Salvos of AT on MCOT monitor
- Consumer Monitor: Regular narrow complex tachycardia
- EPS: AT from LA septum, LA posterior wall isolation AF trigger, Mitral annular flutter AT from RA intercaval bundle

A **Assessment**

- Recurrent drug refractory AT correlating with presyncope
- Generated two ED visits

P **Plan**

- Each dysrhythmia focus was ablated
- Flecainide and Metoprolol weaned and eventually discontinued

(Pablo, 2018)

Recurrent Regular SVT

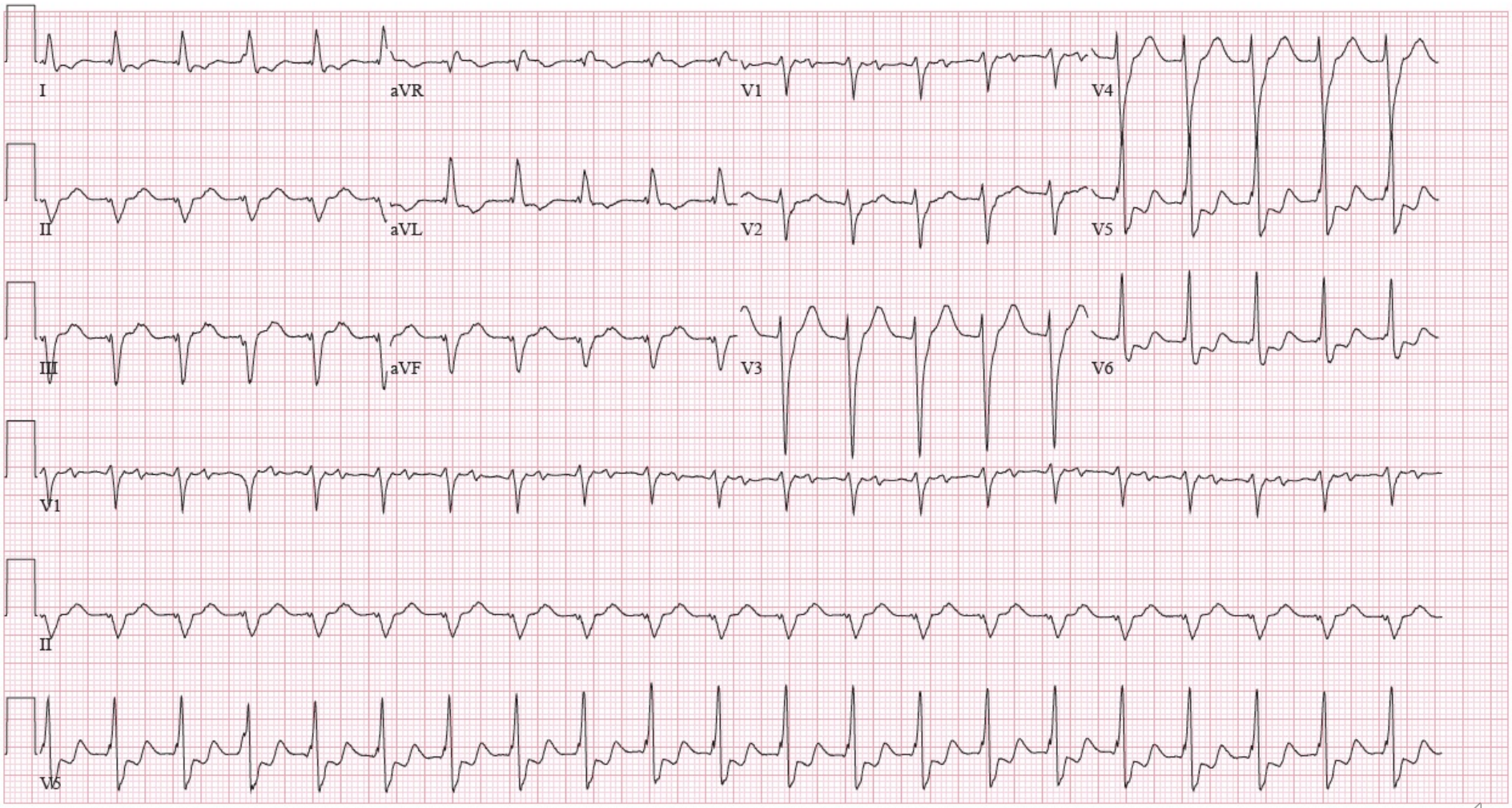
65 M with atrial tachycardia and acute decompensated heart failure

S Subjective

- Dyspnea on exertion, orthopnea
- Ischemic cardiomyopathy, LVEF 25%
- CAD s/p PCI and CABG
- Severe MR, s/p Mech MVR
- CRT-D
- ESRD on HD
- **Medications:**
  - Carvedilol 12.5 q12
  - Diltiazem 300 daily
  - Warfarin

O Objective

- AT/AF burden of 89%
- BiV pacing 59%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(Pablo, 2018)

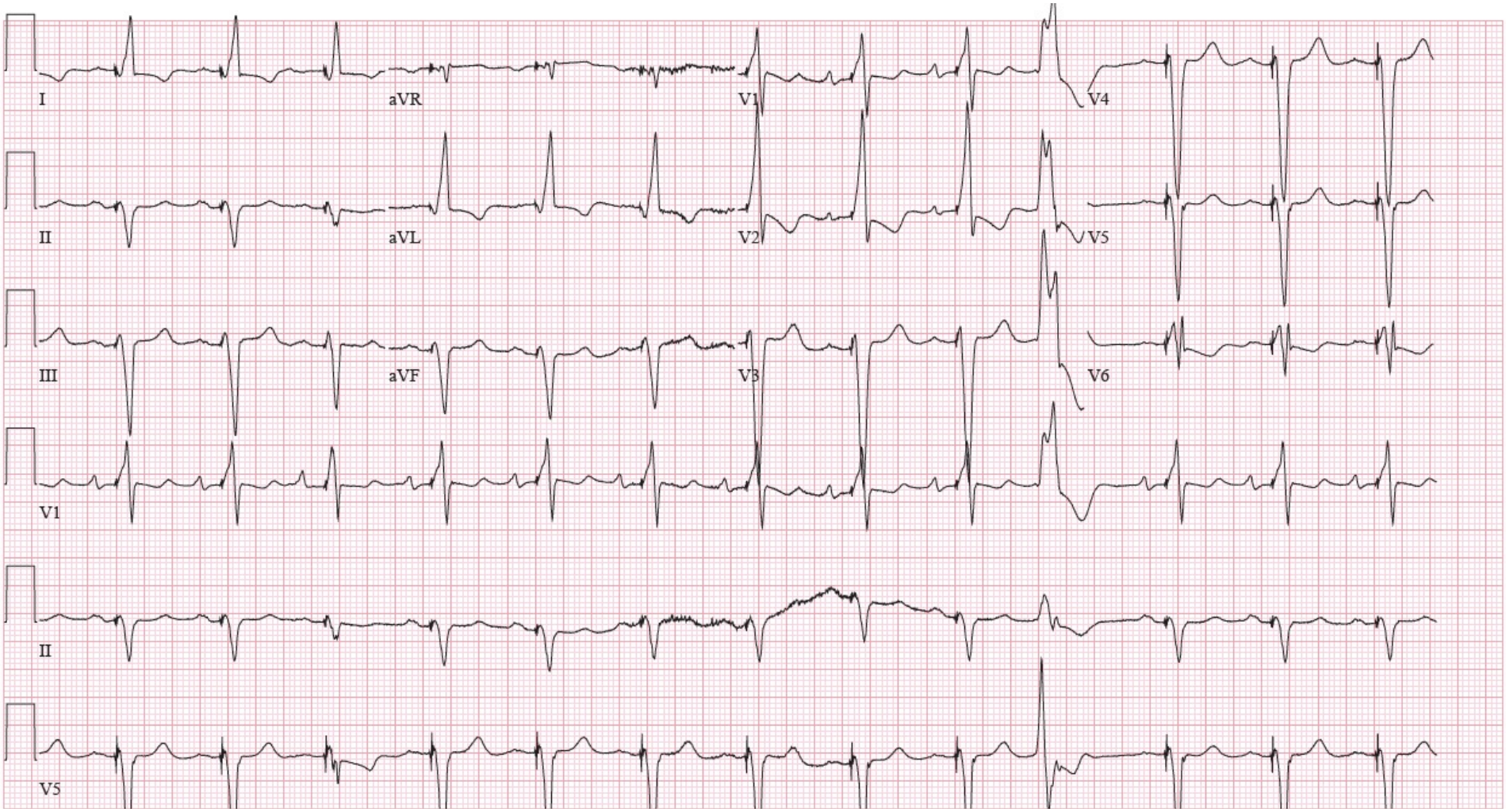
Recurrent Regular SVT

A
Assessment

- Incessant right atrial tachycardia
- Limited drug options; hypotension on high-dosed beta blocker
- Improved rate control on calcium channel blockers but at the expense of negative inotropy in setting of HF

P
Plan

- Right atrial tachycardia ablation
- Improvement in CRT pacing
- Discontinued calcium channel blocker
- Reduced HF decompensations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(Rodnae, 2020)

AF with Suboptimal Ventricular Rate Control

72 F with palpitations and presyncope

S Subjective

- Paroxysmal AF
- CAD s/p PCI
- HTN
- **Medications/AAD History:**
  - Dofetilide (ineffective)
  - Amlodipine
  - Metoprolol succinate (stopped)

O Objective

- MCOT: AF with symptomatic post conversion pauses up to 7 seconds
- EPS: AF triggers from left and right pulmonary veins. Mitral annular flutter. Inducible cavotricuspid isthmus flutter.


Ch 1
Ch 2
30s
Ch 1
Ch 2
30s

(Rodnae, 2020)

AF with Suboptimal Ventricular Rate Control

A Assessment

- Pauses correlate presyncope
- Limited ability to use beta blocker in setting of CAD.
- Dofetilide was ineffective, this limited drug options that avoid decreased HR

P Plan

- Ablation to manage atrial fibrillation, typical atrial flutter, and atypical atrial flutter ablation
- Replaced Toprol for CAD
- Implanted loop recorder
- No further symptoms to date

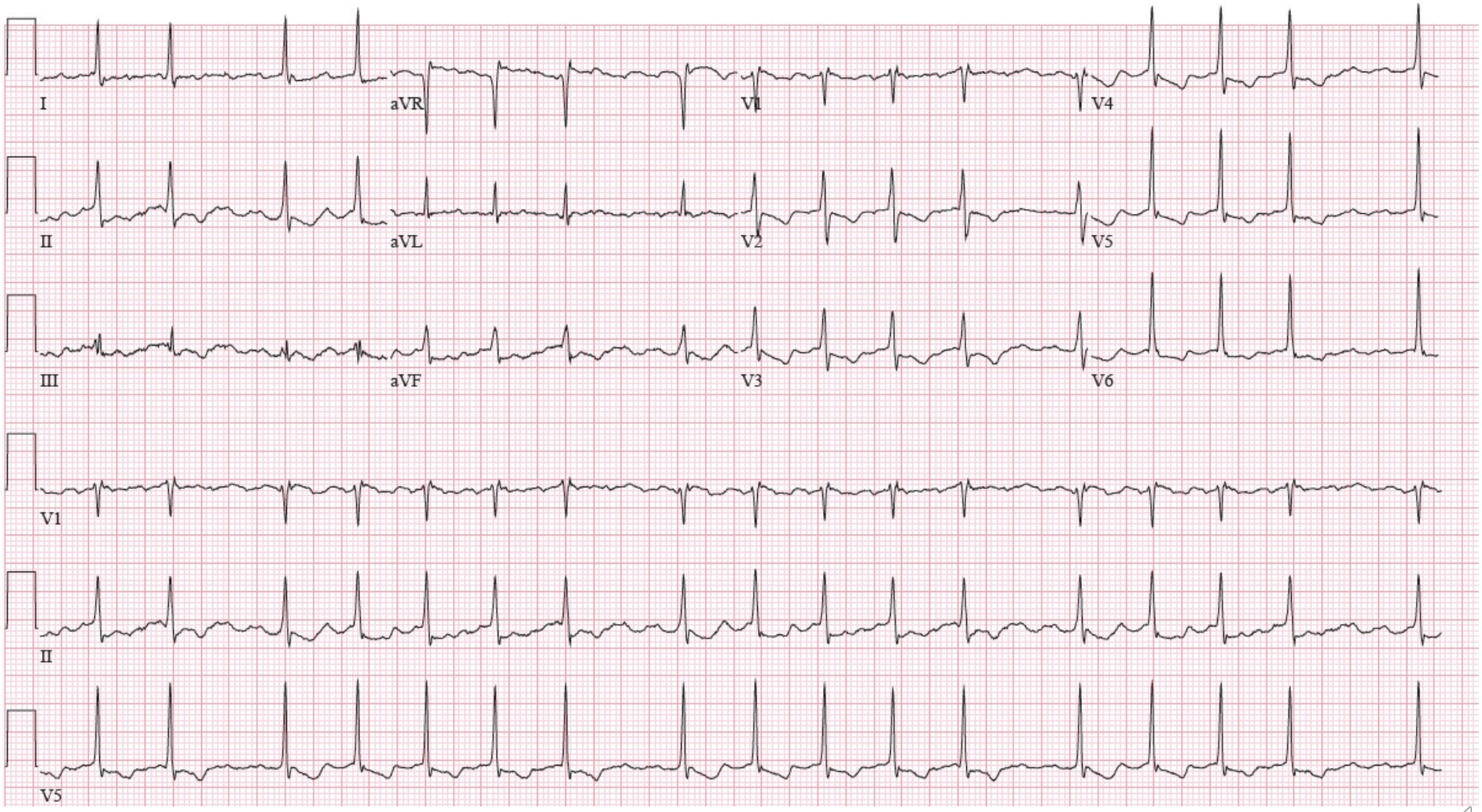

(Tankilevitch, 2020)

AF with Ineffective Treatment on Class IC Antiarrhythmics

61 F with SOB and palpitations

S Subjective

- Recurrent persistent AF s/p cardioversion x3 and despite propafenone
- CHA2DS2-VASc 2 (HTN, Female)
- Hypertension
- **Medications/AAD History:**
  - Propafenone 225mg and 325mg (ineffective respectively)
  - Toprol 100mg daily
  - Losartan
  - Amlodipine
  - Xarelto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(Tankilevitch, 2020)

AF with Ineffective Treatment on Class IC Antiarrhythmics

O **Objective**

- EPS: Extensive atrial scarring and multiple non-Pulmonary vein triggers

A **Assessment**

- Recurrent persistent propafenone-refractory atrial fibrillation

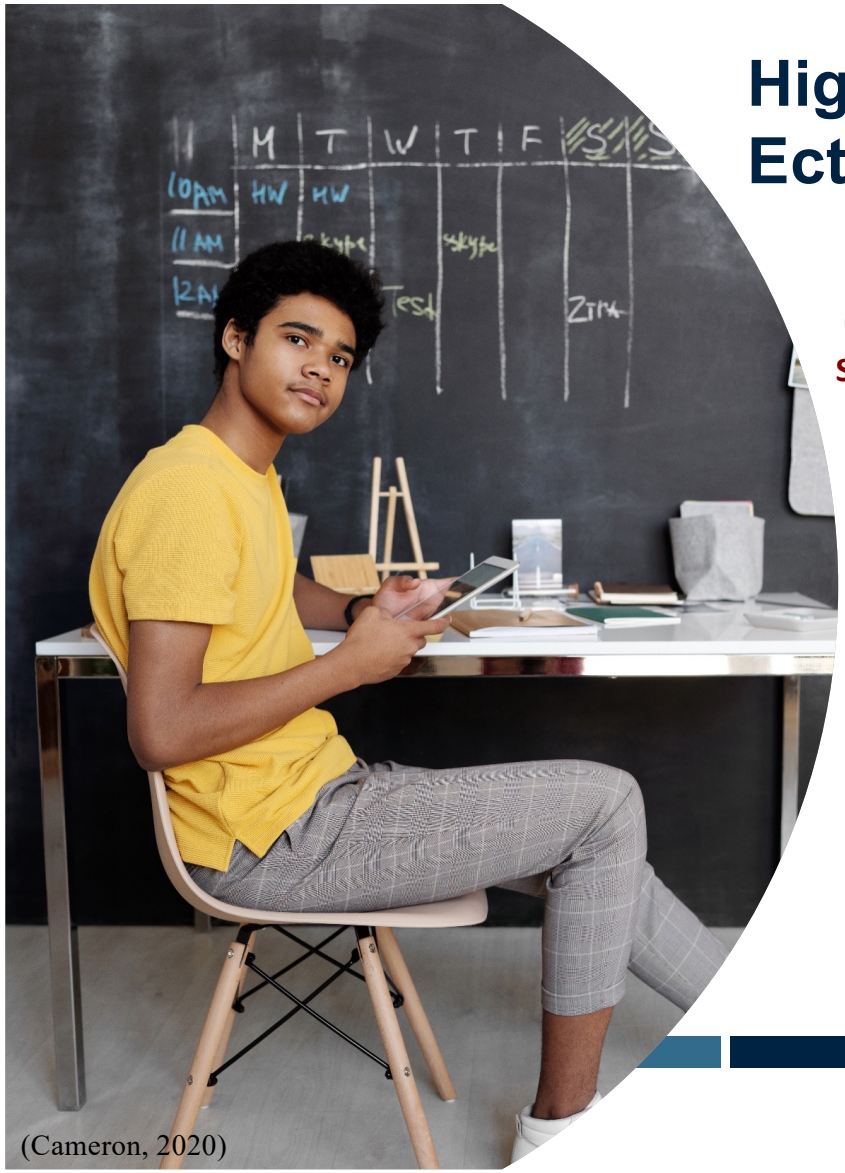
P **Plan**

- AF ablation (PVI, PWI, ablation of multiple non-PV triggers
- Relief of SOB and palpitations

Ventricular Dysrhythmias

Patients with:

- Highly symptomatic ventricular ectopic activity
- Candidates for prophylactic ICD implantation
- Symptomatic VT with or without prophylactic ICD indication
- Patients suspected of having a “sudden cardiac death syndrome”



(Cameron, 2020)

Highly Symptomatic Ventricular Ectopic Activity

S Subjective

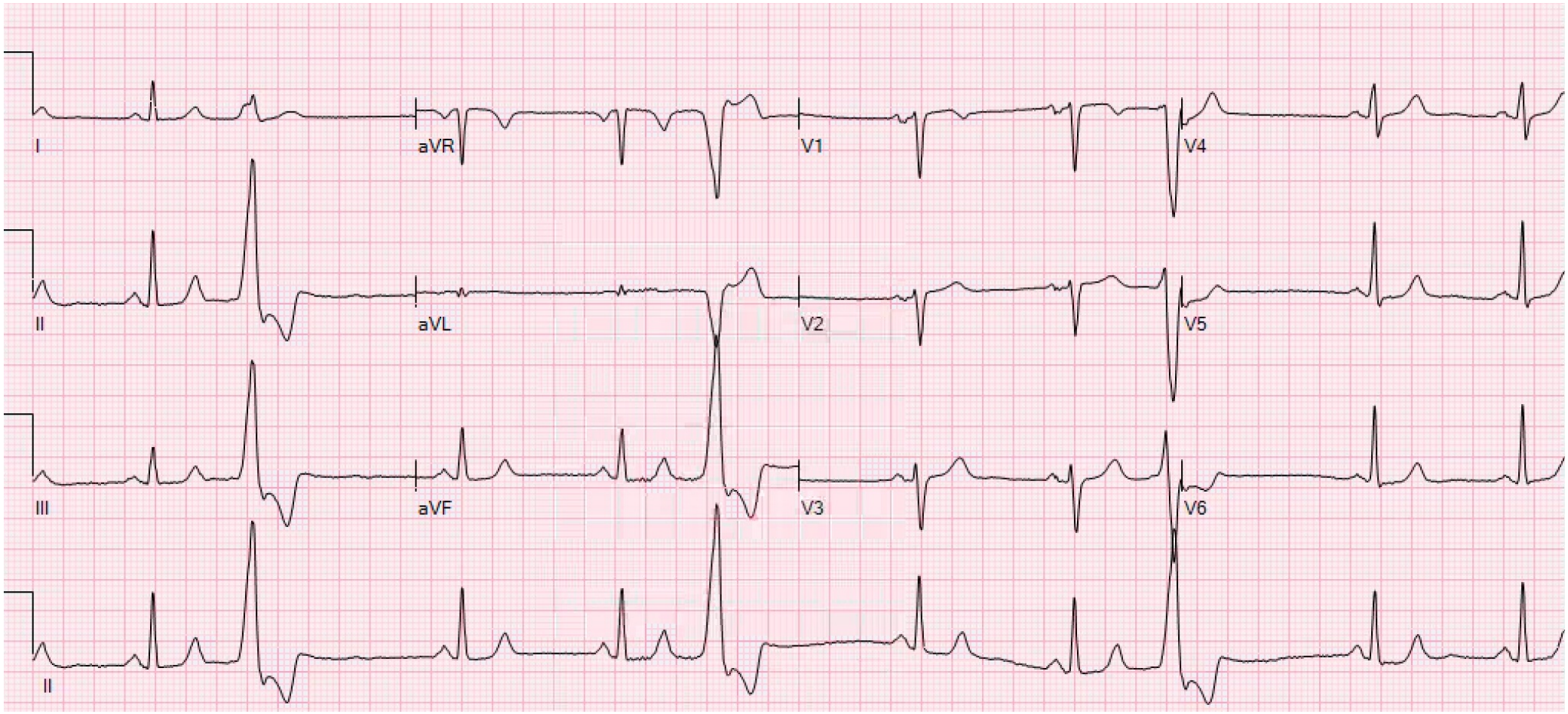
19 M with ?presyncope and palpitations

- Frequent PVCs
- Presumed syncope
- Nonsustained ventricular tachycardia
- **Medications**
  - Metoprolol succinate 25mg daily
  - Flecainide 100mg and 150mg daily (ineffective)

O Objective

MCOT: Frequent PVCs (12.7%), NSVT

12 Lead Holter: Frequent PVCs (42%)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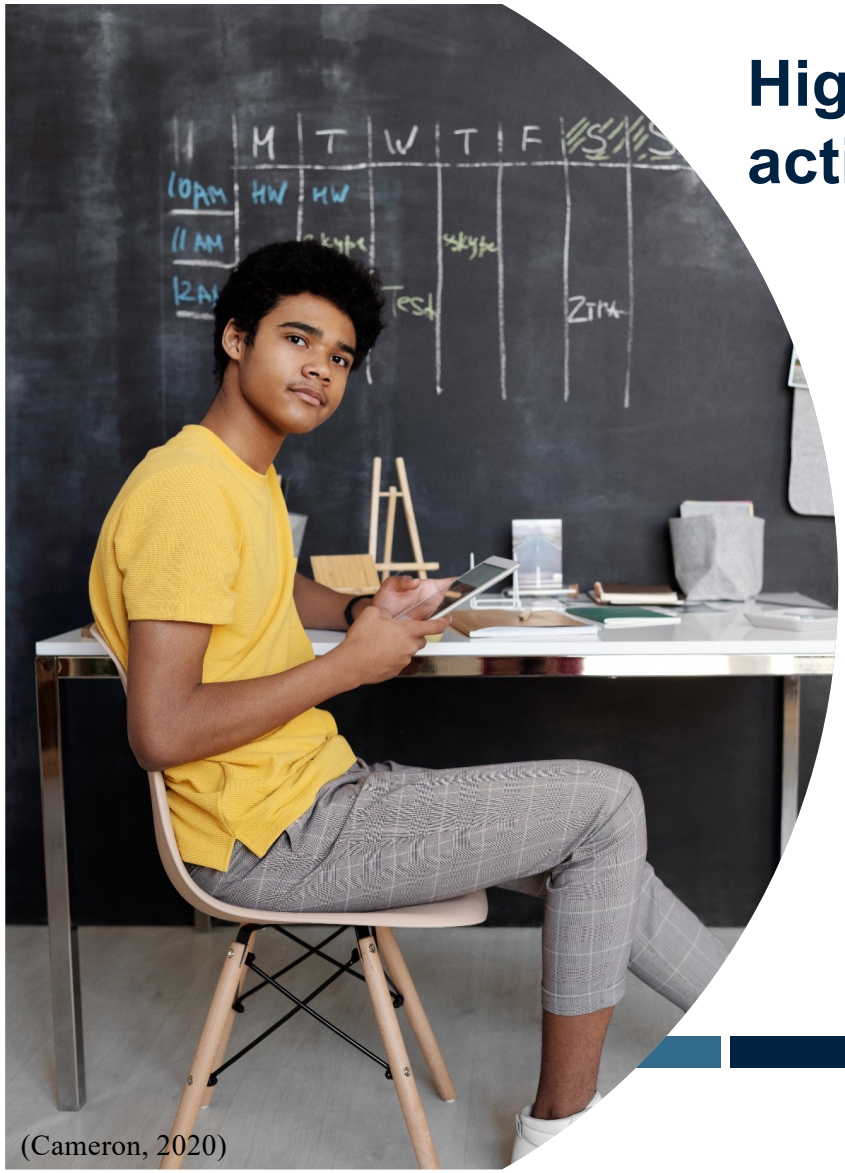


(Cameron, 2020)

Highly symptomatic ventricular ectopic activity

O Objective

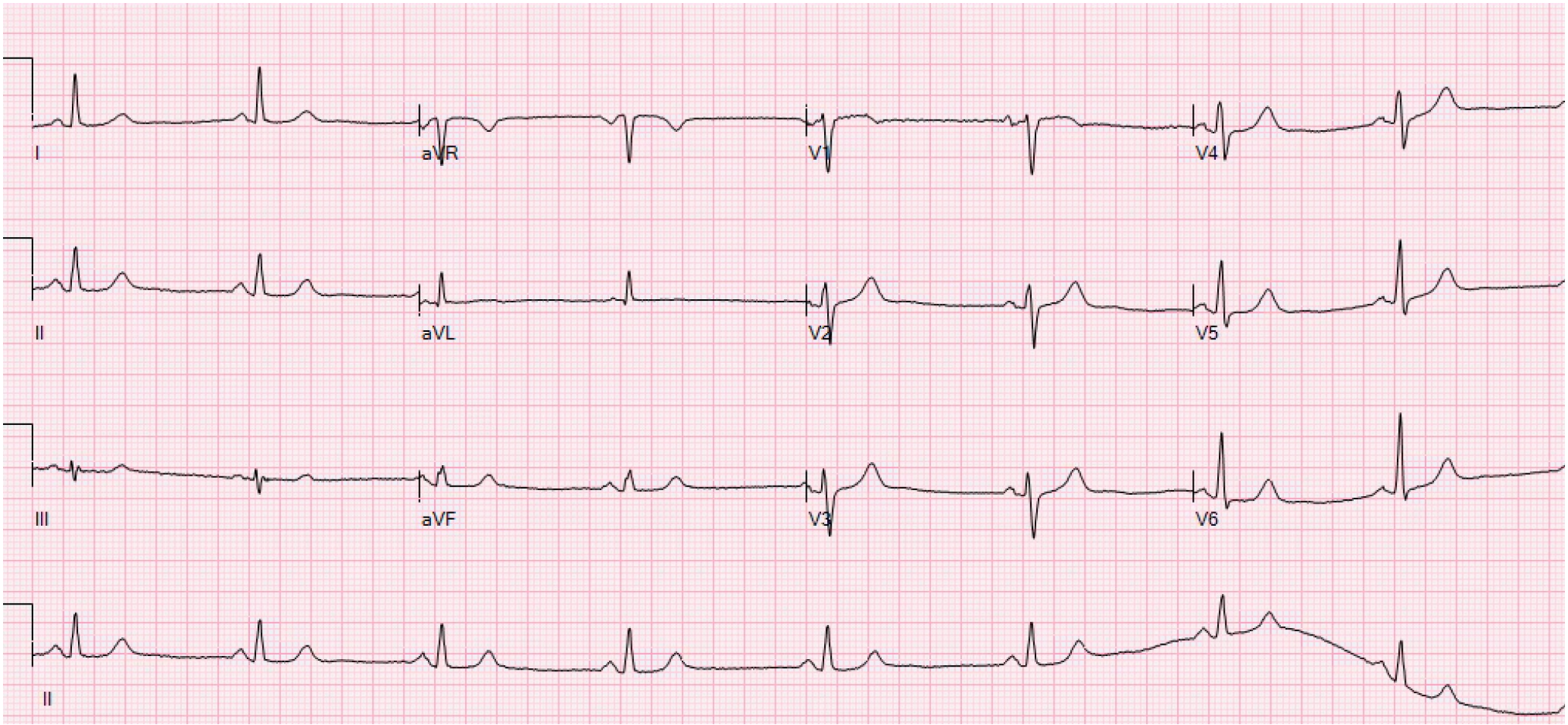
- TTE: LVEF 45%, LVDD 6.22cm
- CMRI: Dilated LV, LGE in the base
- EPS: Frequent PVCs . Late potentials suggestive of mid septal scarring.

A Assessment

- Recurrent, AAD-refractory PVCs
- PVC-induced cardiomyopathy

P Plan

- Ablation of LVOT PVCs
- Normalization of LVEF
- No further symptoms,
- PVC burden <1%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(Piacquadio, 2018b)

Candidates for prophylactic ICD implantation

S Subjective

50 M with Systolic Heart Failure

- Flu-like illness 3M prior to presenting with acute dilated cardiomyopathy
- Chronic systolic heart failure
- Obstructive sleep apnea
- No family history of SCD
- NYHA II-III
- Medication:
  - sacubitril/valsartan
  - Carvedilol
  - Milrinone (temporarily)


(Piacquadio, 2018b)

Candidates for prophylactic ICD implantation

O Objective

- TTE: Severely dilated LV with severely reduced function, LVEF 15%
- RHC/LHC: Low CI of 1.4 with mild to moderate CAD.
- Viral Serology: negative
- EMB: negative
- HIV: negative

A Assessment

- Idiopathic nonischemic dilated cardiomyopathy, EF<35%, NYHA II, on chronic GDMT, with >1 year life expectancy

P Plan

- Primary prevention single chamber ICD


(K, 2020)

Symptomatic Ventricular Tachycardia with or without Prophylactic ICD Indication

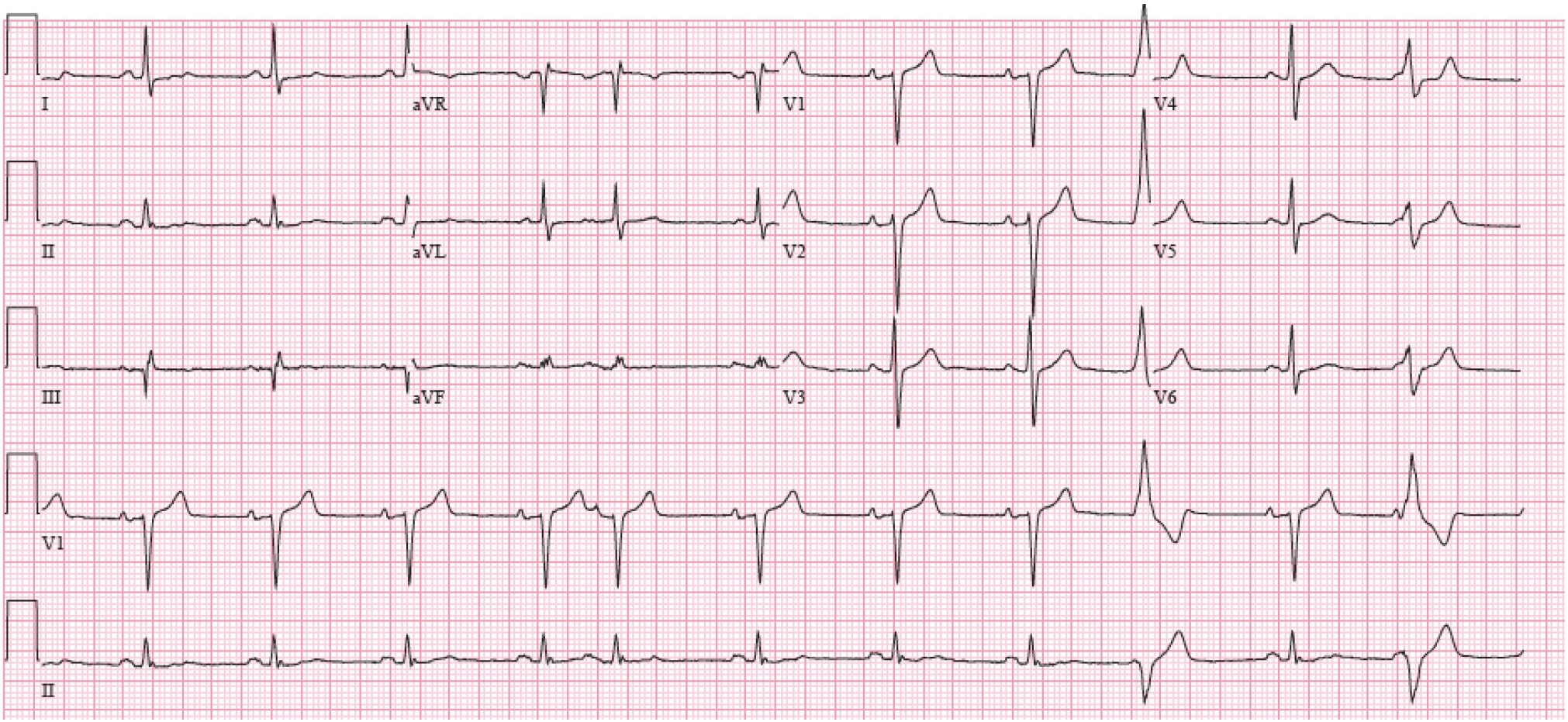
S Subjective

54 M with worsening palpitations

- Longstanding palpitations
- Exercise intolerance
- Hypertension
- **Medications**
  - Diltiazem 300 daily
  - Lisinopril –HCTZ

O Objective

- ECG: rare PAC, PVCs
- LHC: Mild CAD
- TTE: LVEF 65%
- MCOT: Sustained MMVT, PVCs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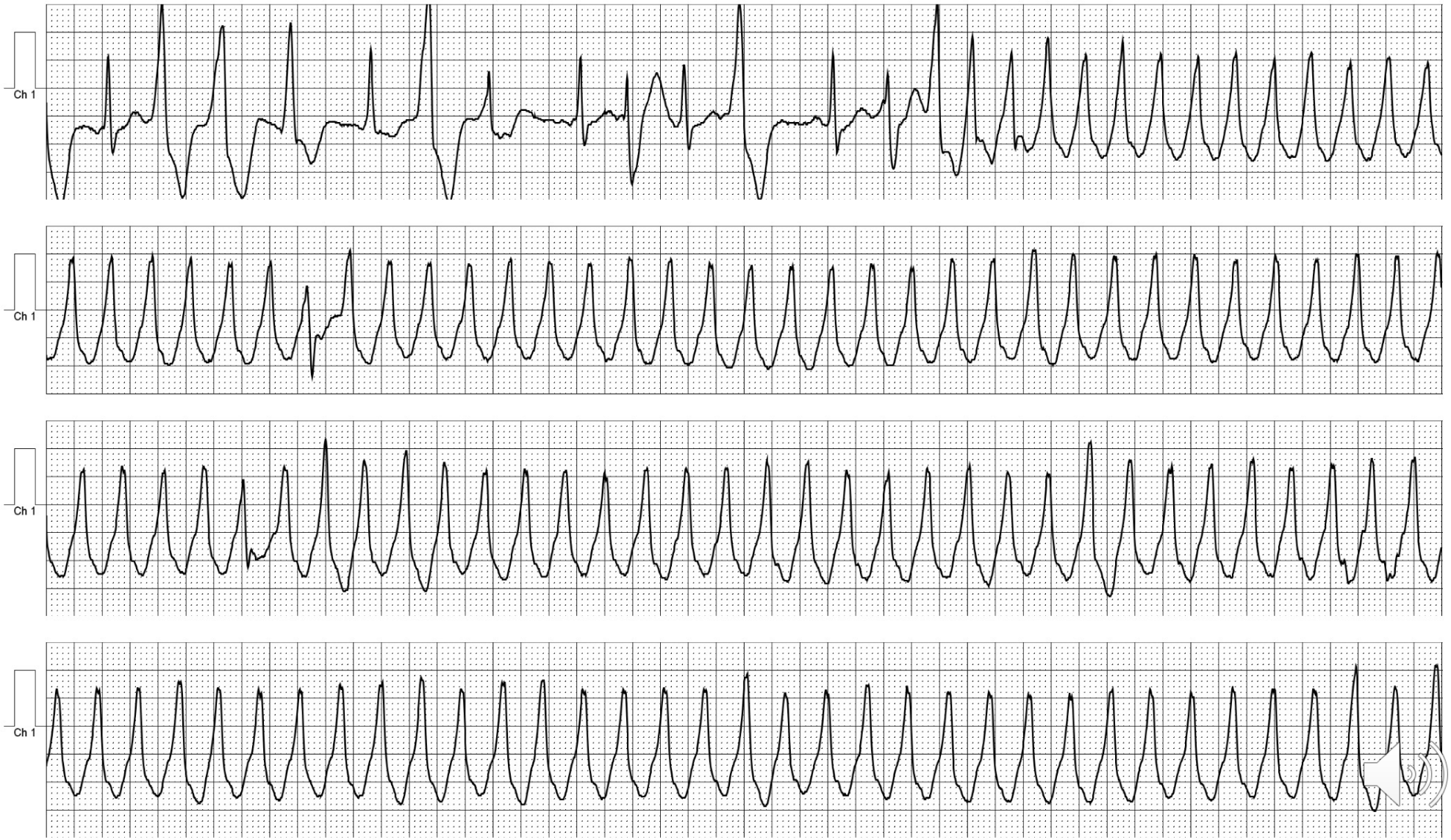
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(K, 2020)

Symptomatic Ventricular Tachycardia with or without Prophylactic ICD Indication

O Objective

- CMRI: LVEF 51% with basal septal and inferolateral transmural scar
- CPET: Inflammation mid-inferior septal/basal septum
- EPS: Inducible for 3 VT morphologies

A Assessment

- Sustained VT with possible sarcoid cardiomyopathy

P Plan

- Ablation of 2 PVC/VT morphologies
- Sotalol for a 3rd septal morphology
- ICD Implant
- Rheumatology for immunosuppression

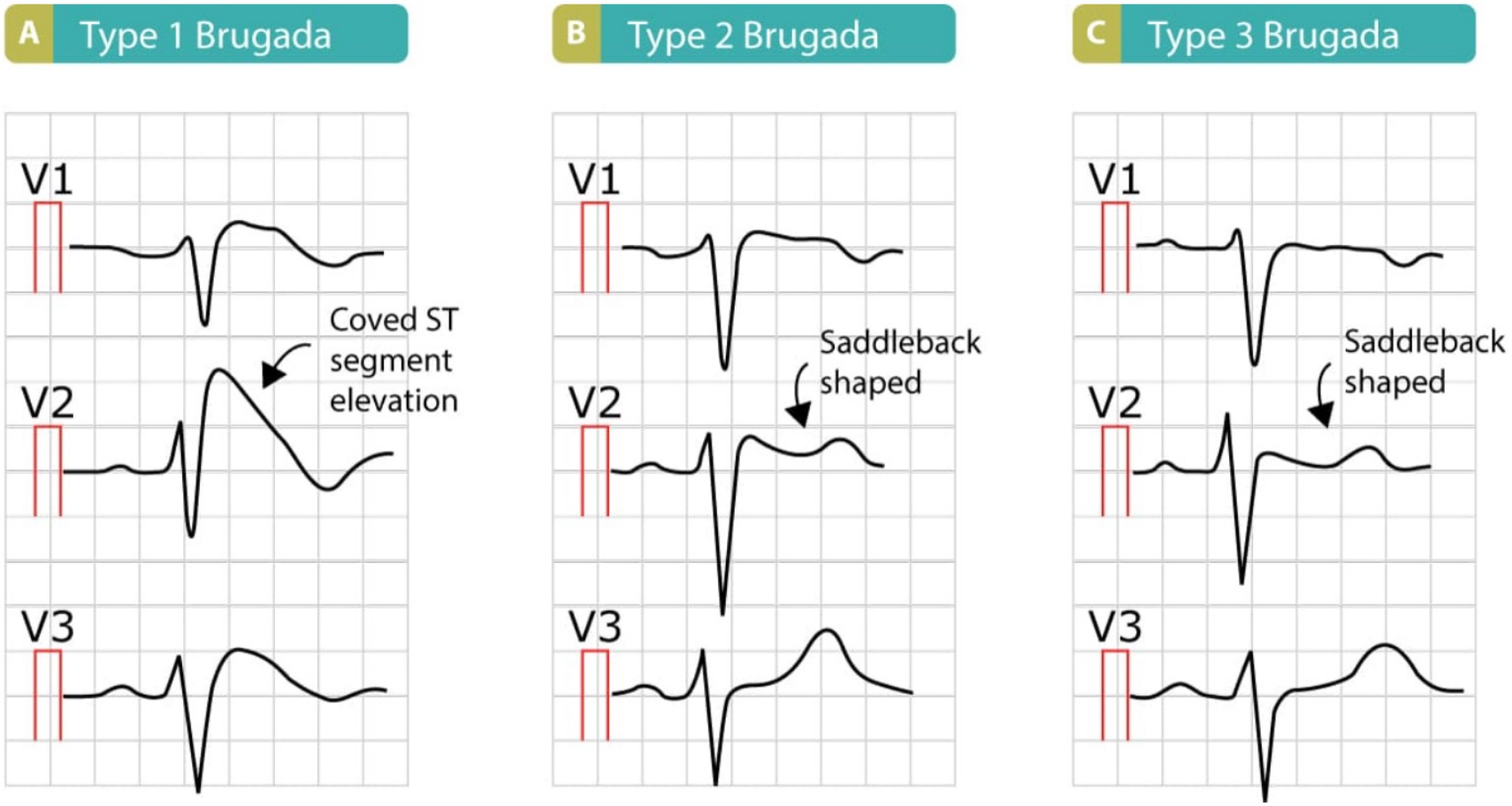


Figure 10. ECGs presenting Brugada syndrome type 1, type 2 and type 3, respectively.

(ECG and Echo Learning, n.d.)

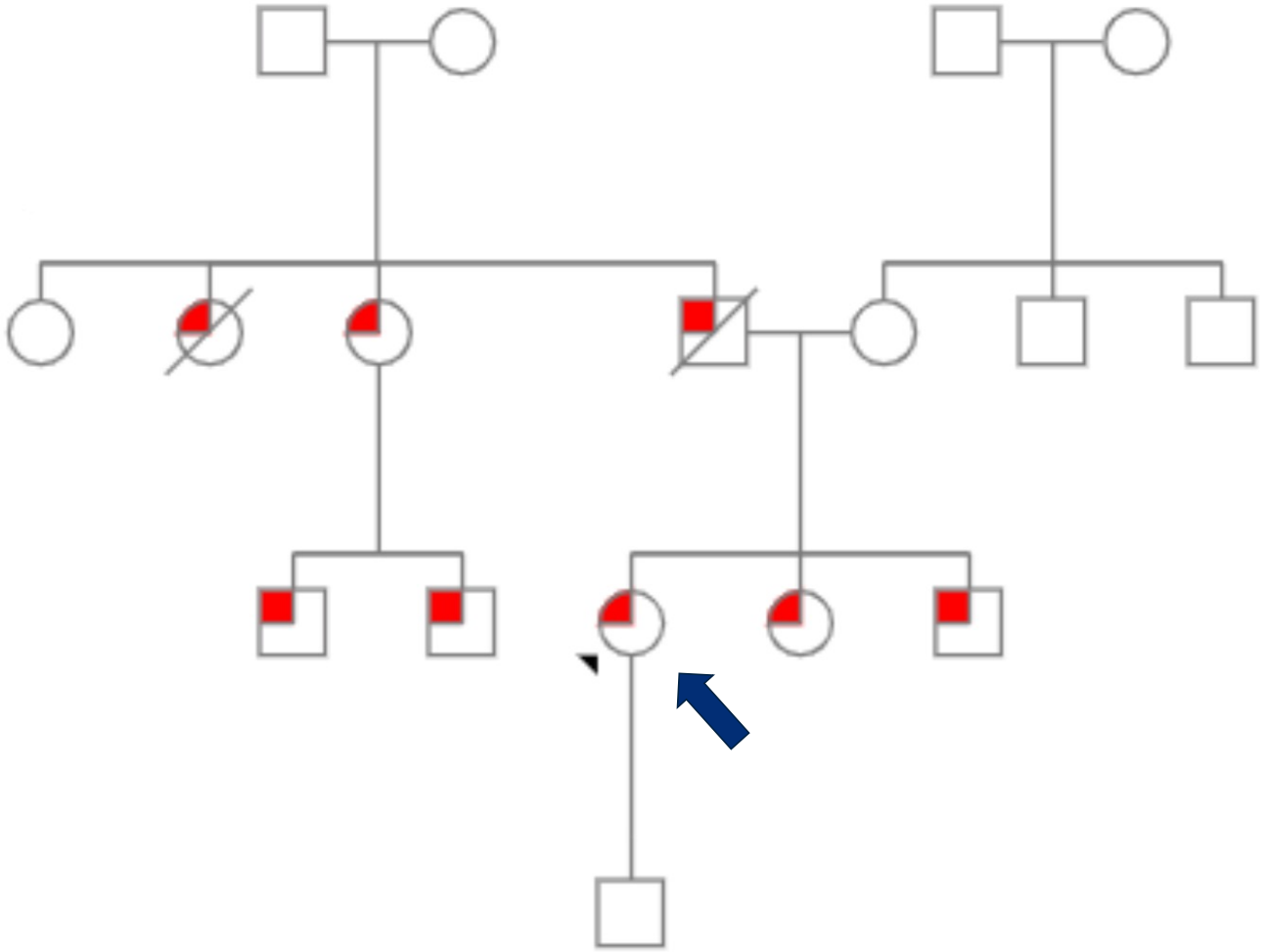
(Piacquadio, 2018a)

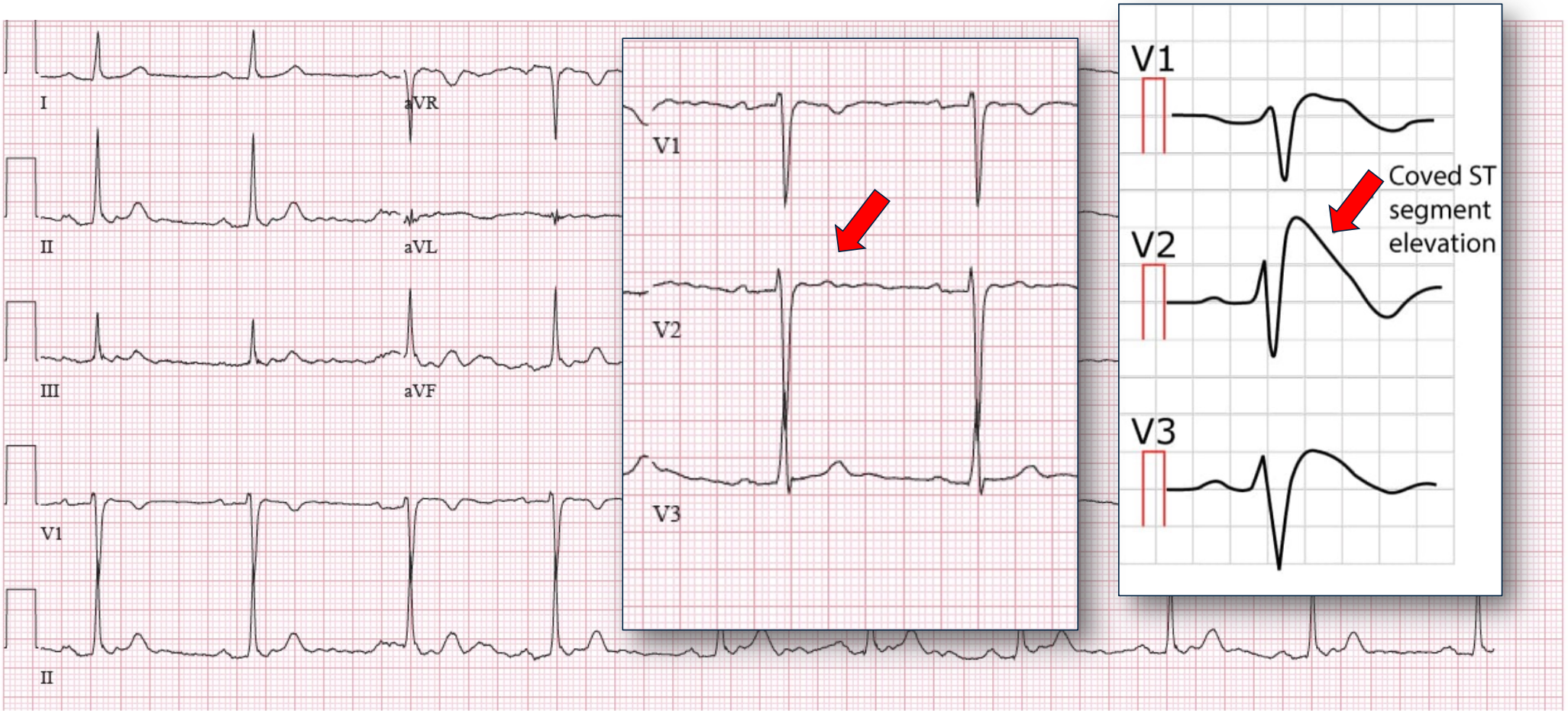
Suspected “sudden death syndrome”

27 F Strong FHx of Brugada Syndrome

S Subjective

- Neurocardiogenic syncope
- FHx SCD father and paternal aunt.
- FHx genotype positive Brugada (SCN5A) in 2 siblings, paternal aunt, and 2 paternal first cousins





(ECG and Echo Learning, n.d.)

(Piacquadio, 2018a)

Suspected “sudden death syndrome”

O Objective

- ECG: No type 1 Brugada pattern
- Genetic Testing: +Brugada (SCN5A)
- EPS: Negative procainamide infusion

A Assessment

- Positive personal and family history of Brugada syndrome
- Negative pharmacologic challenge
- Negative program electrical stimulation for inducible ventricular dysrhythmias

P Plan

- Observe without therapy

Abnormal Electrocardiogram

Patients with:

- Prolonged Long QT
- Brugada Pattern
- Arrhythmogenic right ventricular cardiomyopathy

(Zhu, 2019)

Abnormal ECG: Brugada Pattern

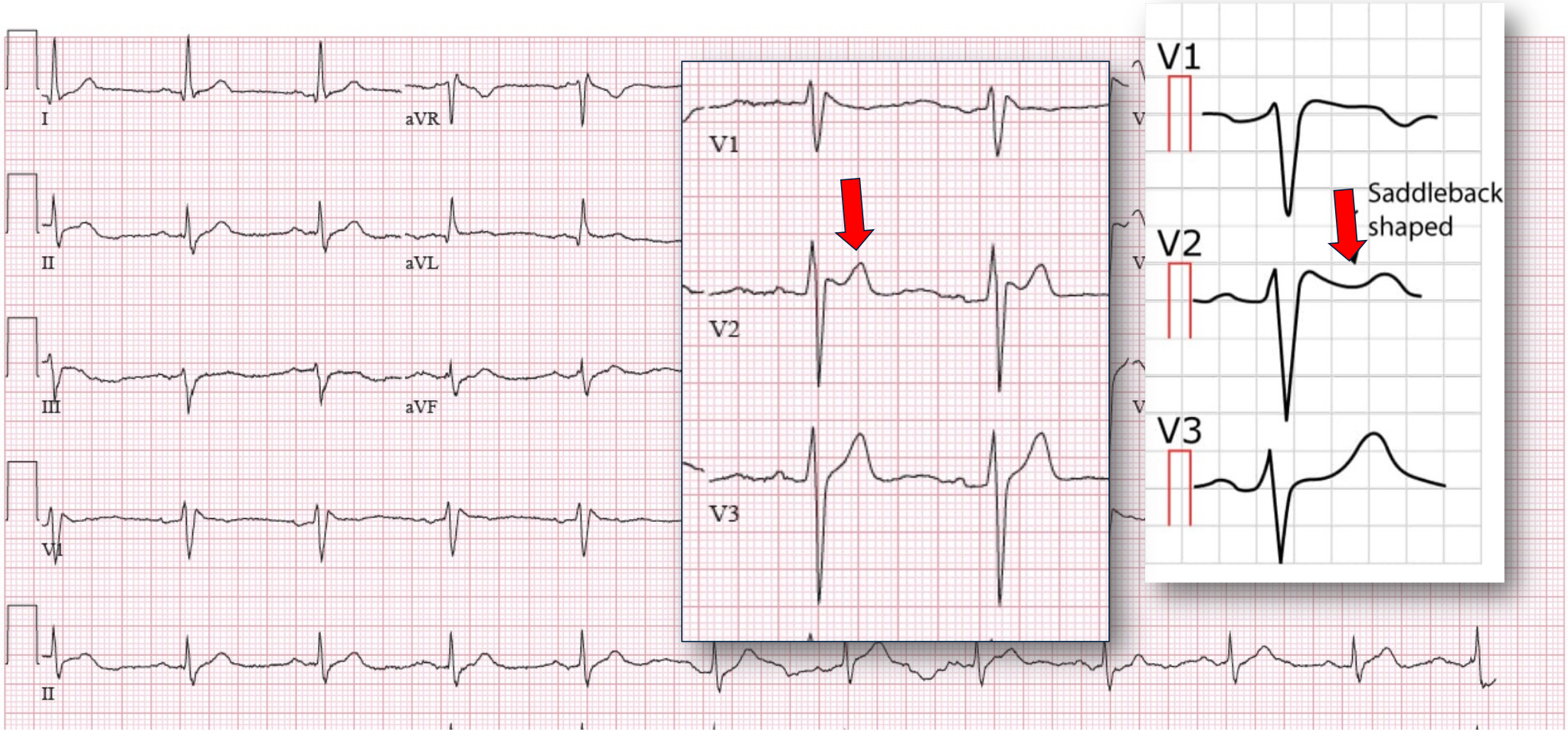
40 M with abnormal ECG

S Subjective

- Severe febrile illness with dizziness, nausea, and presyncope
- ECG was noted to be abnormal and was referred for further evaluation.

O Objective

- ECG: Brugada Type 2 pattern
- TTE: LVEF 68%, unremarkable
- Stress TTE: Normal. Rare PVCs and couplets



(ECG and Echo Learning, n.d.)

Abnormal ECG: Brugada Pattern

Objective

- CMR: LVEF 65%, No delayed enhancement
- EPS: QRS widening with pacing RVOT free wall. Reproducible VF induction with double extrastimuli consistent with a dysrhythmia risk.
- Drug Challenge: Dramatic effect with procainamide with (a) Brugada type 1 ECG with V1 and V2 at 3rd and 2nd intercostal space, and (b) Further QRS widening with pacing RV free wall.

(Zhu, 2019)

Abnormal ECG: Brugada Pattern

A Assessment

- Spontaneous Brugada Type 2 ECG, positive procainamide challenge, and inducible VF with double extrastimuli during PES.

P Plan

- Primary prevention subcutaneous ICD implantation.

(Piacquadio, 2018c)

Abnormal ECG: Prolonged QT

21 F with abnormal ECG

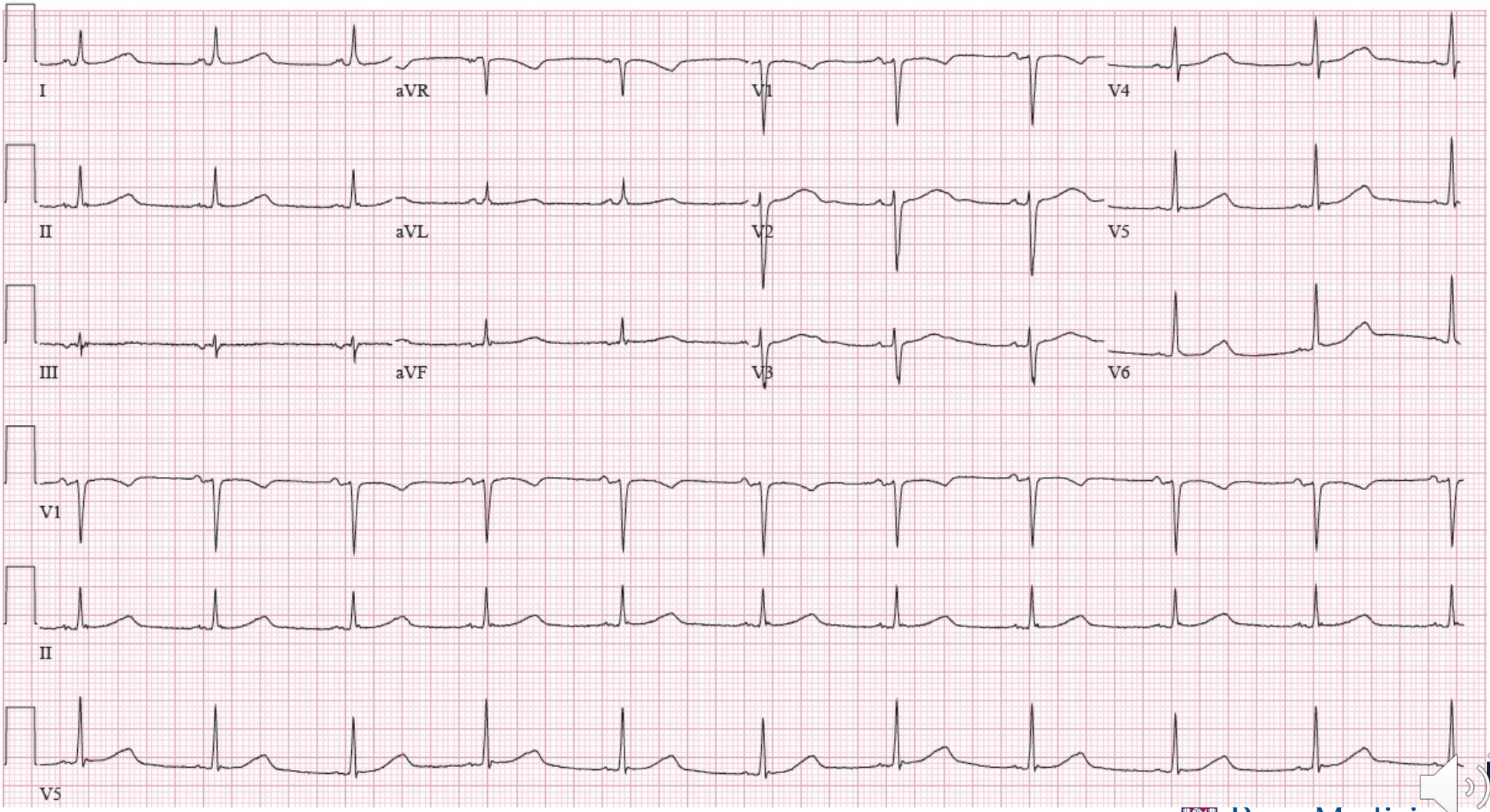
S **Subjective**

- Celiac disease
- Syncope when startled by lawn sprinkler turning on, age 15
- Syncope during exercise, age 21
- ECG was noted to be abnormal and was referred for further evaluation.

O **Objective**

- ECG: QT/QTc 474/481ms
- Genetic testing: Mutations in the KCNH2 gene, resulting in Long QT Type II

Penn Medicine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(Piacquadio, 2018c)

Abnormal ECG: Prolonged QT

A Assessment

- Unexplained syncope x 2 in the setting of prolonged QT interval and mutation in the KCNH2 gene, resulting in Long QT Type 2

P Plan

- Primary prevention ICD implantation
- Treatment with Nadolol

Syncope

Patients with:

- **Structural heart disease**
- **Abnormal electrocardiogram**

(Darly, 2020)

Syncope: Structural HD & Abnormal ECG

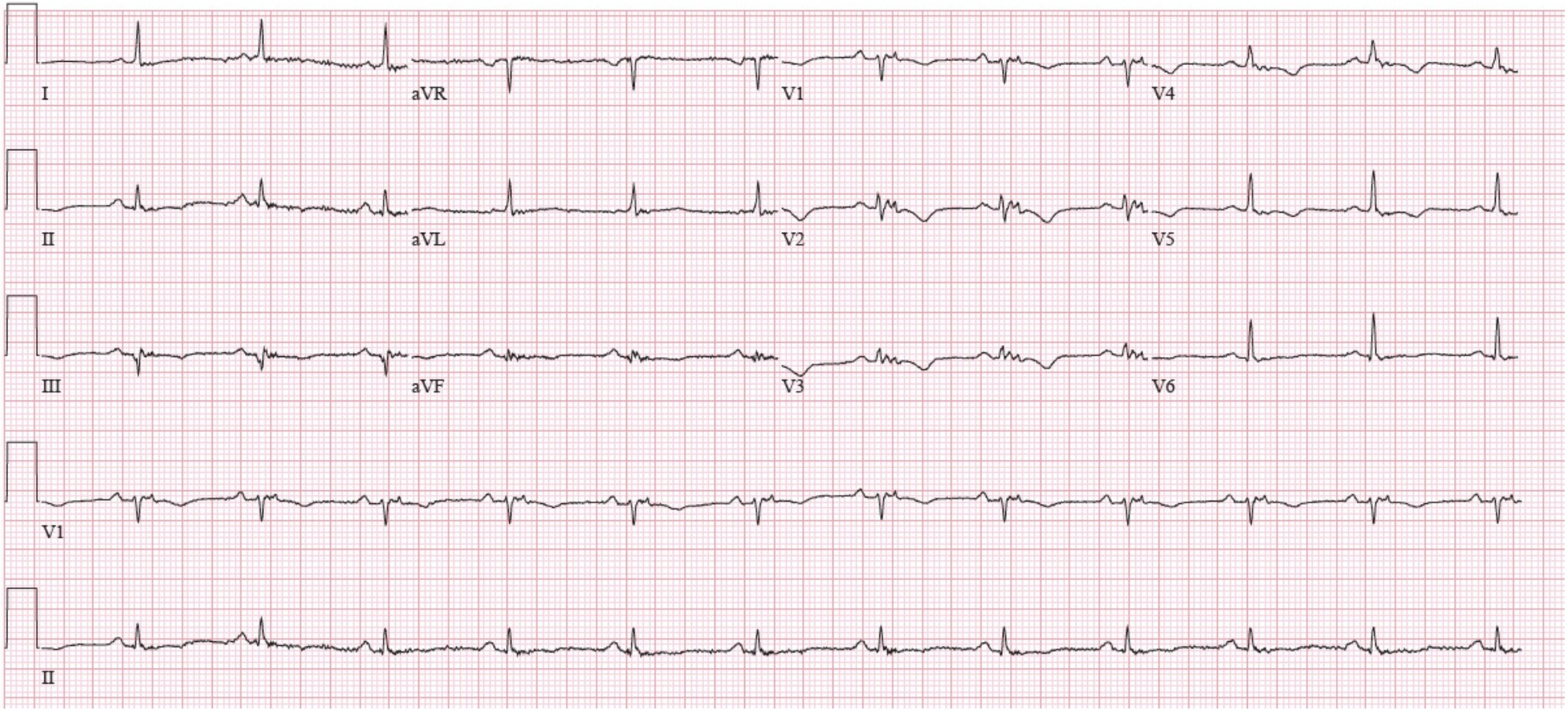
33 M with Recurrent Syncope

S Subjective

- History of “extra heart beats”
- At least 5 prior syncopal episodes, and never sought treatment.
- Most recently at work, and sent to ED by workers

O Objective

- ECG: Epsilon waves, QRSD >110, TWI
- TTE: Mildly dilated, trabeculated RV, with segmental abnormality, PLAX 30
- SAECG: Positive by all 3 Criteria
- Holter: 23 % RVOT PVCs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Analysis Filter: 40-250Hz					
Std. QRS Duration (unfiltered)	:	86 ms	Number of Beats Averaged	:	251
Total QRS Duration (filtered)	:	161 ms	Number of Beats Detected	:	381
Duration of HFLA signals < 40 uV	:	75 ms	Noise Level (Std. Deviation)	:	0.17 uV
RMS Voltage in terminal 40 ms	:	3 uV			
Mean Voltage in terminal 40 ms	:	2 uV			

(Darly, 2020)

Syncope: Structural HD & Abnormal ECG

A Assessment

Definite diagnosis:

Major

- Inverted T waves
- Epsilon waves

Minor

- >500 ventricular extrasystoles per 24hrs
- Regional RV dyskinesia; PLAX RVOT 30 mm

P Plan

- ICD Implantation

Every Patient

With:

- Uncertain dysrhythmia mechanism
- Unacceptable side effects from antiarrhythmic drugs


(RF Studio, 2020)

Uncertain Dysrhythmia Mechanism

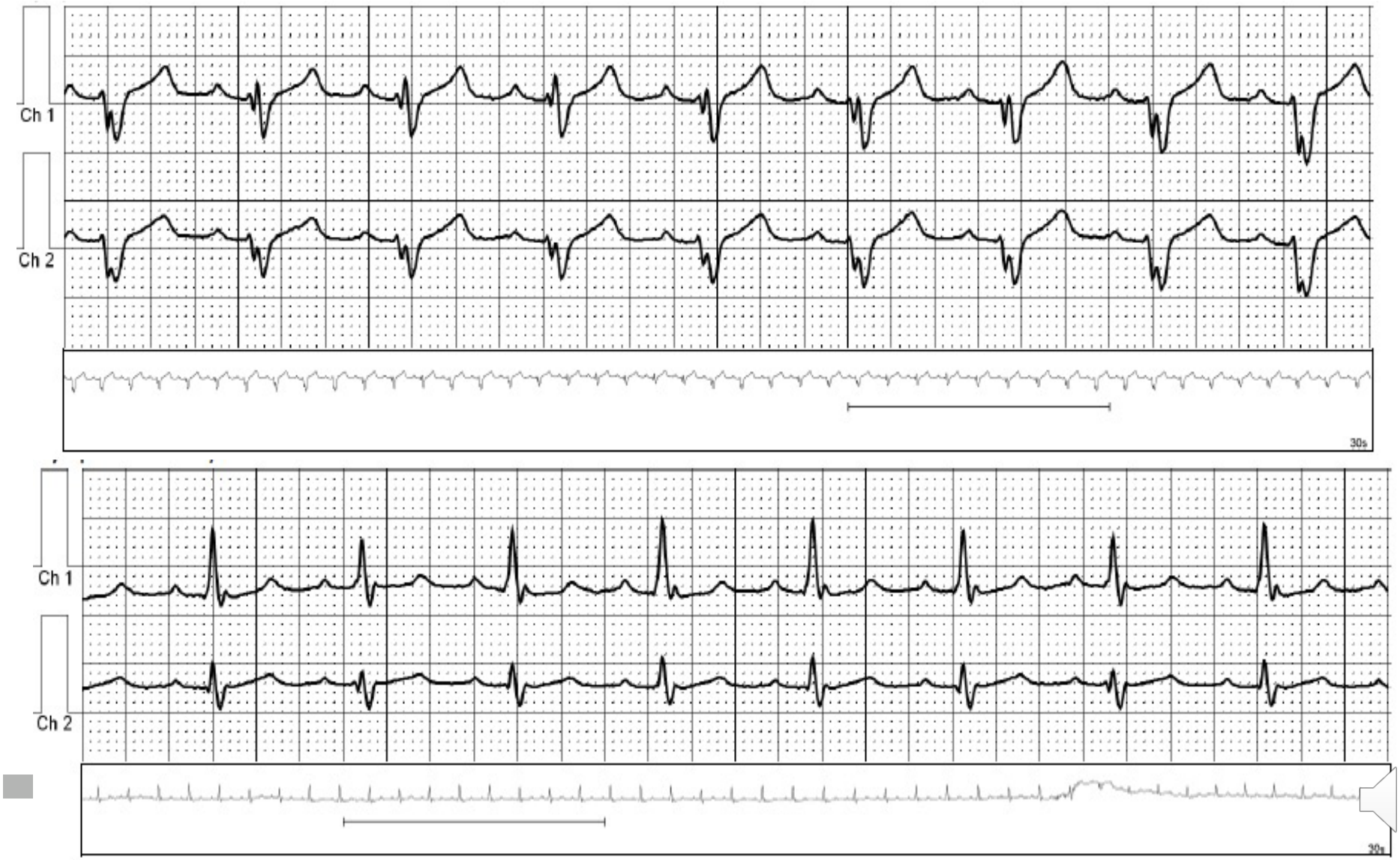
81 F with syncope and lightheadedness

S Subjective

- Ischemic right MCA stroke
- Hypertension
- “Intermittent” LBBB, by report
- Syncope in hot weather, followed by two episodes of LH one month apart.

O Objective

- MCOT: fluctuating QRS duration, rare PVCs
- TTE: LVEF 55%, unremarked
- EPS: HV: 74 ms


Ch 1
Ch 2
30s
Ch 1
Ch 2
20s


(RF Studio, 2020)

Uncertain Dysrhythmia Mechanism

A Assessment

- Episode of syncope with LBBB and presence of infra-nodal delay and abnormal conduction (HV of 75 msec)

P Plan

- Permanent pacemaker implantation.

Who Should Not Be Referred to EP?

- Single episode of a supraventricular dysrhythmia, without reoccurrence
- No document dysthymia and no potentially dysthymia-related symptoms

(Grabowska, 2020)

References

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