High Yield ECG Pearls for the Internal Medicine Boards 2025

Michael F. Krug, MD, FACP
Clinical Associate Professor
Associate Residency Program Director
University of Washington School of Medicine
UW Boise Internal Medicine Residency
krugm@uw.edu

I have no financial disclosures.

I am a general internist.

Many thanks to Dr. Zach Goldberger (a cardiologist) and ACP's MKSAP for allowing me to use some of their content.

American Board of Internal Medicine®

Internal Medicine

Certification Examination Blueprint

Medical Content Category	% of Exam
Allergy and Immunology	2%
Cardiovascular Disease	14%
Dermatology	3%
Endocrinology, Diabetes, and Metabolism	9%
Gastroenterology	9%
Geriatric Syndromes	3%
Hematology	6%
Infectious Disease	9%
Nephrology and Urology	6%
Neurology	4%
Obstetrics and Gynecology	3%
Medical Oncology	6%
Ophthalmology	1%
Otolaryngology and Dental Medicine	1%
Psychiatry	4%
Pulmonary Disease	9%
Rheumatology and Orthopedics	9%
Miscellaneous	2%
Total	**100%**

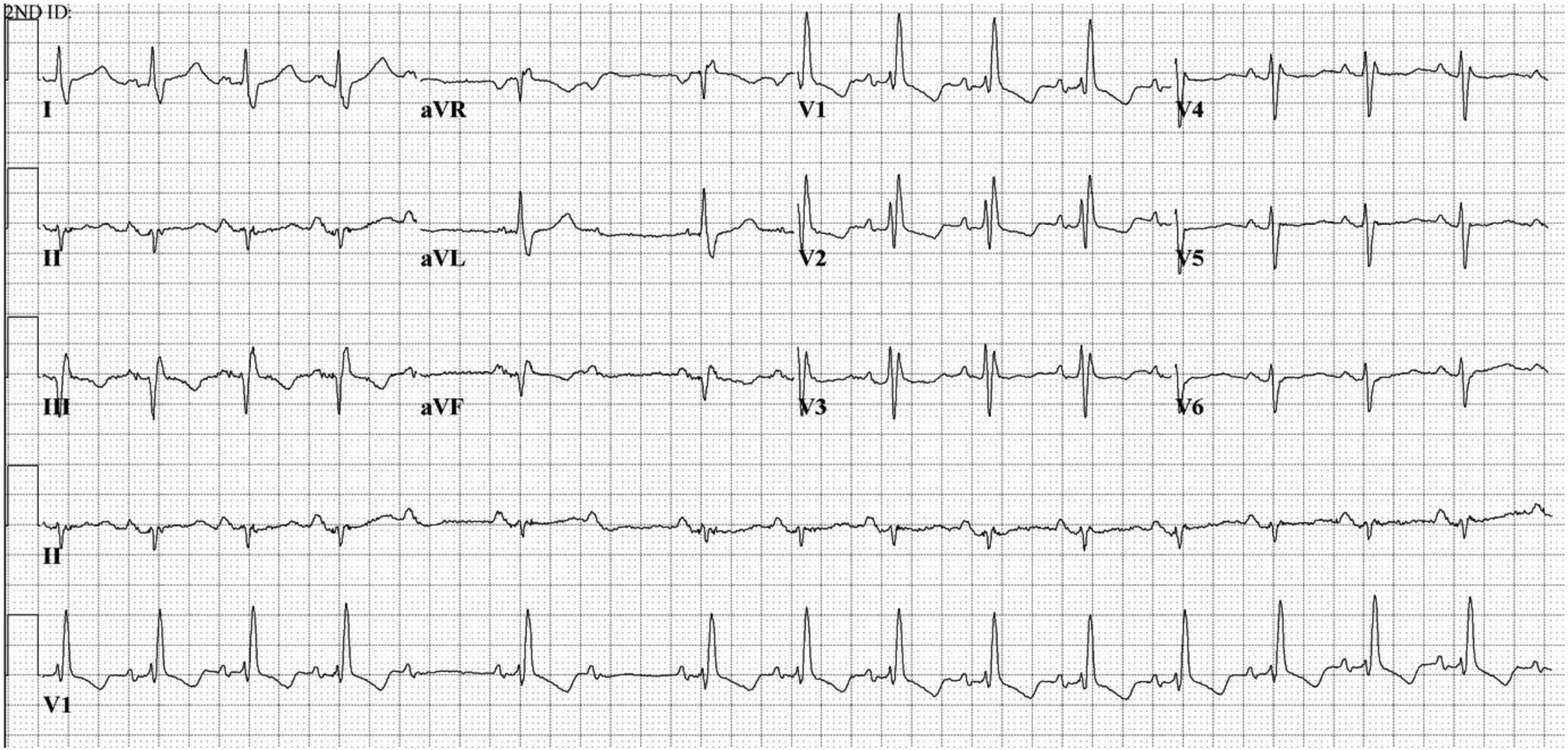
Cardiovascular Disease — 14% of Exam

- **Hypertension** *(NOTE: This total includes the **Hypertension** content listed under **Endocrinology, Diabetes, and Metabolism; Nephrology and Urology**)* — 5%
  - Essential hypertension
  - Renal (including renal parenchymal, renovascular)
  - Coarctation of the aorta
  - Hypertensive urgency and emergency
  - Undifferentiated hypertension
- **Pericardial disease** — <2%
  - Pericarditis
  - Pericardial effusion
  - Constrictive pericarditis
- **Ischemic heart disease** — <2%
  - Stable angina pectoris
  - Acute coronary syndrome (ACS)
  - ACS complications
  - Heart failure from ischemic cardiomyopathy
  - Evaluation of undiagnosed chest pain
  - Other ischemic heart disease (coronary artery disease, spasm)
- **Dysrhythmias and conduction defects** — <2%
  - Conduction defects
  - Bradyarrhythmias
  - Tachyarrhythmias
  - Other dysrhythmias (cardiac resuscitation)
- **Congenital heart disease in adults** — <2%
  - Atrial septal defect and patent foramen ovale
  - Bicuspid aortic valve
  - Other congenital heart disease (patent ductus arteriosus, ventricular septal defect, pulmonic stenosis)
- **Valvular heart disease** — <2%
  - Aortic stenosis
  - Aortic regurgitation
  - Mitral regurgitation
  - Mitral stenosis
  - Prosthetic heart valve
- **Myocardial disease** — <2%
  - Heart failure with preserved ejection fraction (HFpEF)
  - Myocarditis
  - Hypertrophic cardiomyopathy with and without obstruction
  - Restrictive cardiomyopathy
  - Dilated cardiomyopathy
  - Cor pulmonale
  - Undifferentiated myocardial disease
- **Endocarditis and other cardiovascular infection** — <2%
  - Endocarditis
  - Infections of the pericardial space
  - Endocarditis prophylaxis
  - Undifferentiated cardiovascular infection
- **Vascular disease** — <2%
  - Carotid artery disease
  - Aorta
  - Peripheral arterial disease
  - Pulmonary vascular disease
  - Venous disease of the lower extremities
  - Superior vena cava syndrome (not due to cancer)
- **Syncope** — <2%
  - Neurocardiogenic syncope (vasovagal syncope)
  - Situational syncope (including cough syncope, micturition syncope)
  - Postural hypotension
- **Preoperative consultation** — <2%
  - No testing required
  - Testing indicated
- **Lipid disorders** — <2%
- **Antithrombotic therapy in cardiovascular disease** — <2%
- **Miscellaneous cardiovascular disease (physical examination** — <2%

77year old Oregonian with 3 weeks of fatigue and dyspnea on exertion. No chest pain or pressure. He has a history of COPD and HTN and takes lisinopril and inhaled budesonide/formoterol (ICS/LABA). Labs including TSH & exam are normal. (ECG on next slide)

What will you recommend?

A) Stop inhaled budesonide/formoterol
B) Holter Monitor
C) Pacemaker Placement
D) Cardioversion
E) Work up for other causes of fatigue



ECG c/o ACP MKSAP 18

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E) Work up for other causes of fatigue

Distinguish Type I from Type II Second degree AV Block

Type I:
"Wenckebach"

P-R interval elongates before dropped beat

Type II:

No change in P-R interval before dropped beat.

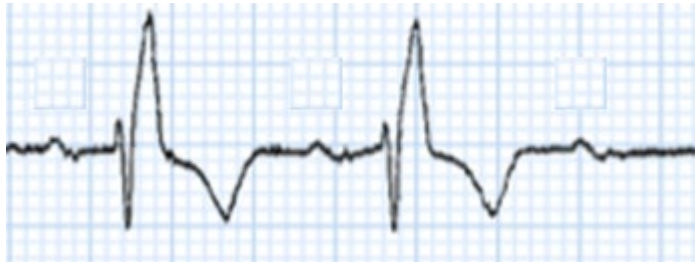
STEP 1: Evaluate and fix reversible causes:
-myocardial ischemia -beta/ca++ channel blockers
-hypothyroid -Lyme Carditis

STEP 2: then:

Type I:
"Wenckebach"

Usually Asymptomatic
NO PACEMAKER UNLESS
SYMPTOMATIC

Type II:



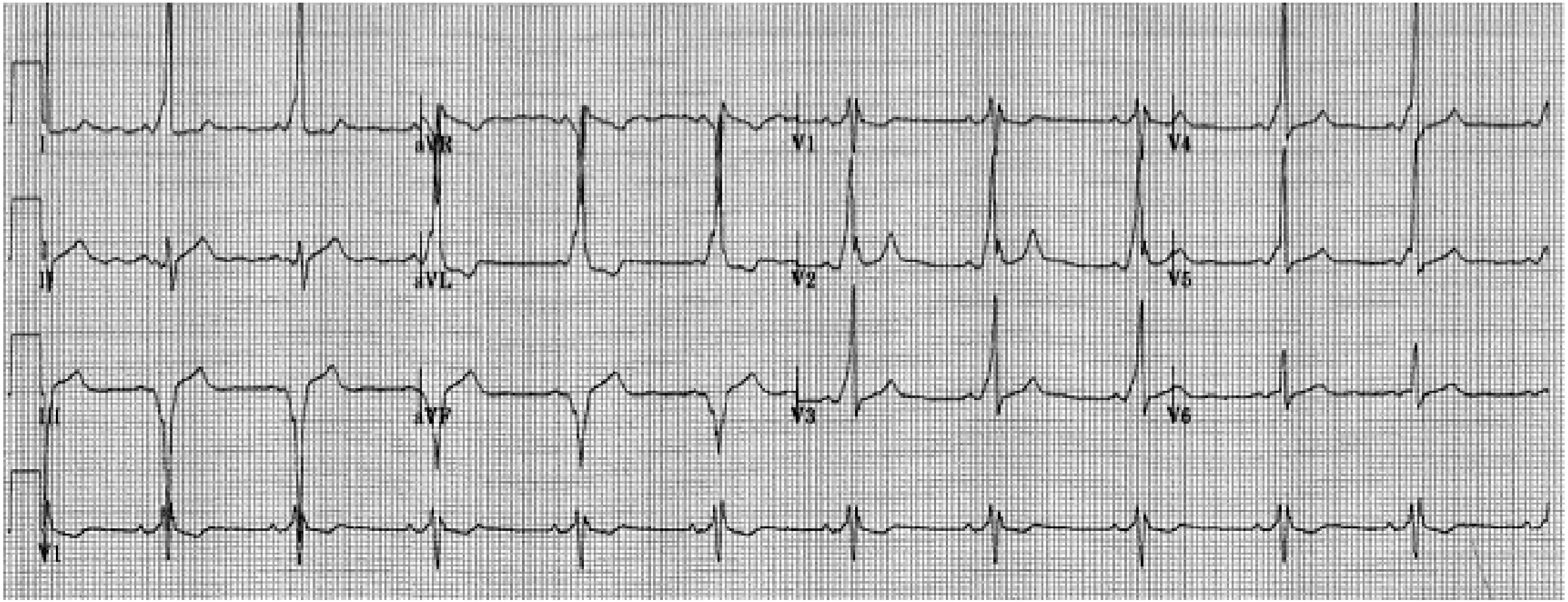
USUALLY WARRANTS
PACEMAKER UNLESS
REVERSIBLE CAUSE

34yo with recurrent abrupt onset palpitations. They last about 5 minutes each time and often subside when she kneels down.

She has bipolar disorder and takes an atypical antipsychotic and an SSRI. Her examination is unremarkable. (ECG on next slide)

What will you recommend?

A) Stop atypical antipsychotic
B) Stop SSRI
C) EP study and ablation
D) Amiodarone
E) Atenolol



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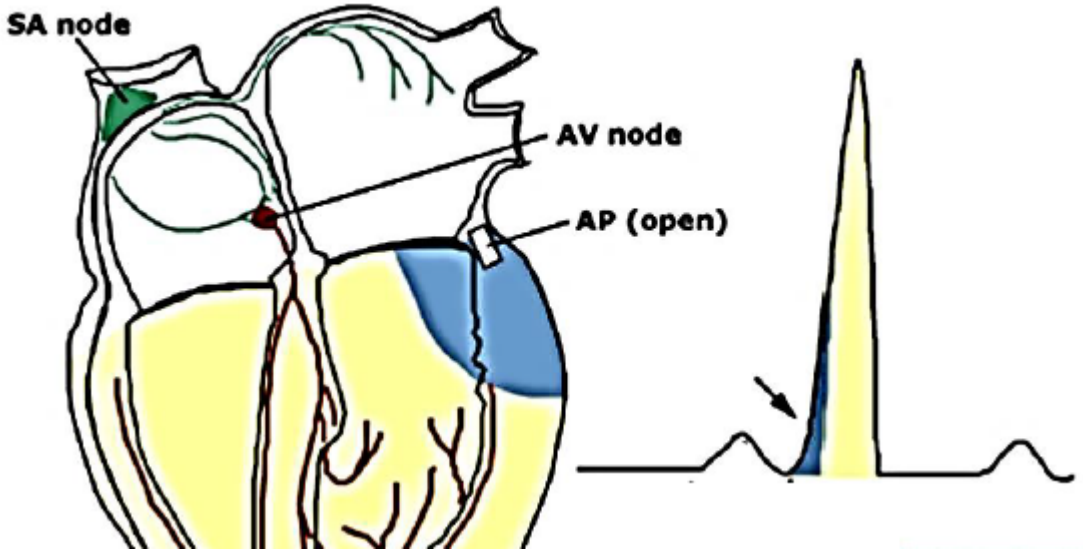
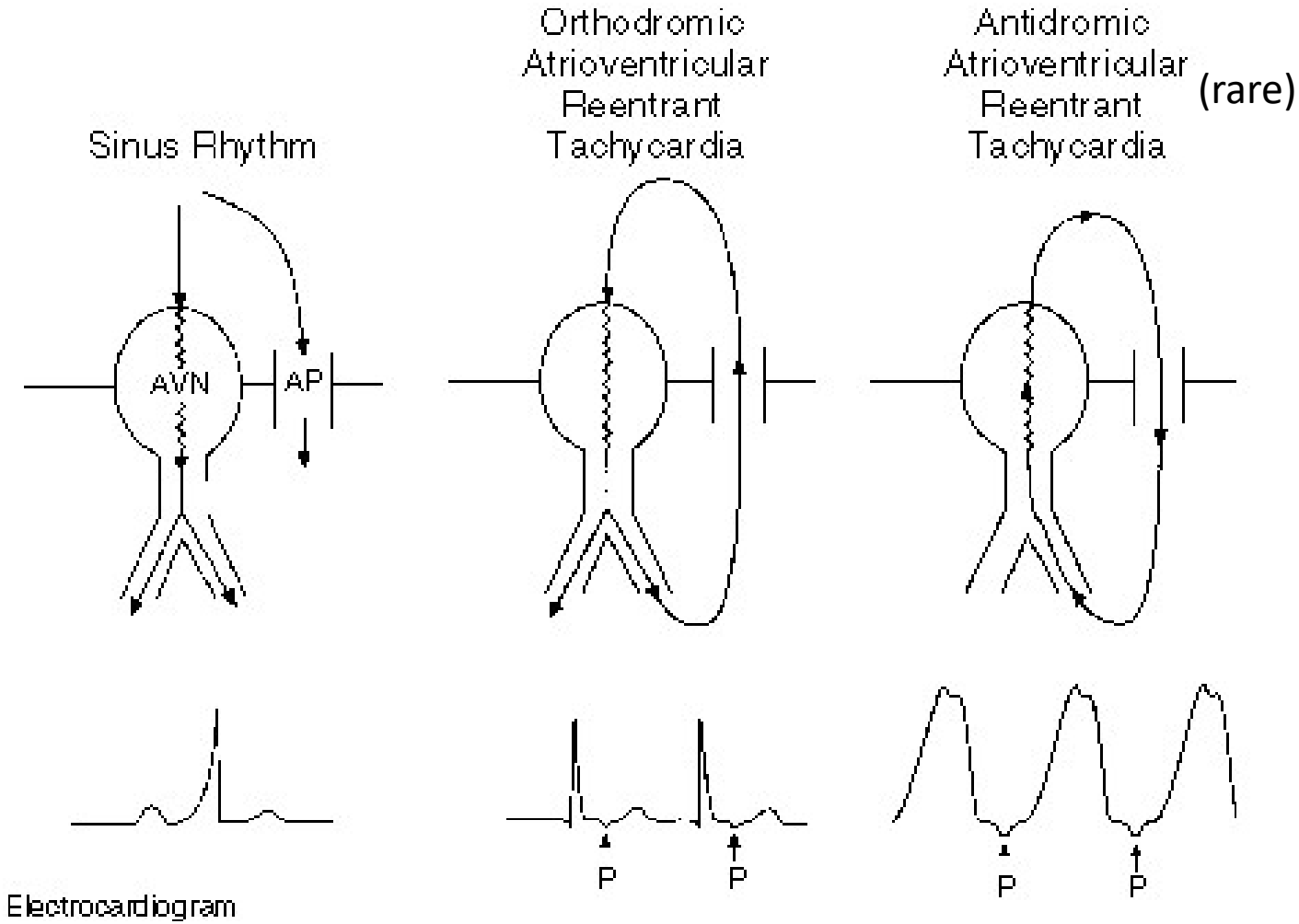
Recognize Wolf-Parkinson White Pattern



- Delta Wave (slurred upstroke of QRS)
- Short P-R interval
- QRS>100

Images c/o Dr. Zach Goldberger



Ganz LI, Friedman PL. N Engl J Med 1995;332:162-173.

Asymptomatic WPW pattern? -> Usually NO treatment indicated

WPW Syndrome (Tachyarrhythmias due to accessory pathway)? -> EP study and ablation is first line

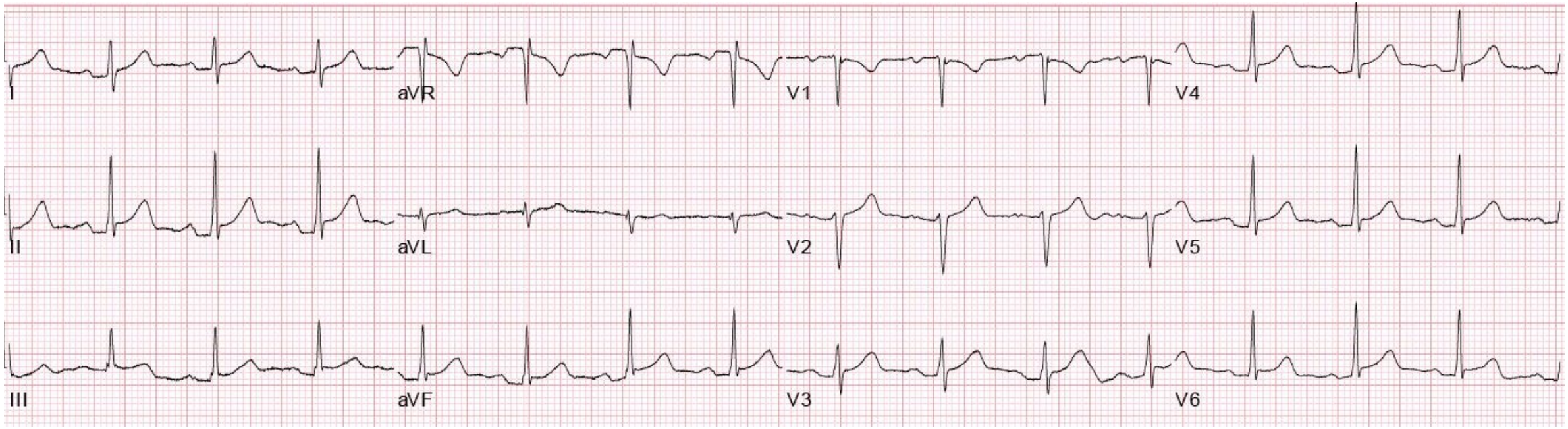
Flecainide, propafenone, beta blockers can be used if not undergoing ablation

62yo presents with sharp, severe central chest pain. She is treated with aspirin 325mg, statin, morphine, NTG with improvement in pain from 8/10->4/10

(ECG on next slide)

What will you recommend?

A) Percutaneous coronary intervention
B) Coronary artery bypass grafting (CABG)
C) Heparin drip
D) NSAIDS
E) Ranolazine


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

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ECG leads and corresponding coronary anatomy

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

Inferior: RCA

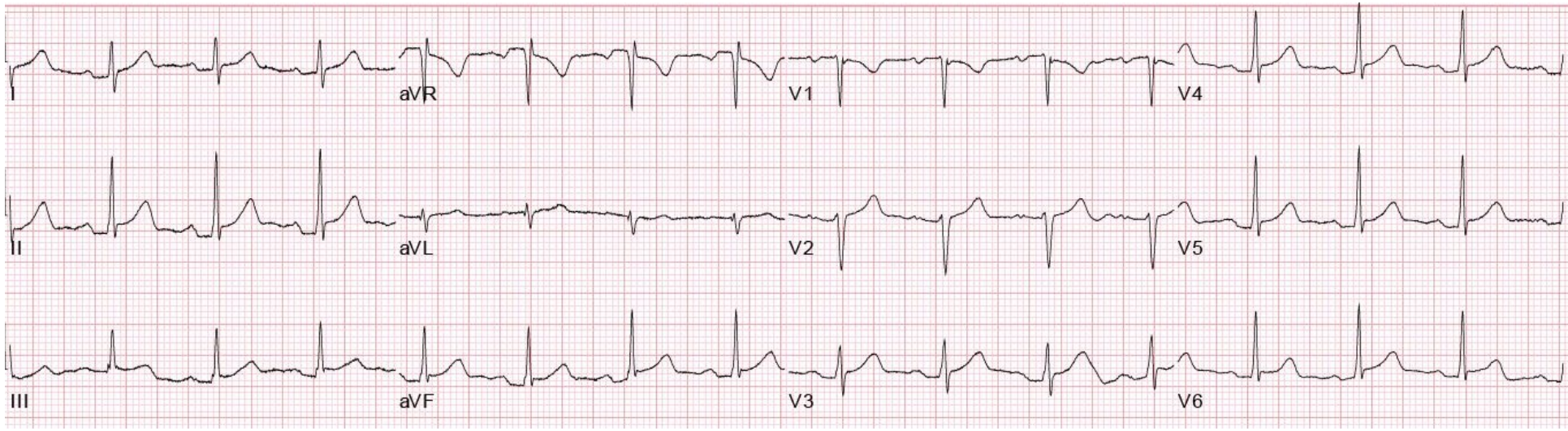
Septal: LAD

Anterior: LAD

Lateral: Circ

Recognize Acute Pericarditis

- ST elevation in several coronary distributions
- PR depression in lead II
- Concave ST elevation



Recognize Acute Pericarditis

High Yield History and Physical Clues (that I did not give you in my question)

- Pain is worse supine
- Pain is improved with sitting up and leaning forward
- Pericardial Friction Rub

Common causes

- Idiopathic or viral
- Uremia
- Chest irradiation
- Recent cardiac surgery

ECG c/o ACP MKSAP 18

Acute Pericarditis - Management

Workup:

-> Echo (eval for effusion)

-> Troponin (eval for myopericarditis)

Treatment:

-> NSAIDS are first line +/- colchicine as adjunct

-> Reserve glucocorticoids for:

NSAID contraindication; recurrent refractory pericarditis; autoimmune condition-mediated pericarditis

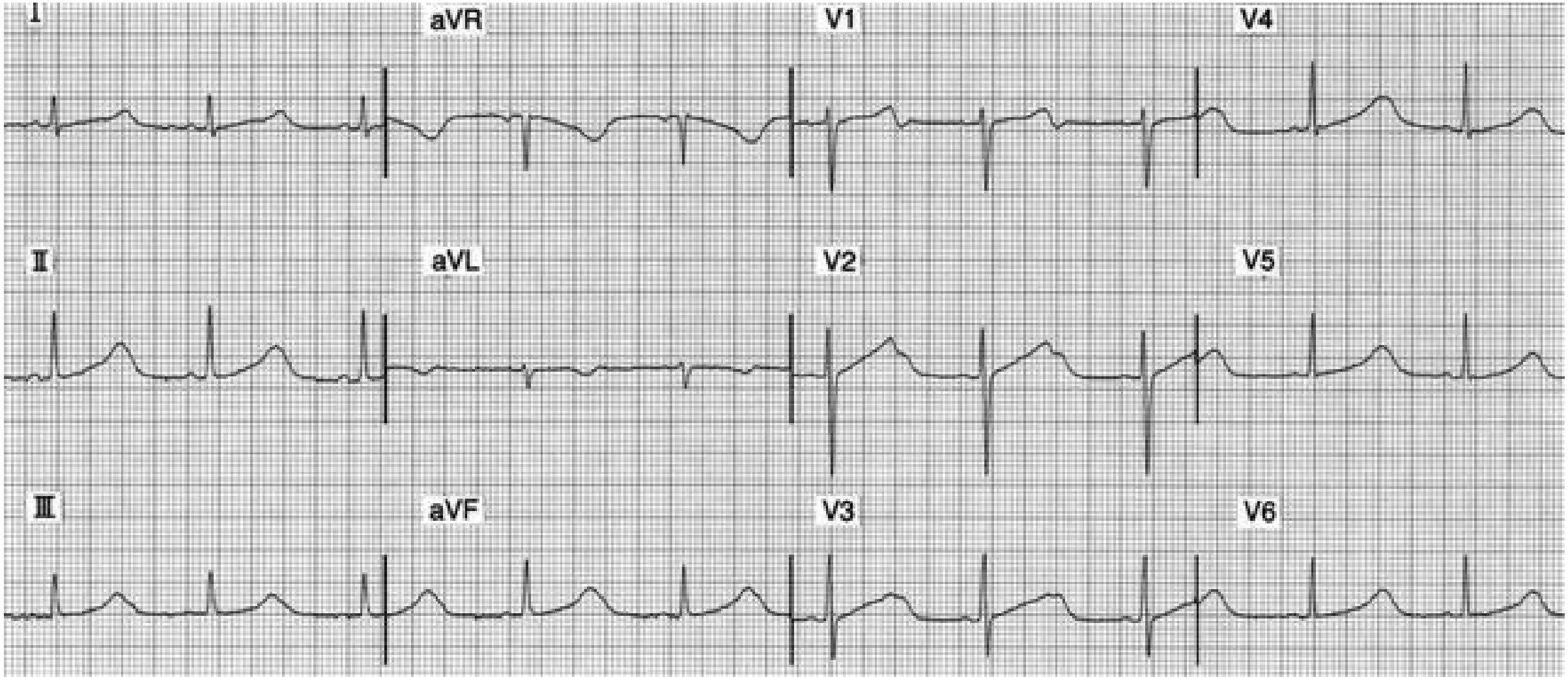
ECG c/o ACP MKSAP 18

41yo admitted to the hospital.
PMH: Chronic Pain
Home Meds: methadone, turmeric, diclofenac gel
Old Studies: he had a normal ECG 14 months prior

New Studies: (ECG on next slide)

What happened in the hospital that led to this ECG abnormality?

A) Patient received haloperidol
B) Patient received promethazine
C) Patient received doxycycline
D) Hyperkalemia
E) Hypercalcemia



ECG c/o Zach Goldberger, MD

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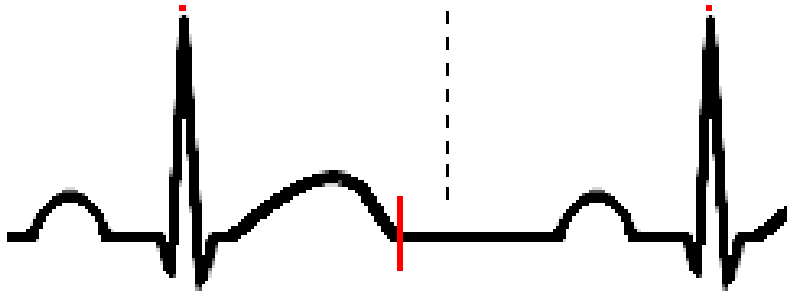
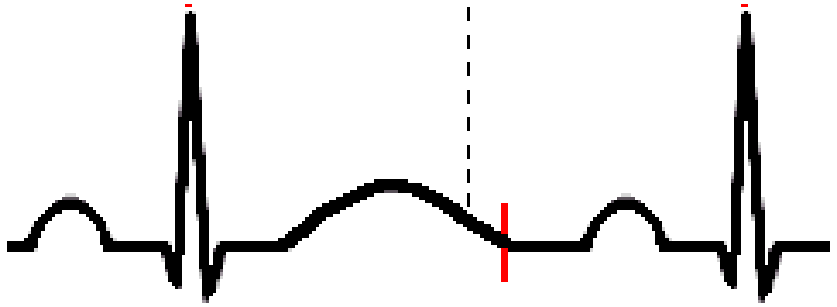
Long QT Syndrome

If regular rhythm, QT is very long if T wave ends more than ½ the distance between the QRS complexes



T wave ends before the midpoint between the QRS complexes
-> QT is not severely prolonged



T wave ends after the midpoint between the QRS complexes
-> QT is severely prolonged

Common Causes of Acquired Long QT Syndrome

Psychotropic drugs:

Antipsychotics (esp IV haloperidol)

TCAs

Anti-infective drugs:

Fluoroquinolones

Macrolides

Azole antifungals

Antiarrhythmics:

Sotalol, amiodarone, flecainide, etc

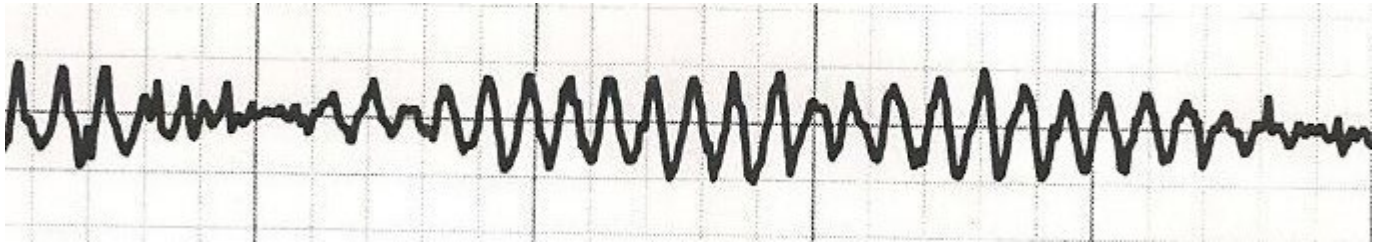
Opioids:

Methadone, buprenorphine

Electrolytes:

Hypokalemia, Hypocalcemia

The same 41yo patient develops the following abnormality on telemetry.



She feels “off” and lightheaded. She is oriented and lucid.

In addition to placing pads for possible cardioversion or pacing, what will you administer?

A) IV calcium
B) IV amiodarone
C) IV atropine
D) IV magnesium
E) IV epinephrine

Ventricular Tachycardia/Fibrillation

Usually treated with cardioversion/defibrillation

If stable or as adjunct to electricity:

IV magnesium sulfate for polymorphic VT (torsades) from long QT

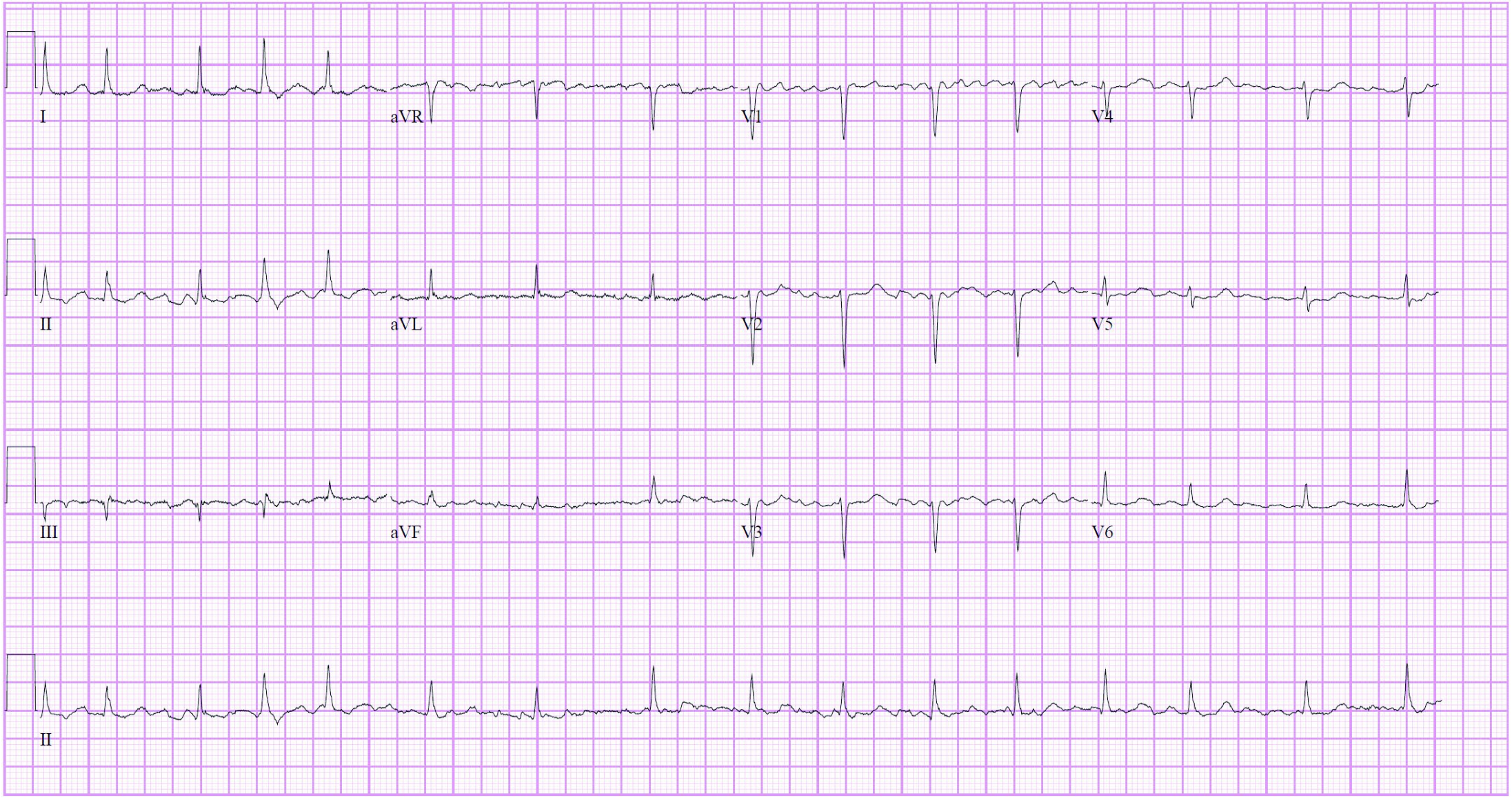
amiodarone for monomorphic VT or V Fib

73yo presents with 3 days of palpitations and marked dyspnea with exertion.
PMH: no history of arrhythmia or heart disease
VS: HR 105 BP 108/55
He is uncomfortable but lucid and conversational.
Labs: chem 8 and TSH are normal.
Studies: trans-thoracic Echo with diastolic dysfunction, normal atrial size

(ECG on next slide)

What will you recommend?

A) Immediate Cardioversion
B) Trans-esophageal echocardiogram then cardioversion
C) Adenosine
D) EP study and ablation
E) Vagal Maneuvers



ECG c/o MKSAP 18

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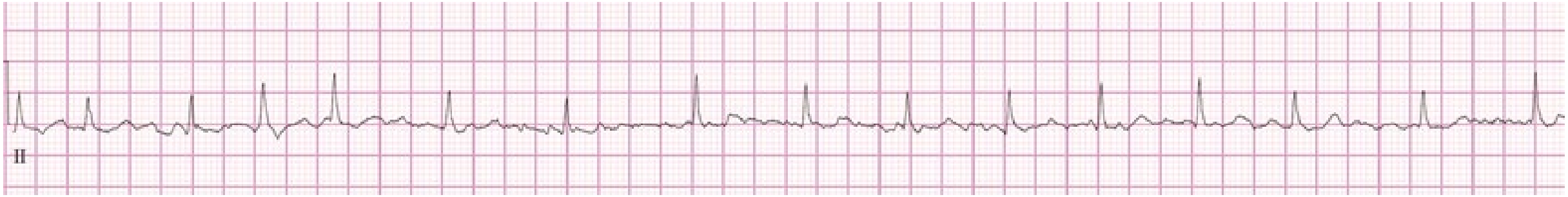
Atrial Fibrillation:

No pattern to QRS complexes (irregularly irregular)

Fibrillating or indiscernible P waves



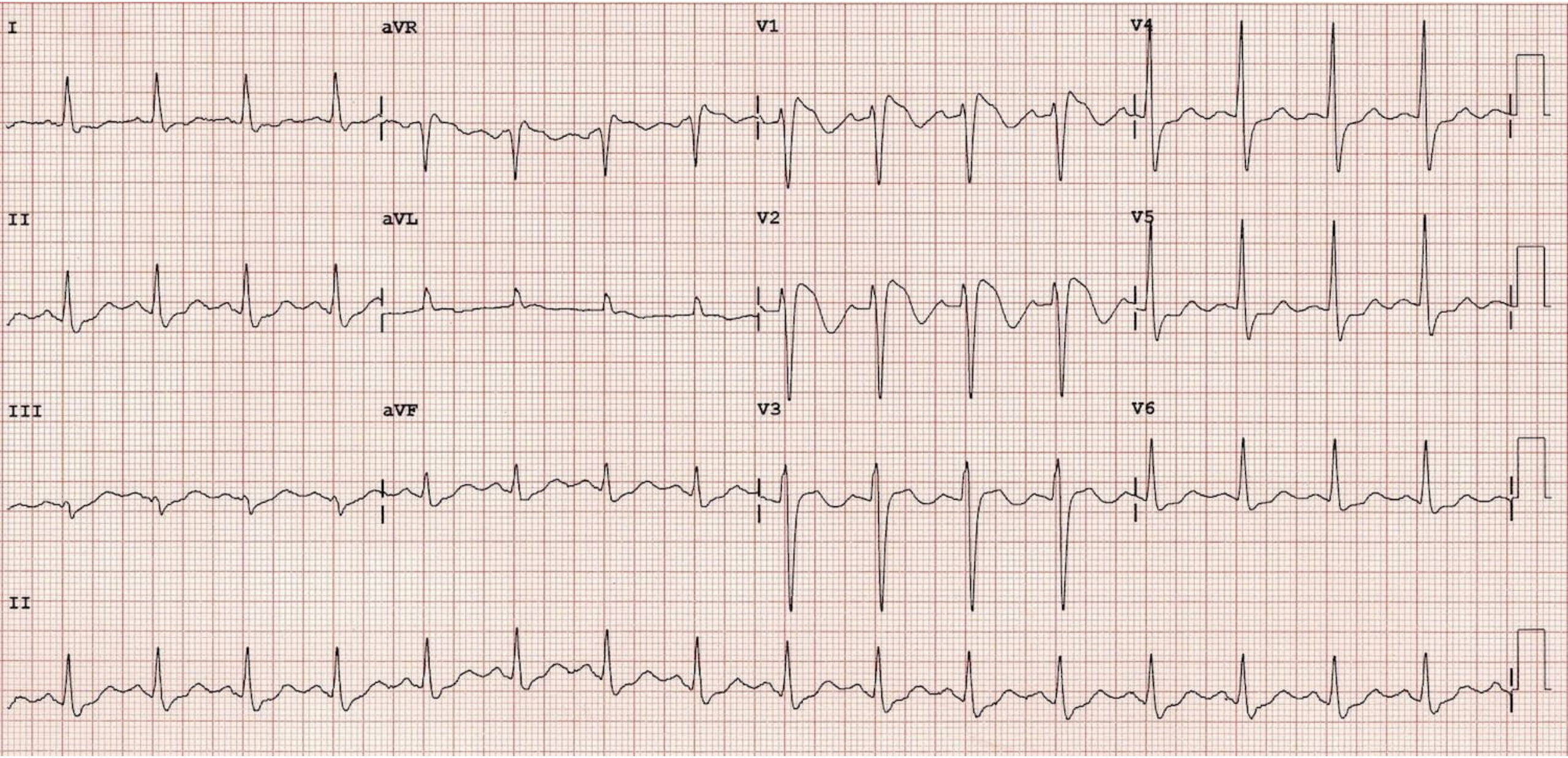
ECG c/o MKSAP 18

Cardioversion in A Fib

"Critical" A Fib (Hypotension/Myocardial ischemia/Critical CHF related to A. Fib)	→ Immediate Cardioversion <u>Needed</u>
Non-Critical A Fib with <u>known</u> duration <48 hours	→ Immediate Cardioversion OK
Non-Critical A Fib with duration >48 hours or unknown	→ Must either: • Trans-esophageal echo to rule out thrombus then cardioversion • Anticoagulate for 3+weeks then cardioversion

Which of the following conditions is this ECG consistent with (in the right clinical setting)?

A) Wellen's Syndrome
B) Brugada Syndrome
C) Pericarditis
D) Hypokalemia
E) Hyperkalemia



ECG from Life in the Fastlane website 2024

Which of the following conditions is this ECG consistent with (in the right clinical setting)?

A) Wellens Syndrome
B) Brugada Syndrome
C) Pericarditis
D) Hypokalemia
E) Hyperkalemia

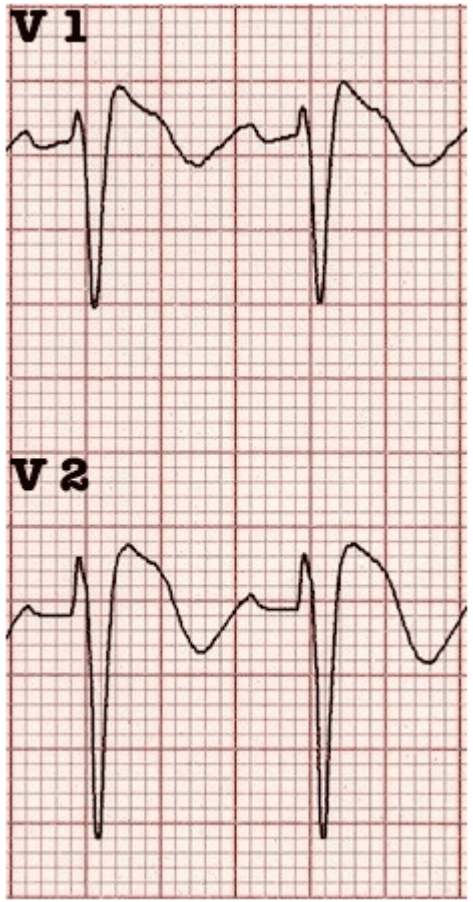
Brugada Syndrome

- Due to one of many possible cardiac sodium channel gene mutations
- ECG changes may be transient and may be induced by fever, meds, or electrolyte abnormalities

- If ECG pattern accompanied by VT or VF, family history of sudden cardiac death, syncope, or inducible VT/VF

  → ICD placement

Identify Brugada Syndrome pattern on ECG

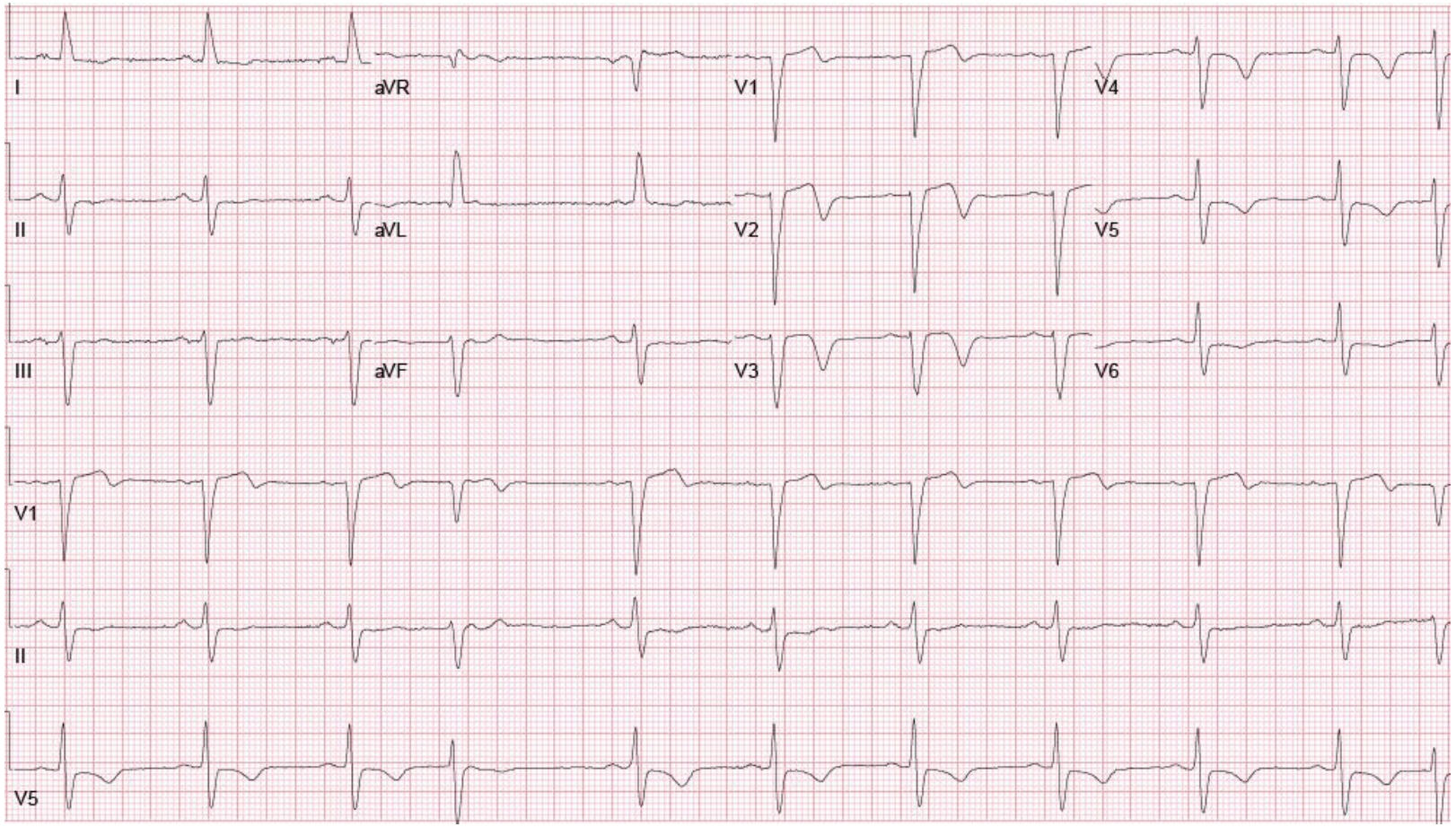


Prominent ST elevation in V1-V3 that is often straight or concave, with subsequent inverted T wave

Wellens pattern

Deep T wave inversions in multiple precordial leads (eg V1-V4)

In the setting of ischemic chest pain this pattern is caused by high-grade Stenosis of the left anterior descending Artery (LAD)

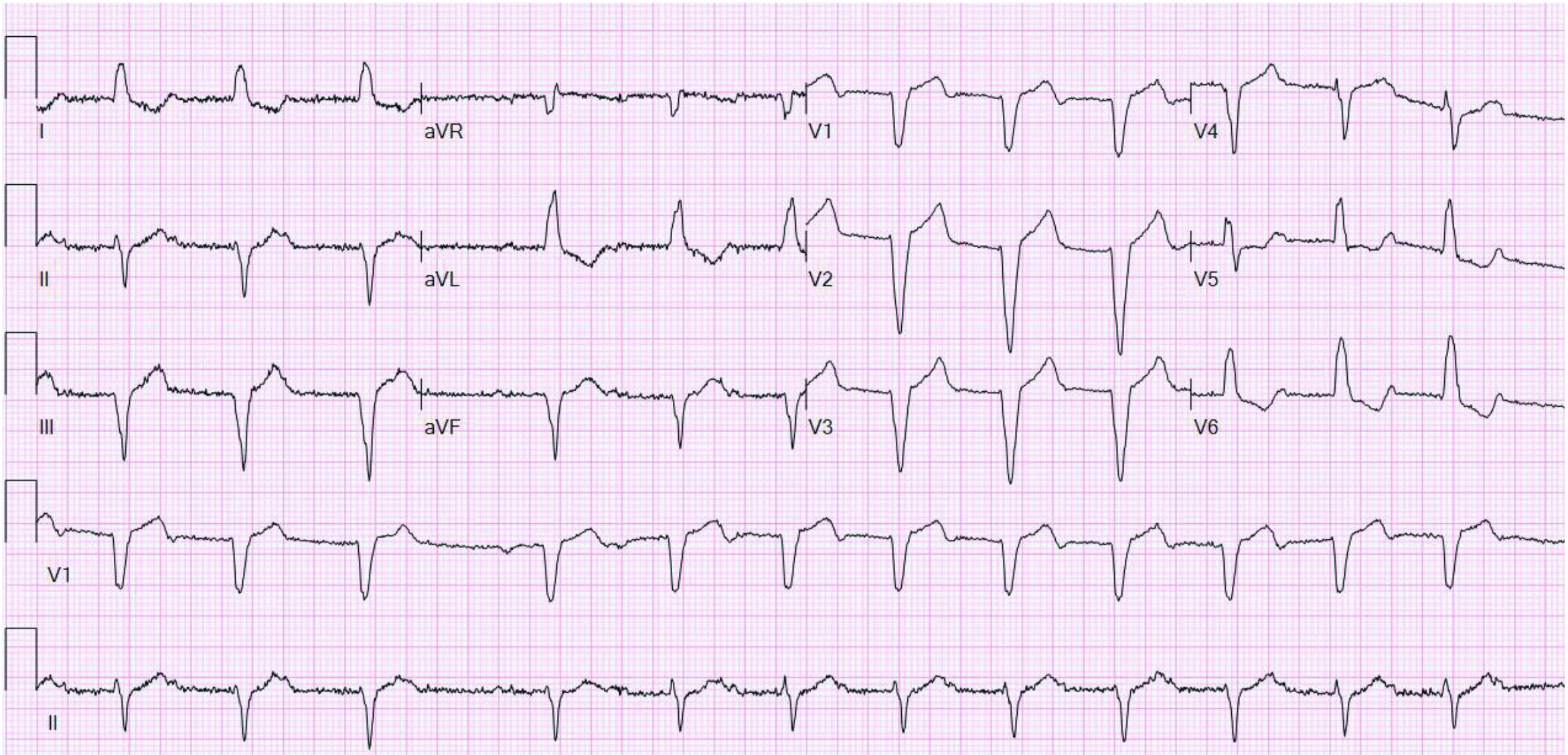


71yo with 2 hours of substernal chest pressure and diaphoresis.
Prior ECG from 2 years ago was normal.

(New ECG on next slide)

What is the most appropriate next step?

A) Emergent cardiac catheterization
B) Medical management of ACS with likely cath within 24 hours
C) Nuclear Medicine Stress Test
D) Hemodialysis
E) NSAIDs and colchicine



ECG c/o MKSAP 18

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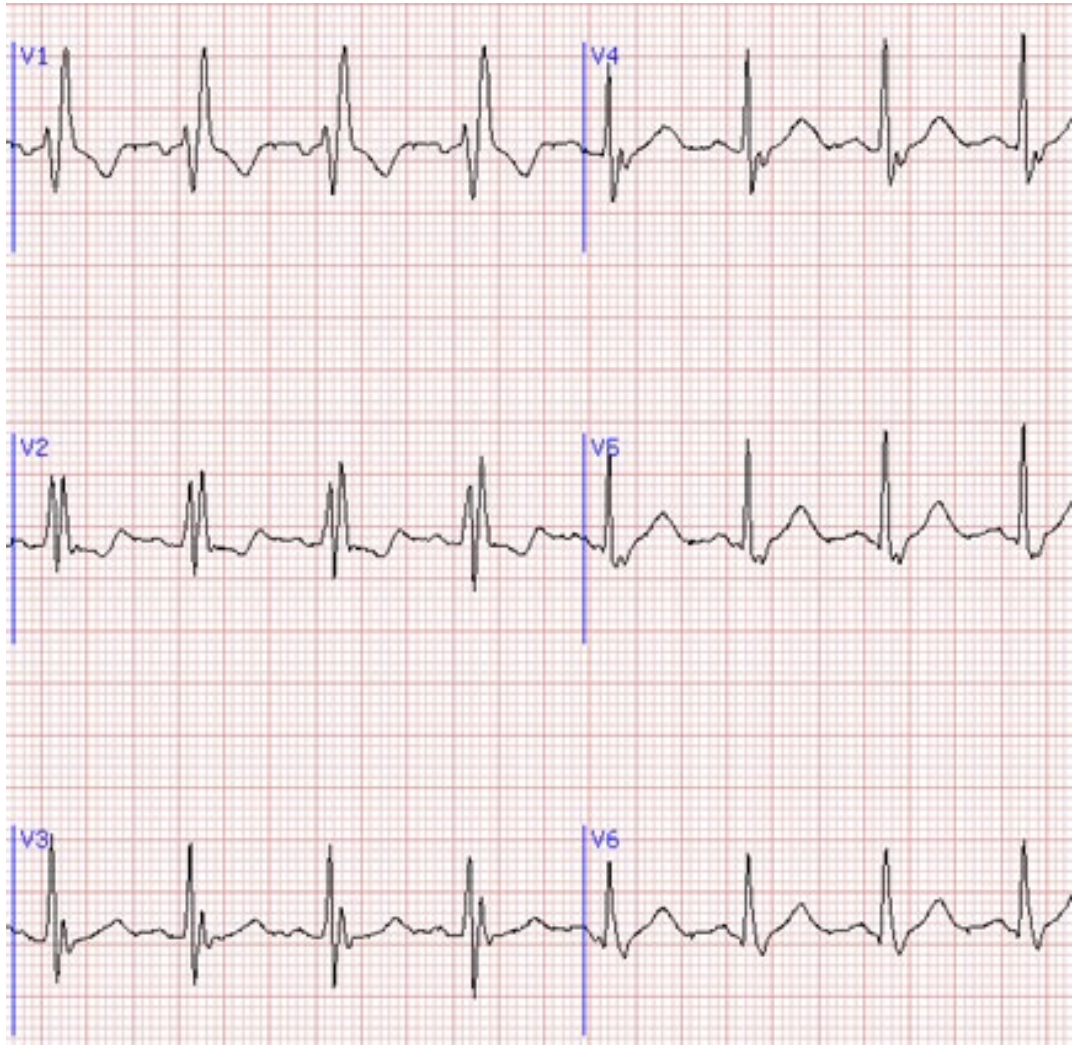
Left Bundle Branch Block

- Wide QRS (>120msec or 3 small boxes)
- Broad, slurred or notched R wave in V5-V6
- Broad S wave in V1

Right Bundle Branch Block

- Wide QRS (>120msec or 3 small boxes)
- rSR` in V1 and V2

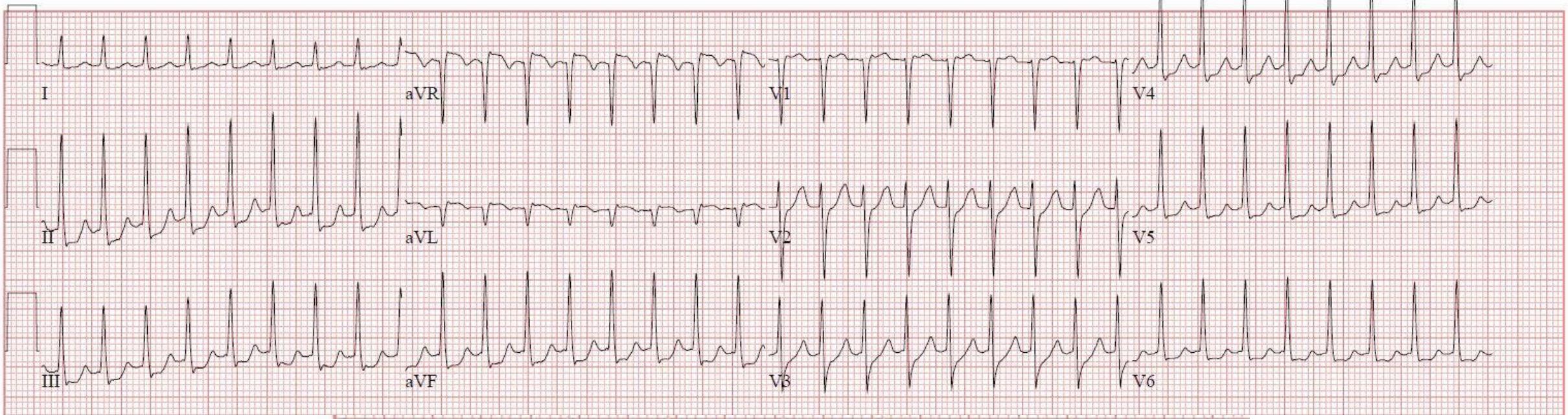


🔑 <u>New</u> Left Bundle Branch Block in an ACS workup is considered a STEMI equivalent*

*However, keep in mind that the prevalence of LBBB is roughly 1% of the general population and is usually due to slowly progressive degeneration of the conduction system

27 year-old man presents to the ED with 2 hours of palpitations.
He has had this several times in the past but previously it had resolved on it's own after 5-10 minutes.
PMH: none
FH: father with MI at age 53
VS: HR 200 BP 124/75
He is anxious. Heart is tachycardic, regular, with no murmur
Carotid sinus massage is performed with no effect. (ECG on next slide)

What is the next step in management?
A) Synchronized Cardioversion
B) Unsynchronized Cardioversion
C) Amiodarone
D) Adenosine



ECG c/o Dr. Zach Goldberger

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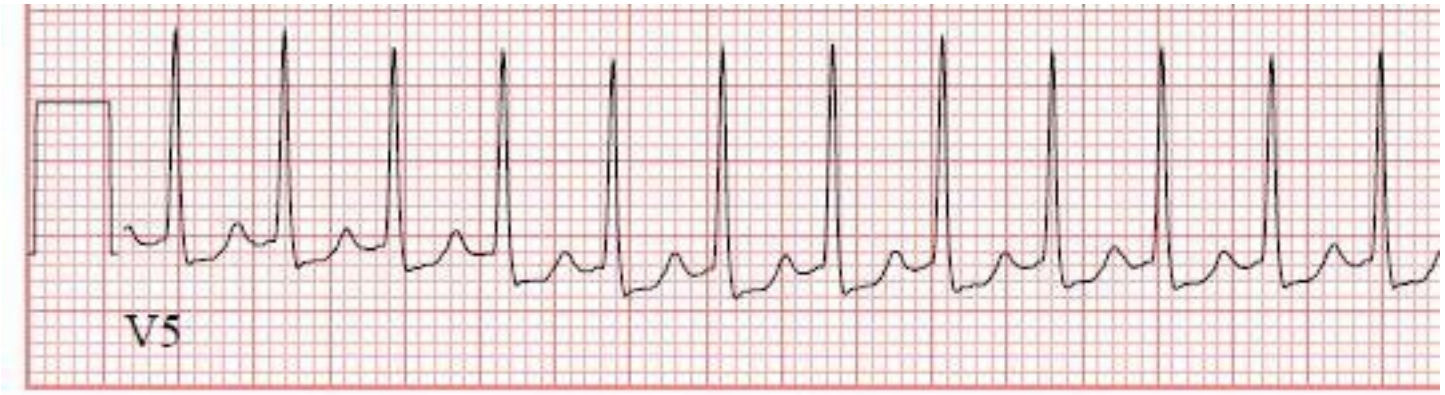
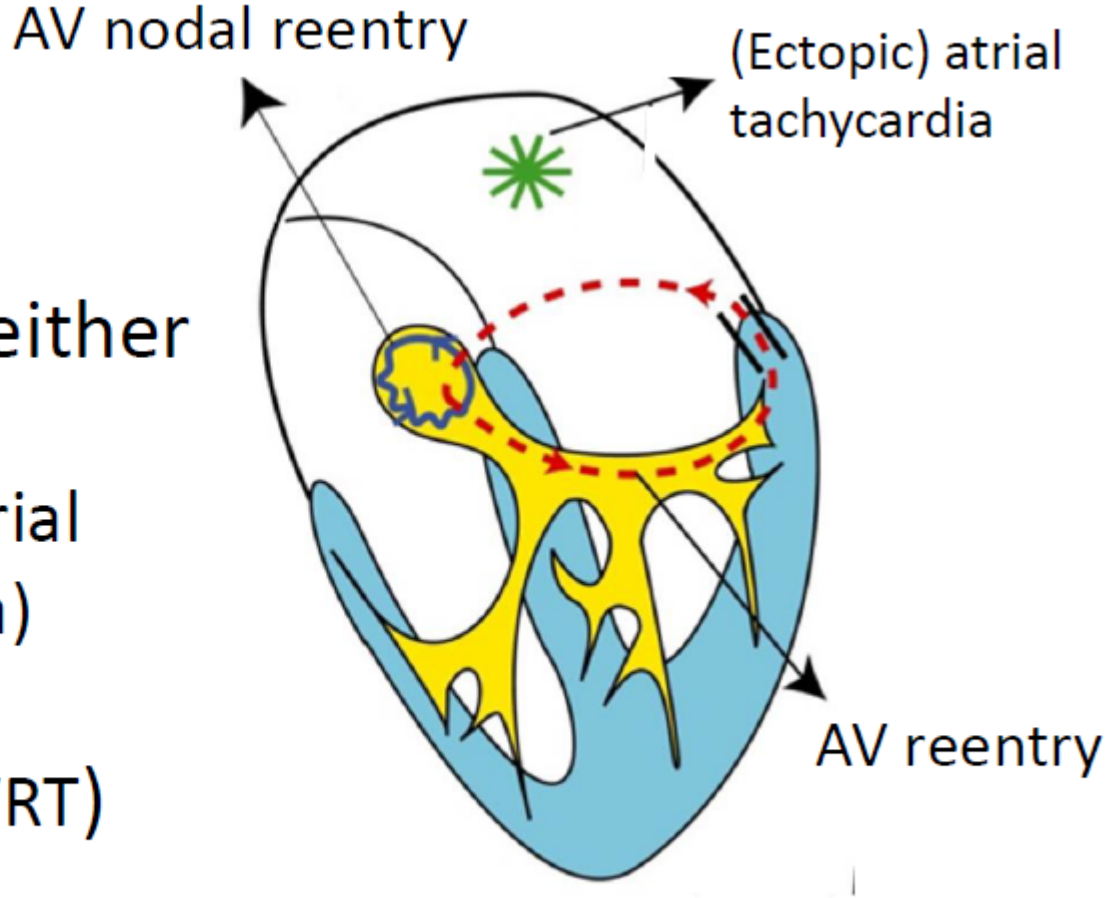
Paroxysmal Supraventricular Tachycardia (PSVT)

- Regular, narrow complex
- HR usually 180-200
- Sudden onset and termination



Paroxysmal Supraventricular Tachycardia (PSVT)



Mechanism is either

- Automatic
  (ectopic atrial tachycardia)
- Reentrant
  (AVNRT, AVRT)

Note: atrial flutter is also a reentrant rhythm, and may be paroxysmal, but not typically classified as "PSVT"

Image c/o Dr. Zach Goldberger

AV Nodal Reentrant Tachycardia (AVNRT)

- Most common version of PSVT
- Retrograde inverted P waves next to the QRS

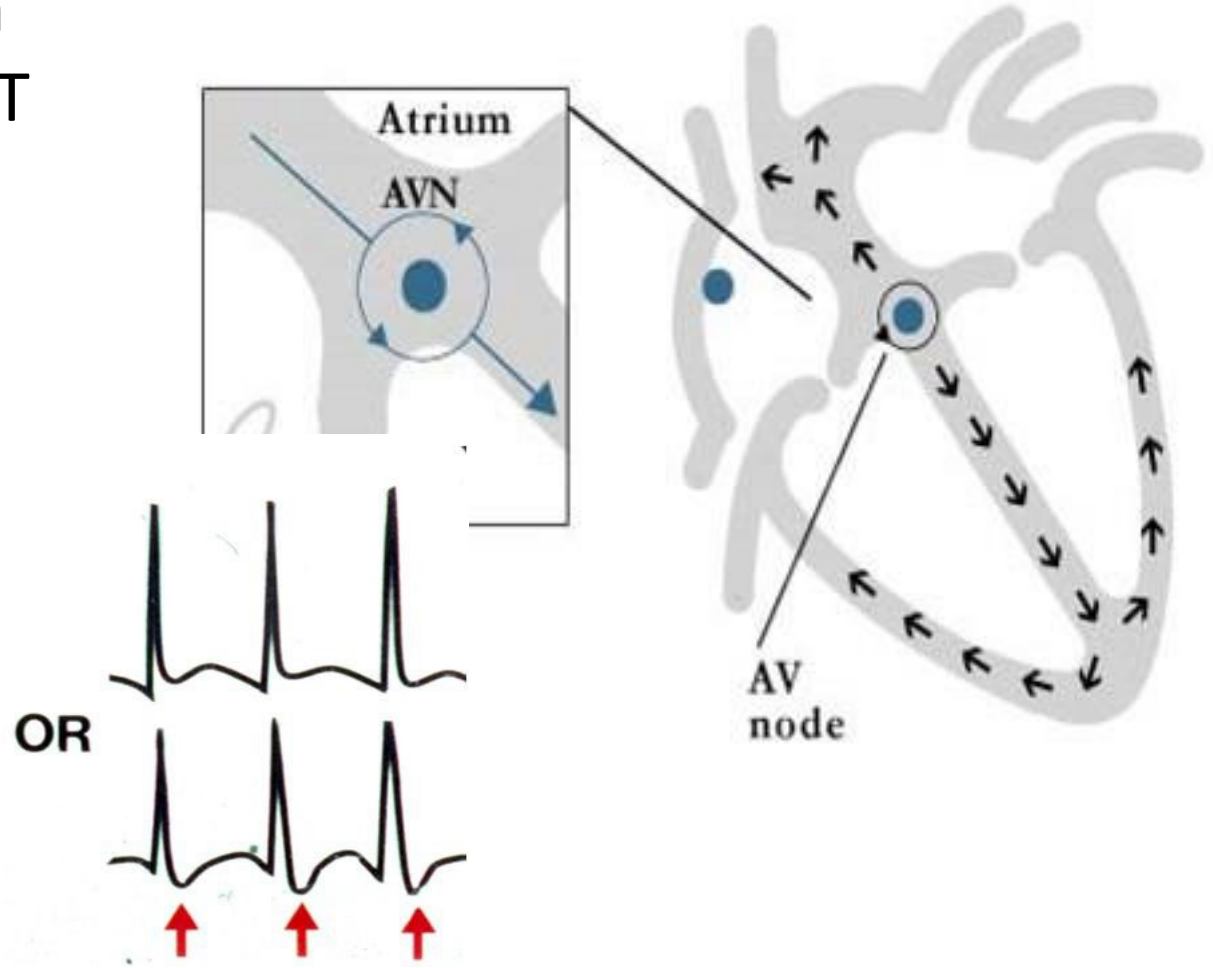


Image c/o Dr. Zach Goldberger

Paroxysmal Supraventricular Tachycardia (PSVT) - Treatment

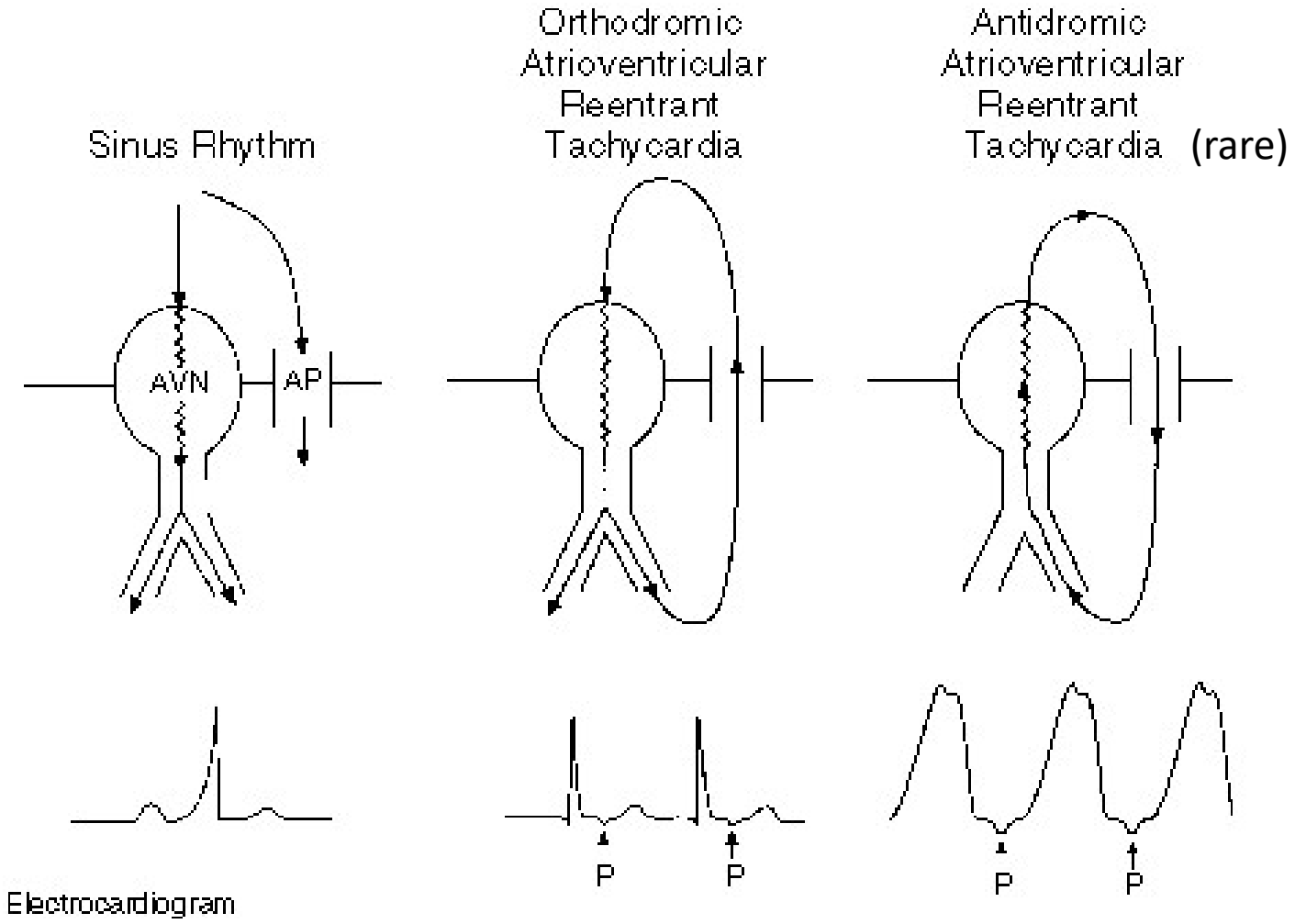
Acute abortive therapy: Slow conduction through AV node*

- Vagal maneuvers first (carotid massage, Valsalva)
- If ineffective, administer adenosine rapid IV push (6mg IV. Then 12mg IV if 6 ineffective)

Long-Term Therapy:

Consider: no treatment, ablation, or suppressive therapy with beta blocker or calcium channel blocker depending on clinical circumstances

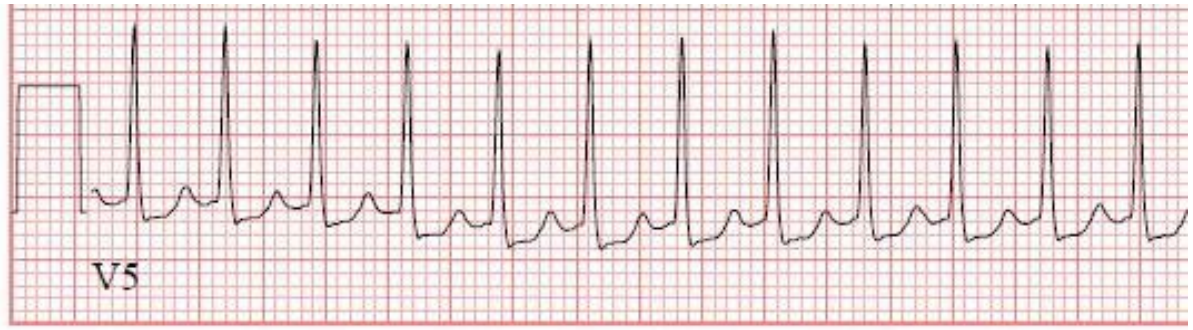
*Avoid AV nodal blockade in antidromic AVRT (wide complex – see next slide)



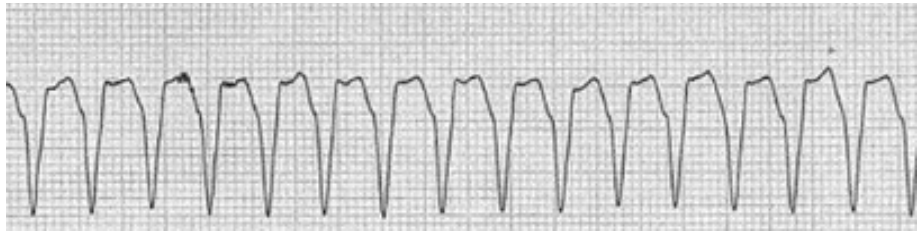
Ganz LI, Friedman PL. N Engl J Med 1995;332:162-173.

Zebra: Antidromic AVRT Treatment

Most PSVT (90-95%) has orthodromic conduction -> treat by slowing conduction through the AV node

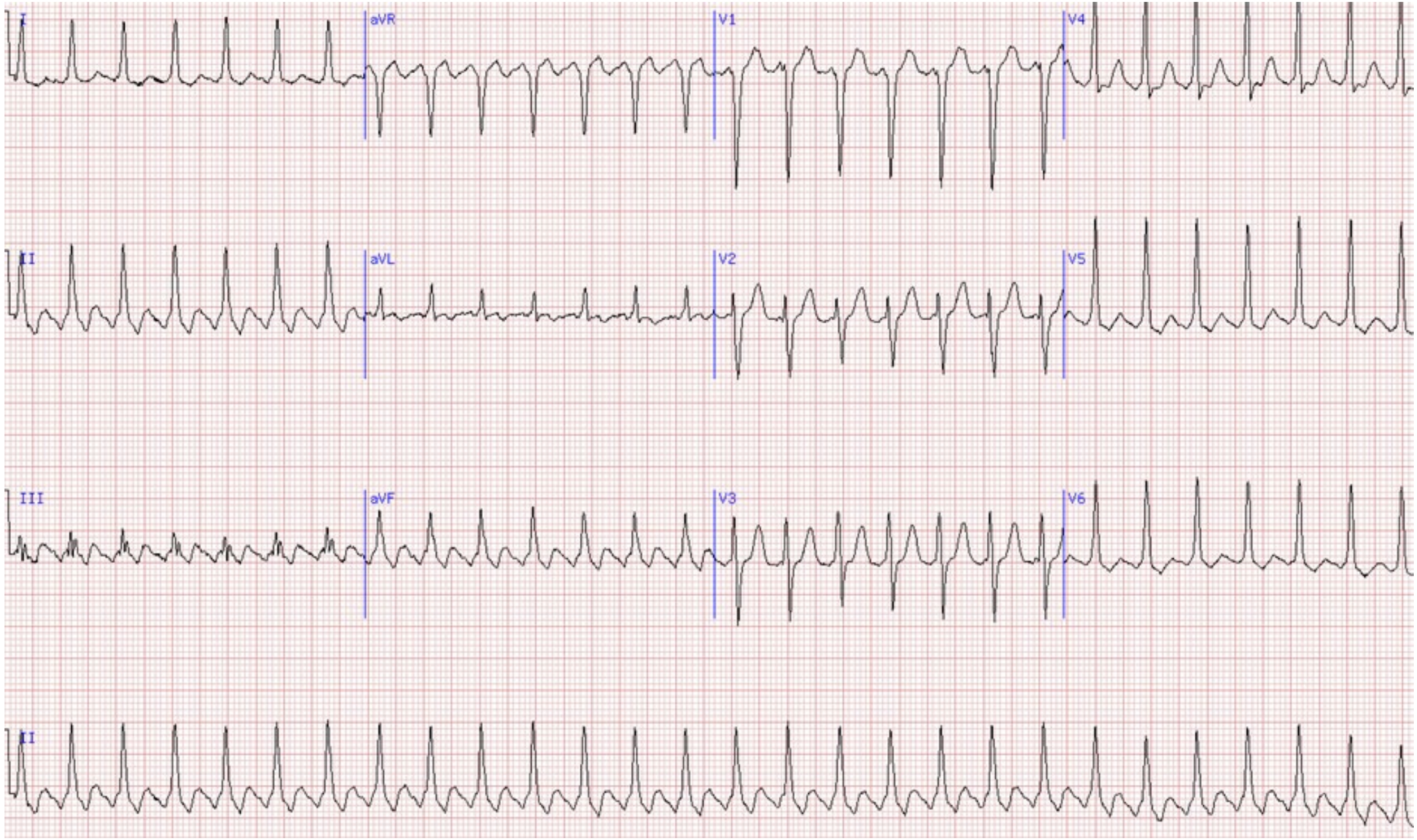


Rare antidromic AVRT (wide complex) -> avoid AV blockers



76yo with COPD presents to the ER with 5 days of intermittent palpitations. She has no history of heart arrhythmia. Blood pressure is 135/75

What will you recommend for initial treatment
A) cardioversion
B) Adenosine
C) diltiazem
D) amiodarone
E) levalbuterol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What will you recommend for initial treatment
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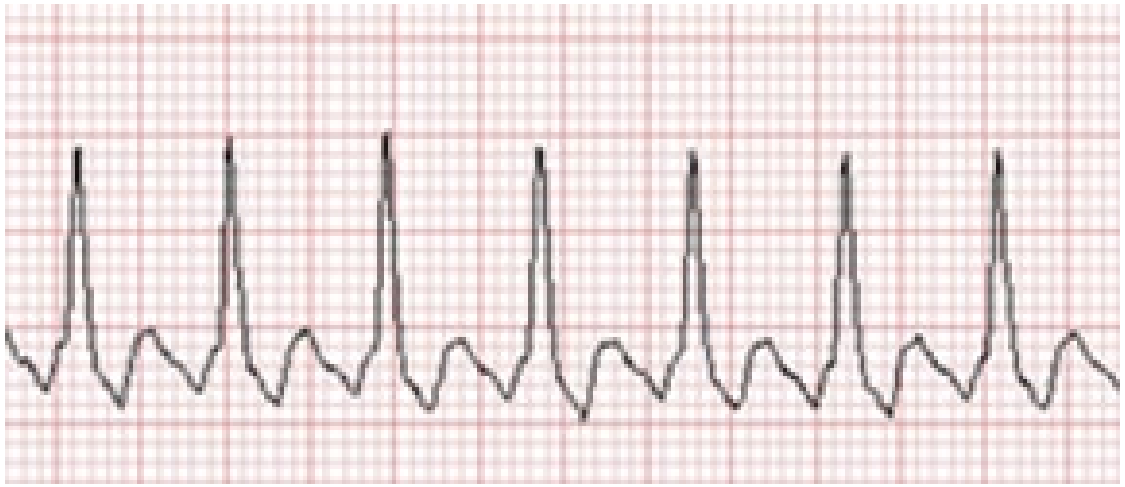
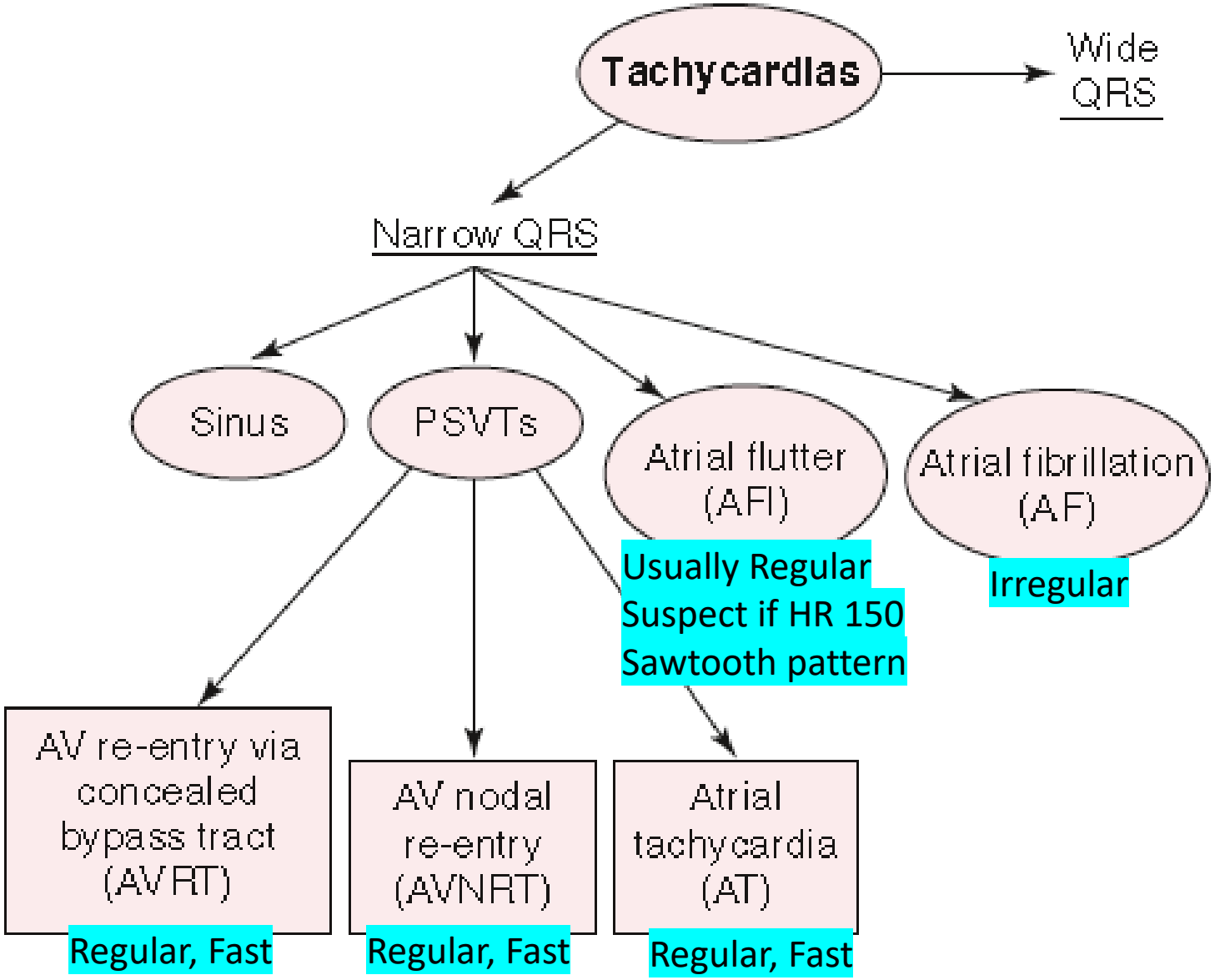
Atrial Flutter

- Usually Regular (but can be irregular)
- Rate often ca 150/min
- Sawtooth pattern



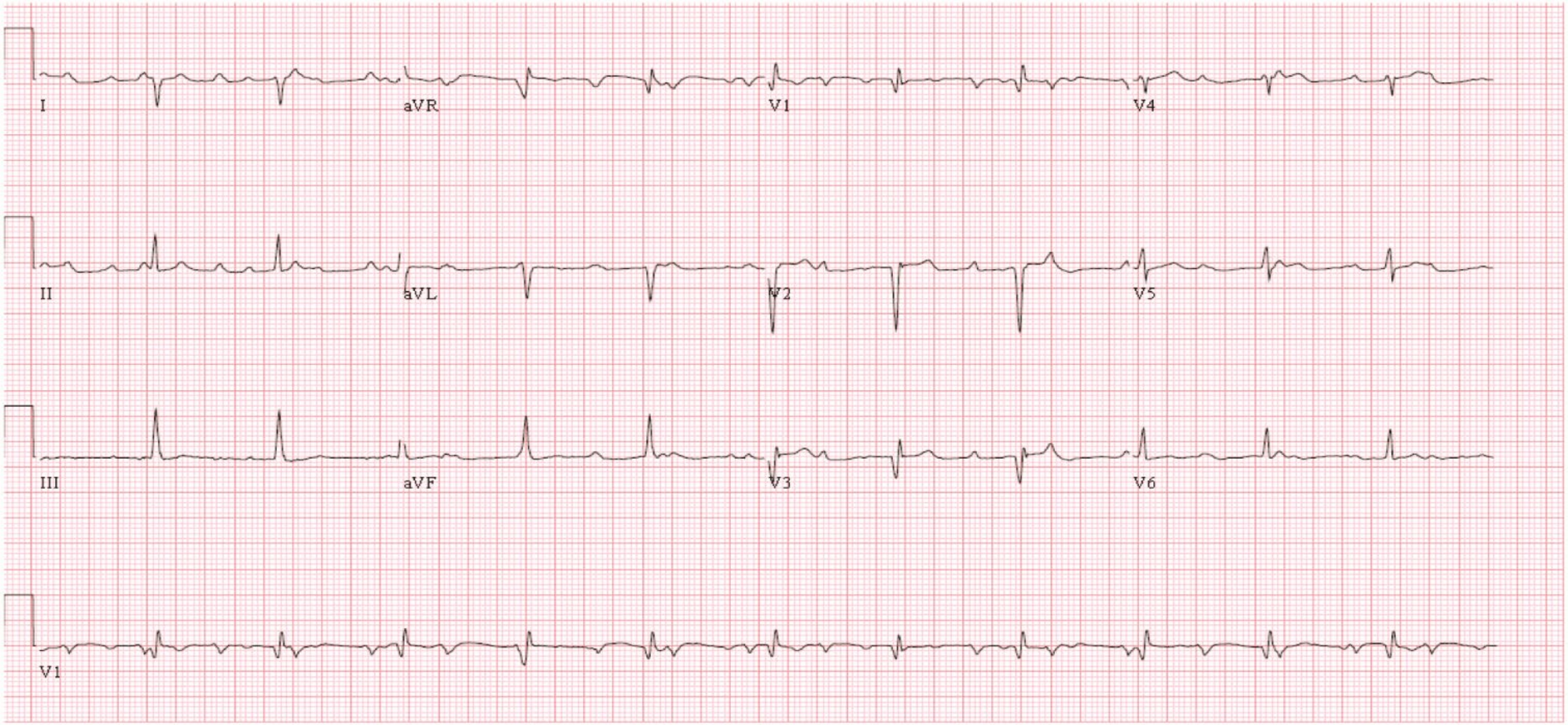
-Typically due to reentrant loop around the tricuspid annulus
-Short term rate control with nondihydropyridine calcium channel blockers, beta blockers, digoxin
-Long term management is typically ablation (ablation for Flutter is generally more effective and simple than in A Fib)

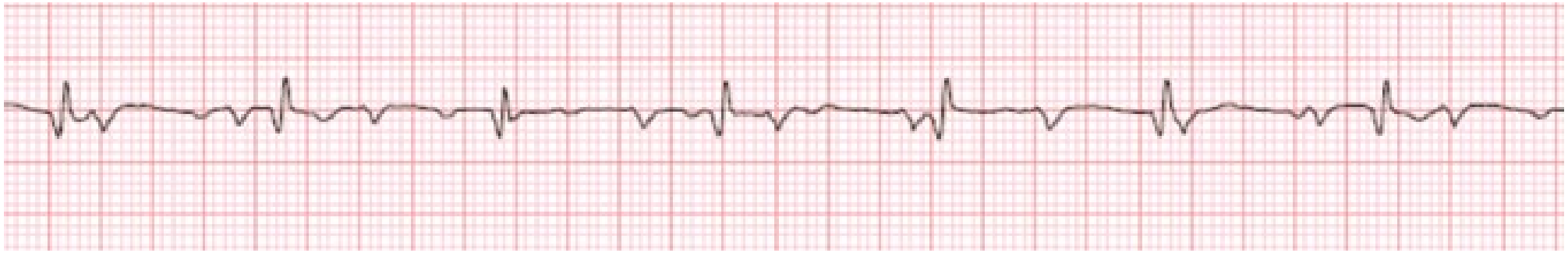
Narrow Complex Tachycardias



82 year old man had an episode of syncope while walking uphill.
He has hypertension and takes chlorthalidone and amlodipine only.
VS: HR 65 BP 106/50
He is oriented and talkative
He has a III/VI systolic murmur best at the right upper sternal border.
Studies: (ECG on next slide)

Which is the most likely cause of his syncope:
A) Aortic Stenosis
B) Hypovolemia
C) Heart Block
D) Neurocardiogenic (aka vasovagal)



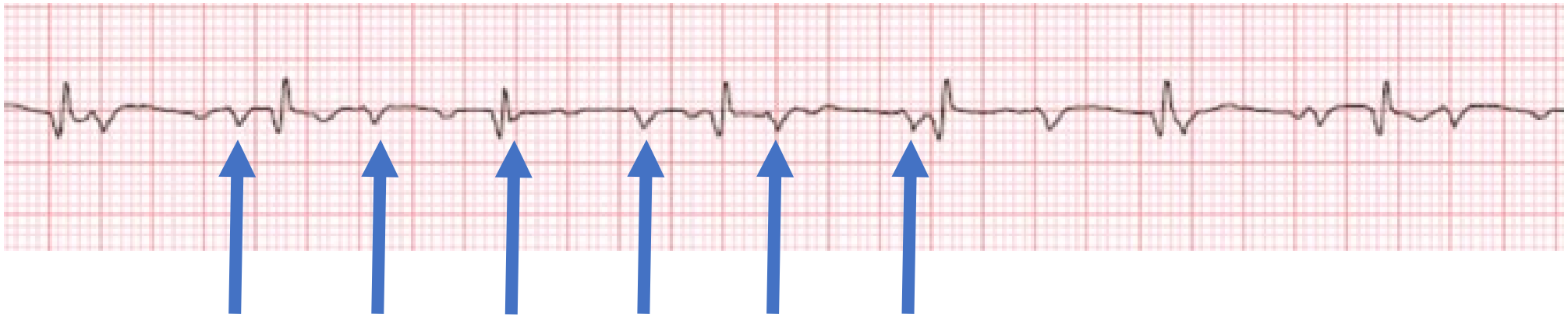


ECG c/o MKSAP 18

82 year old man had an episode of syncope while walking uphill. He has had a cough lately due to allergies.
He has hypertension and takes chlorthalidone and amlodipine only.
VS: HR 65 BP 106/50
He is oriented and talkative
He has a III/VI systolic murmur best at the right upper sternal border.
Studies: (ECG on next slide)

Which is the most likely cause of his syncope:
A) Aortic Stenosis
B) Hypovolemia
C) Heart Block
D) Neurocardiogenic (aka vasovagal) from coughing

3rd Degree Heart Block



Usually bradycardic

<u>Regular</u> appearance (unless PVCs)

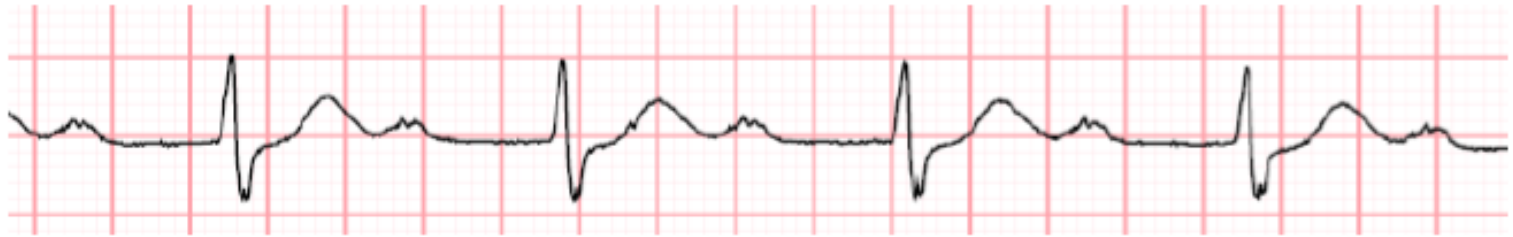
- Unlike 2nd degree blocks which have “dropped” beats

P wave rate > QRS rate

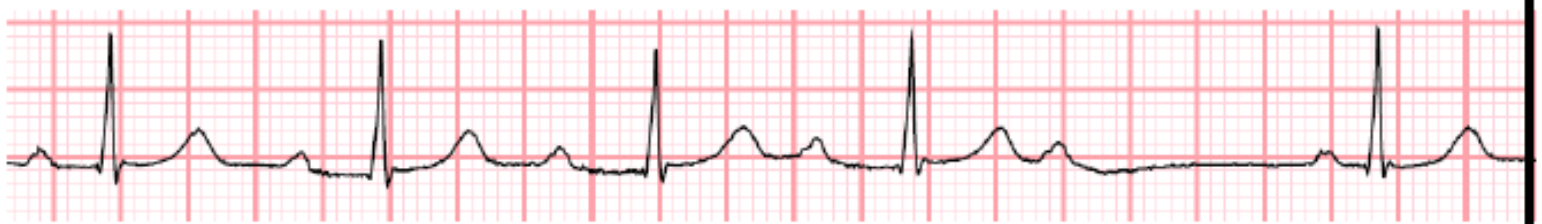
Complete AV dissociation

Summary: Atrioventricular Conduction Disturbances

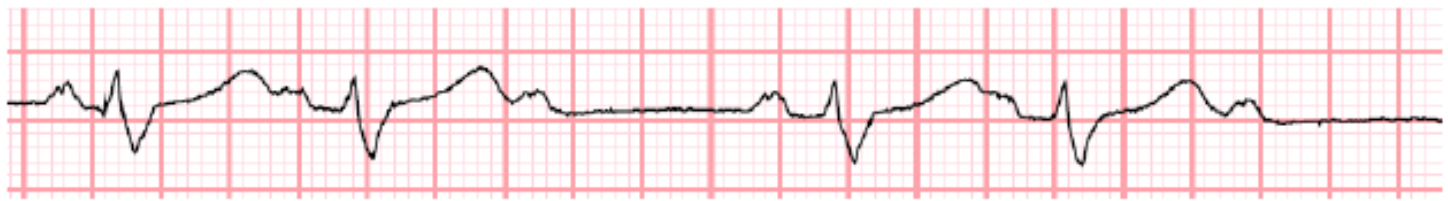
Prolonged PR/first degree
(nodal delay)



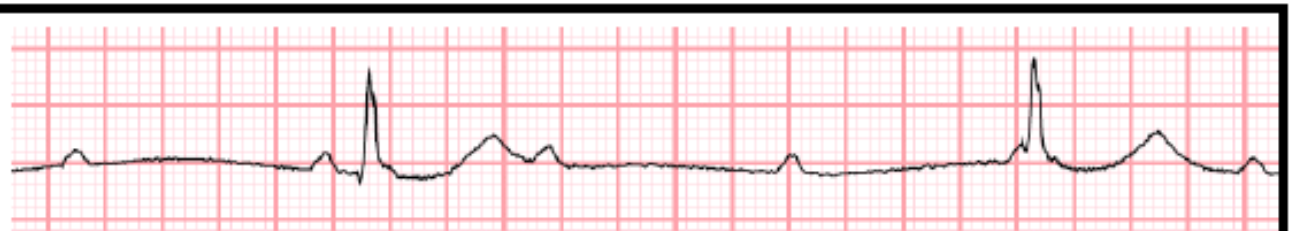
2nd degree
Mobitz I
(intranodal)



2nd degree
Mobitz II
(infranodal)



Complete/3rd degree
(intra or infranodal)



Slide c/o Dr. Zach Goldberger

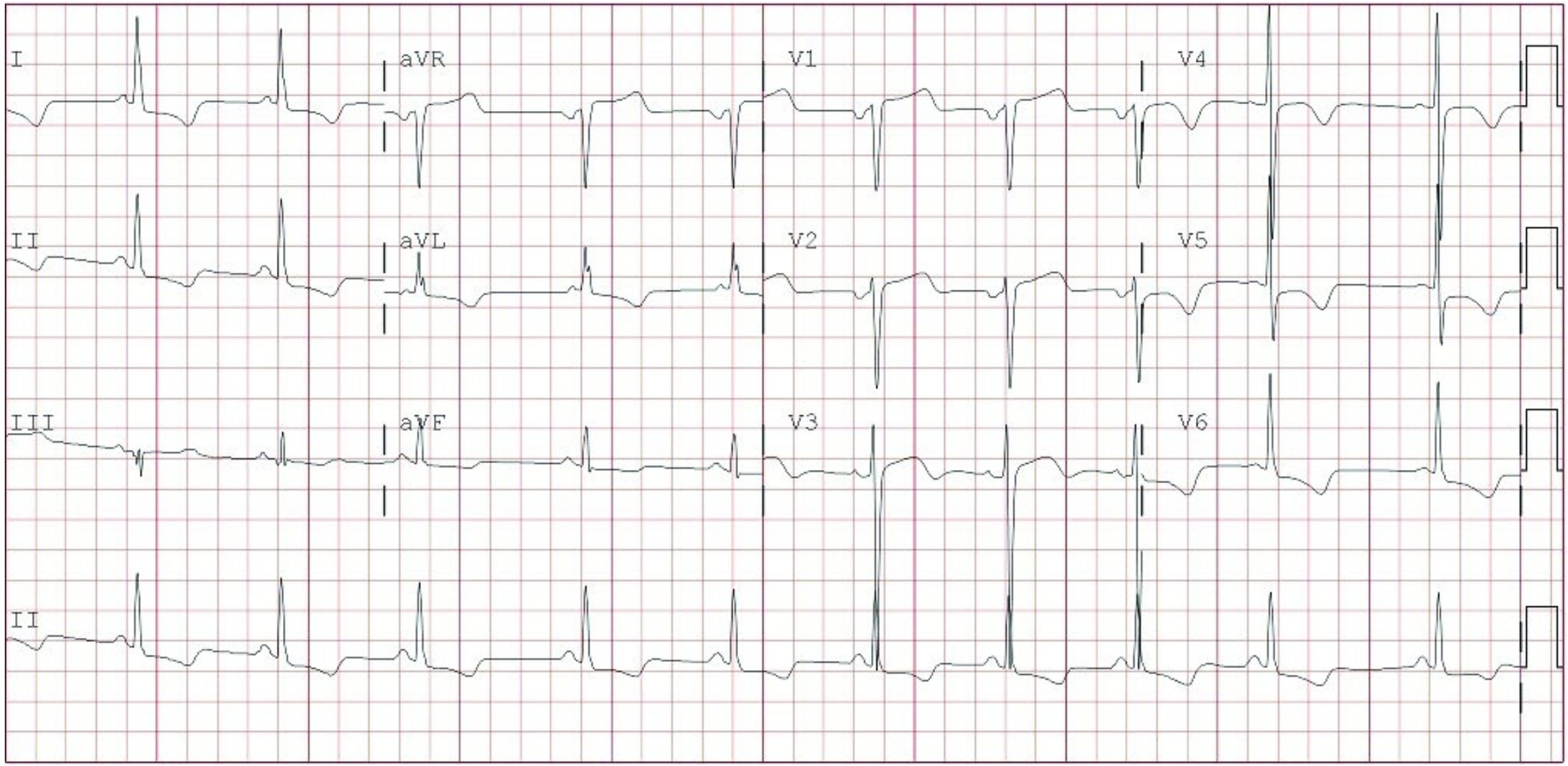
Permanent Pacemakers: Key indications to know

- Symptomatic Bradycardia without reversible cause
- Mobitz II second degree heart block (usually)
- Third degree heart block

Remember: NOT for reversible causes (incl Lyme Carditis)

FYI: After STEMI can get $2^{nd}/3^{rd}$ degree AV block

- Inferior STEMI – can improve (vagally mediated)
- Anterior STEMI – usually does not improve (ischemia/necrosis)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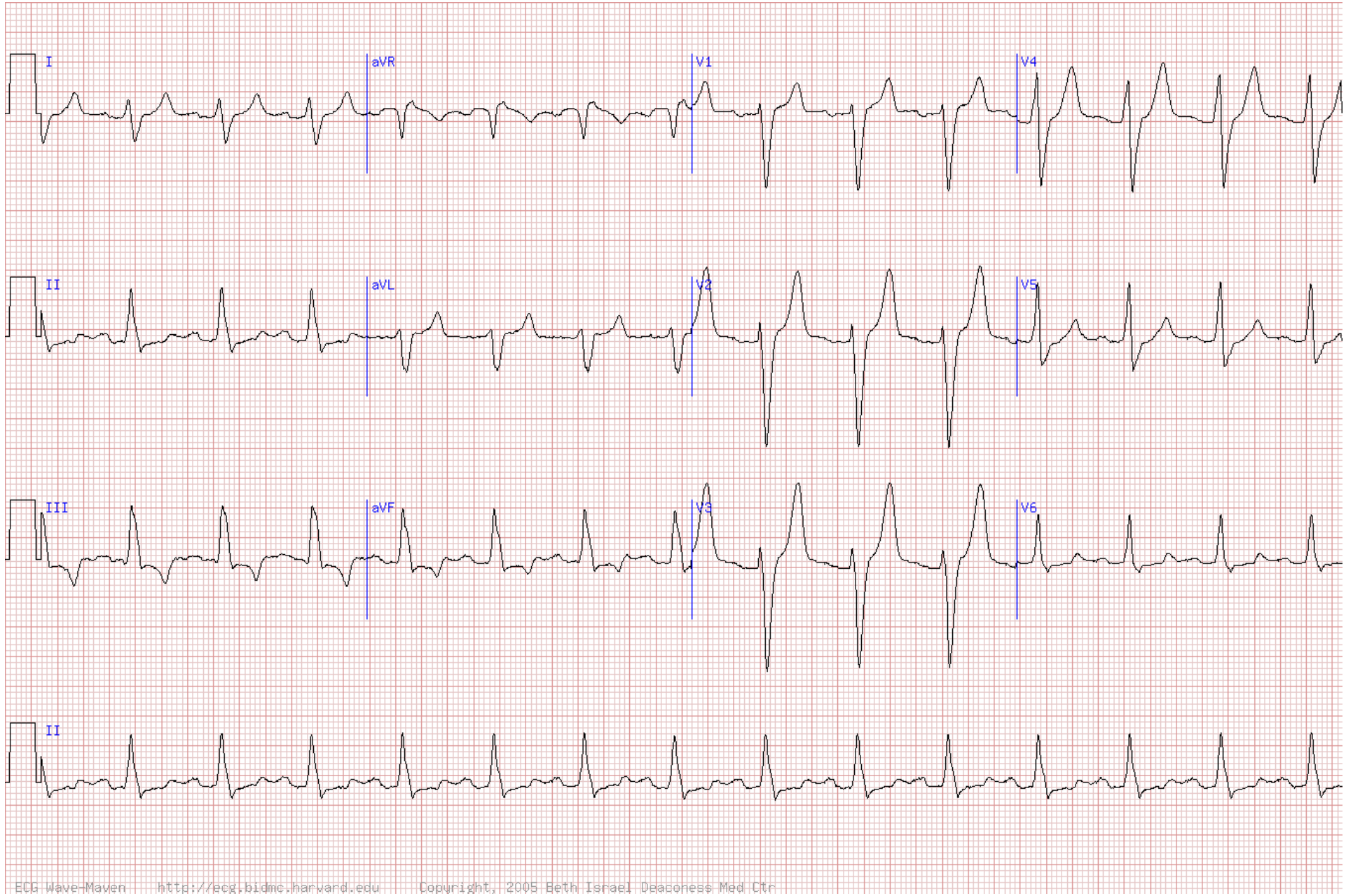
53yo brought in to the ED by medics with weakness and confusion.

Studies: (ECG on next slide)

Which will you do next?
A) activate the cath lab
B) administer IV insulin + glucose
C) administer IV magnesium
D) administer IV calcium



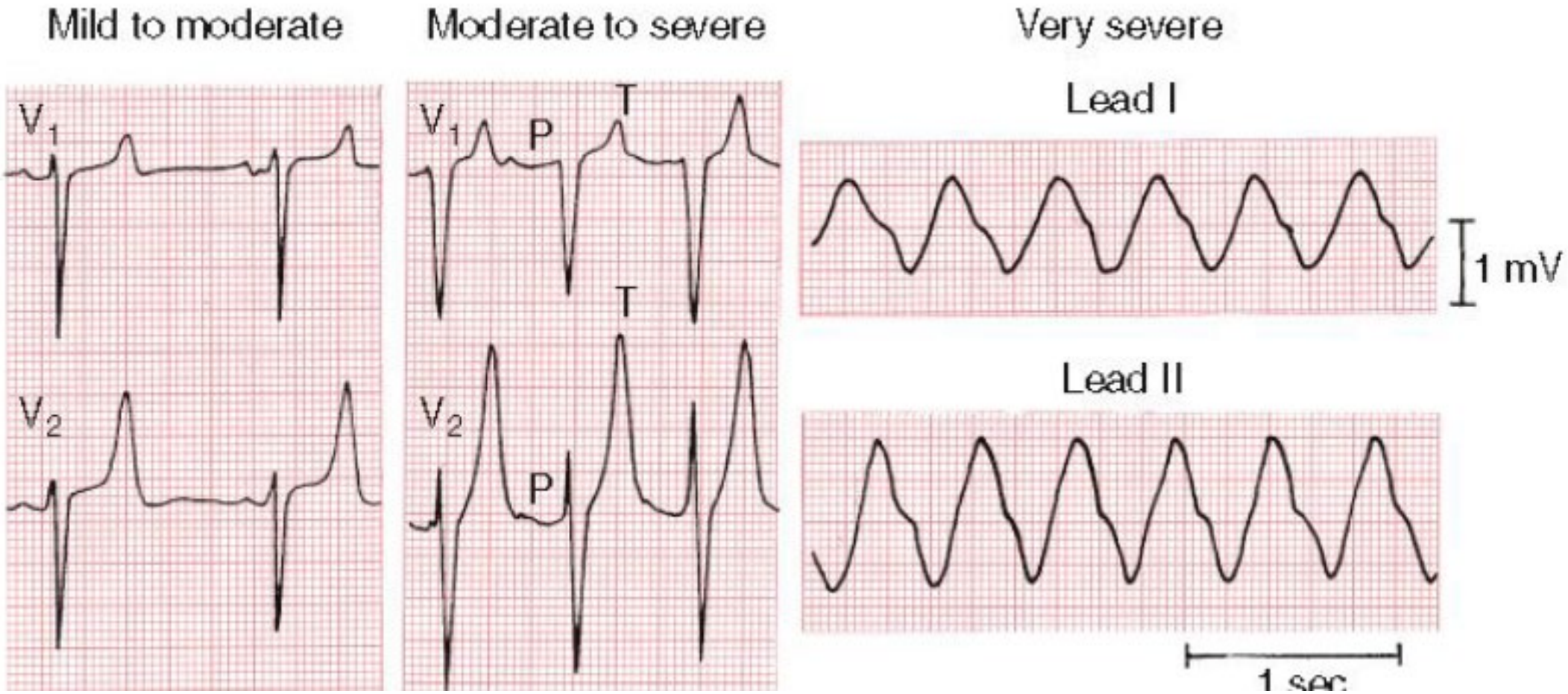
ECG c/o MKSAP 18

53yo brought in to the ED by medics with weakness and confusion.

Studies: (ECG on next slide)

Which will you do next?
A) activate the cath lab
B) administer sodium bicarbonate
C) administer IV insulin + glucose
D) administer IV magnesium
E) administer IV calcium

Hyperkalemia



Slide c/o Dr. Zach Goldberger

Severe Hyperkalemia

Symptoms:

Weakness or paralysis

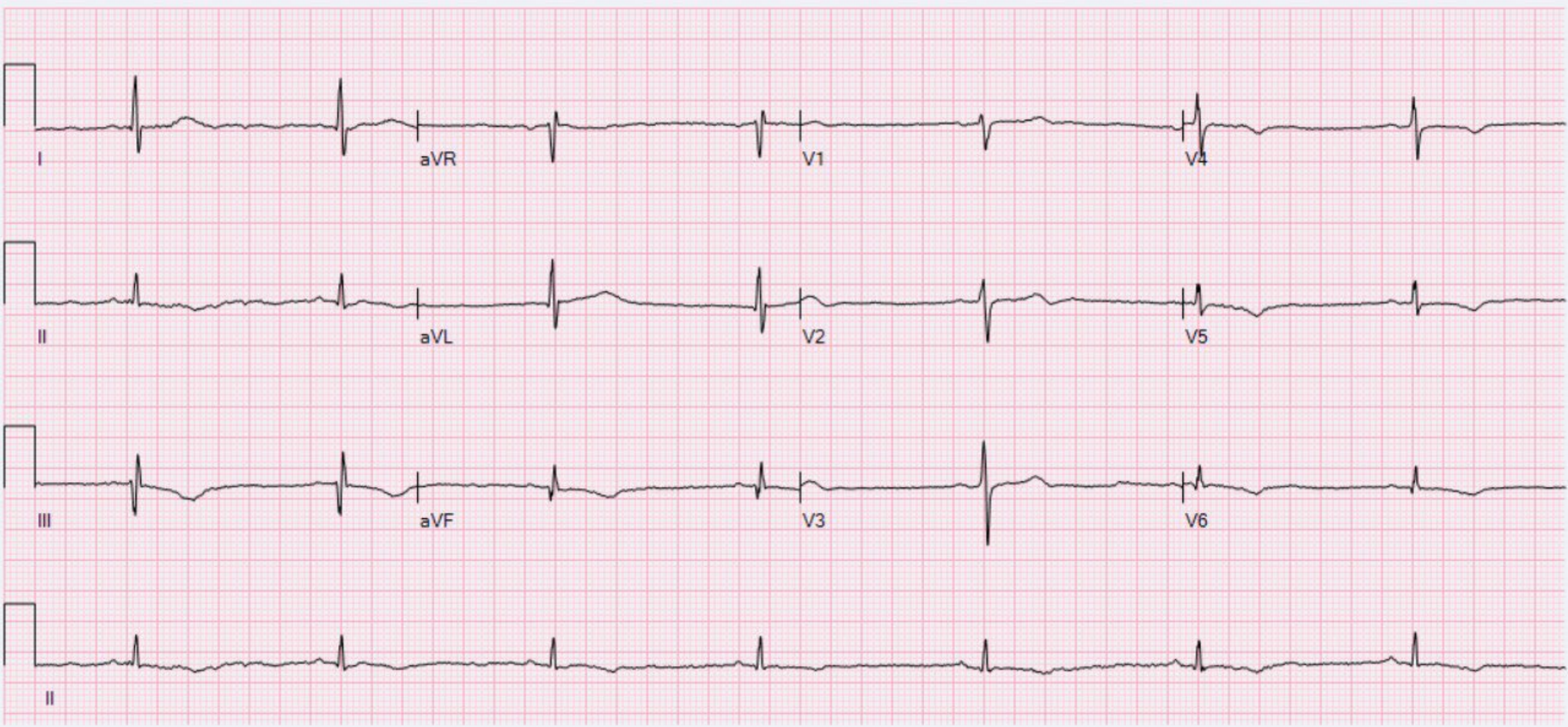
Cardiac conduction abnormalities or arrhythmias

Treatment:

1) If ECG abnormalities are present or severe K+ elevation (>6.5): IV calcium to antagonize cardiac membrane effects of hyperkalemia
2) IV insulin + glucose (shift K+ intracellularly)
3) Therapy to remove K+ from body:
   - Loop diuretic
   - GI K+ binder (kayexalate, patiromer)
   - Hemodialysis

73yo patient presents with 1 week of anorexia, nausea, vomiting, fatigue, and confusion. His lisinopril dose was increased 2 weeks ago.
PMH: CHF with reduced EF, Restless Legs Syndrome
Meds: lisinopril, metoprolol, digoxin, amiodarone, pramipexole
VS: 36.5 49 100/50
Labs: potassium 5.7, BUN 25, creatinine 1.9 (formerly 1.2), TSH 3
(ECG on next slide)

What is the next step in management?
A) Cardioversion
B) Pacemaker
C) IV glucagon
D) IV calcium
E) digoxin immune fab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Recognize Digoxin Toxicity

Clinical Manifestations:

- General: fatigue, malaise, weakness, confusion
- GI: nausea/vomiting, abdominal pain, diarrhea
- Visual: alterations in color vision (classically objects have a yellow appearance)

Common etiologies:

Drug-Drug interactions: amiodarone, calcium channel blockers, anticholinergic drugs, spironolactone

Renal Failure

Dose change or over-ingestion

ECG Manifestations of Digoxin Toxicity are Variable
(can see almost any arrhythmia or conduction prob)

Common: premature ventricular contractions (PVCs)/bigeminy, bradycardia, AV blocks, VT or VF

More rare but highly associated with dig toxicity:

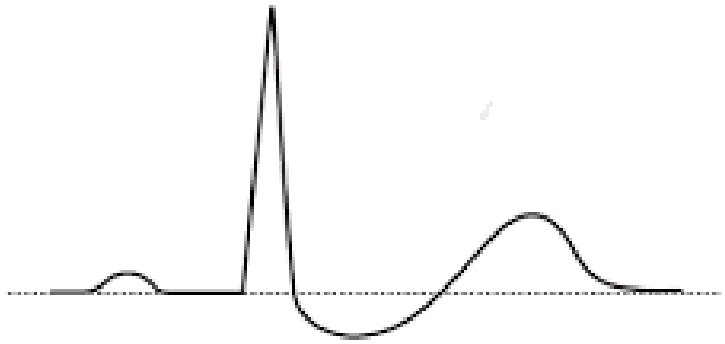
Atrial Tachycardia with 2:1 block

Bidirectional Ventricular Tachycardia

Digitalis Effect (not toxicity)

Curved ST depression

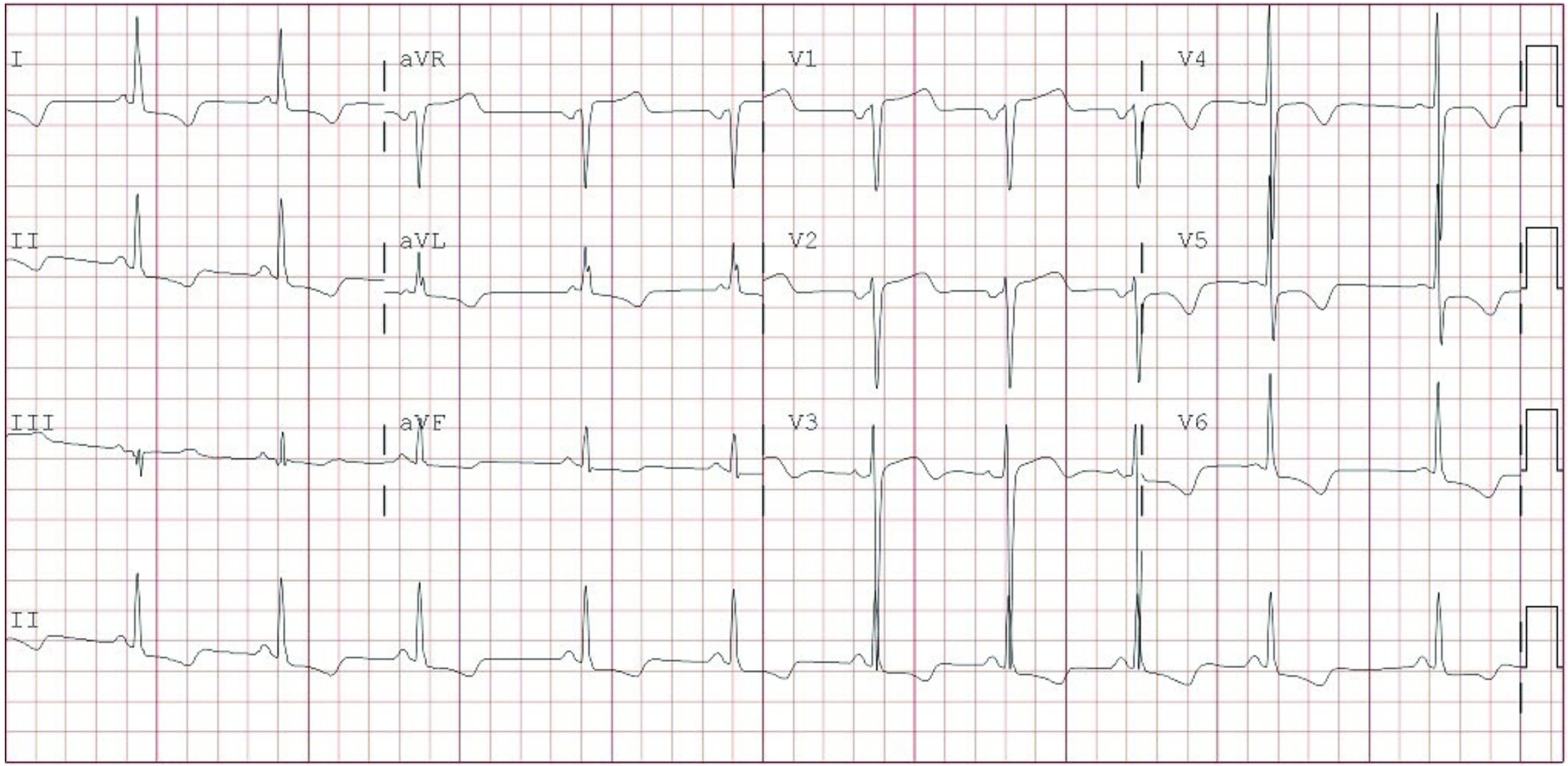
Esp in lateral precordial leads



58yo woman is being worked up for kidney transplant. She has had occasional “twinges” of left sided chest pain over the past 6 months. The transplant team recommends a stress test prior to listing her for transplant.
She is feeling well today and has not had any chest pain for 10 days. She can walk 2 miles on flat ground.
PMH: CKD, hypertension

Studies: (ECG on next slide)

Which will you order?
A) coronary artery calcium scoring
B) exercise ECG stress test
C) nuclear medicine stress test
D) cardiac catheterization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Contraindications to Exercise ECG Stress Test

1. Can’t exercise

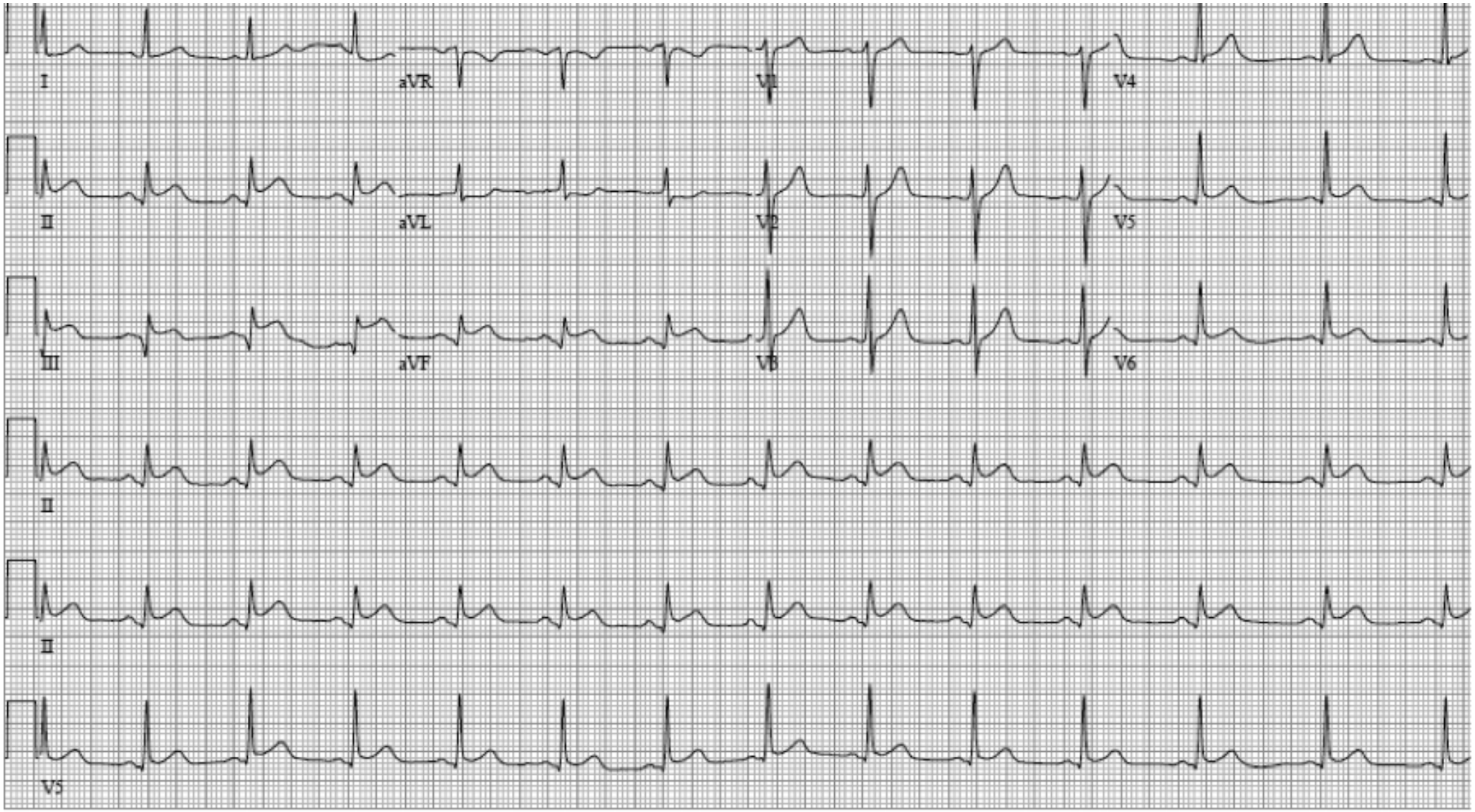
2. Resting ECG abnormalities:

- Left Ventricular Hypertrophy with ST-T abnormalities (this patient)
- Ventricular paced rhythm
- Left Bundle Branch Block
- Preexcitation (WPW pattern)
- Digitalis effect (ST-T abnormality)

62yo presents with substernal chest pressure and diaphoresis.
VS: HR 86 BP 101/48 RR 20 O2 sat 98% on RA
Gen: uncomfortable but lucid
CV: tachycardic with regular rhythm, no gallop, +JVD
Chest: clear bilaterally
Ext: trace bilateral ankle edema, cool

Studies: (ECG on next slide)

You have given aspirin and a statin and activated the cath lab. What else will you do?
A) sublingual nitroglycerin
B) IV beta blocker
C) oxygen via nasal cannula
D) repeat ECG with right sided leads
E) IV dobutamine



ECG c/o MKSAP 18

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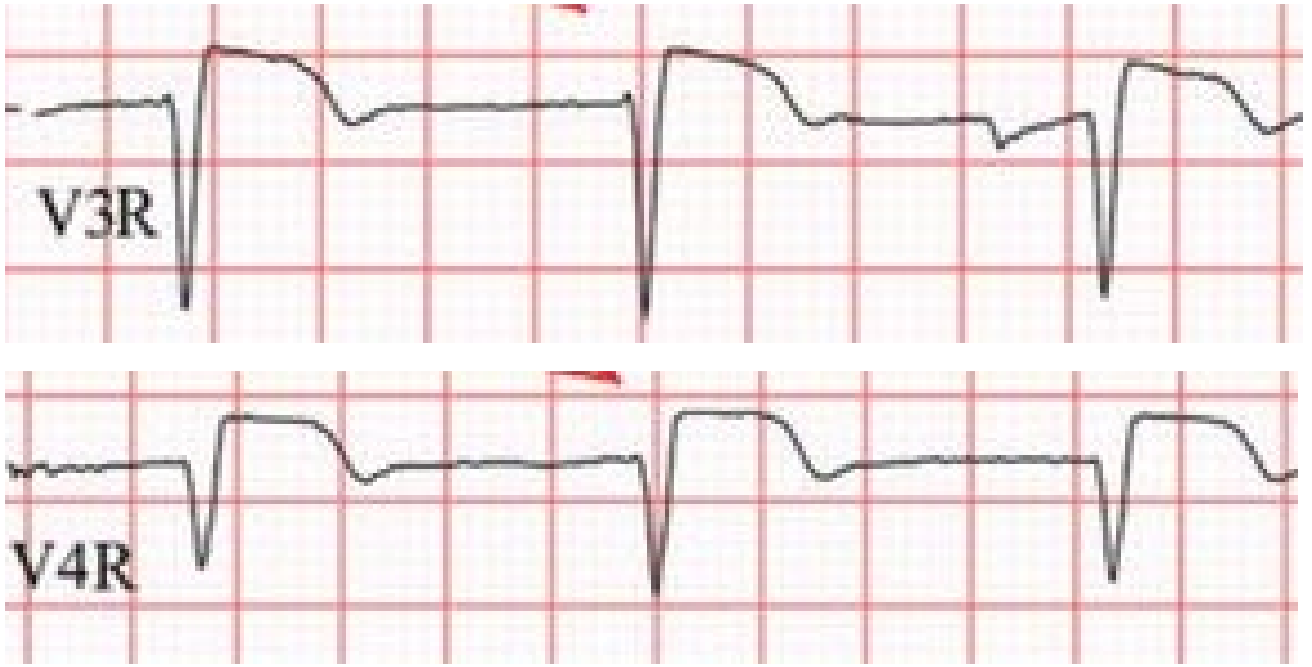
Check Right Sided ECG in Inferior STEMI to look for R sided infarct

Right Sided Infarct:

- Hypotension is common due to reduced preload delivery by ischemic right ventricle
- Treat with IV fluid bolus
- Avoid nitrates (they reduce preload). Caution with beta blockers



Common Early STEMI complications

Inferior/R sided:

- Hypotension d/t low preload
- AV blocks (vagal)
- Arrhythmia

R sided ECG

IV fluids

Avoid NTG

Caution with B blockers

I Lateral	aVR	V1 Septal	V4 Anterior
II Inferior	aVL Lateral	V2 Septal	V5 Lateral
III Inferior	aVF Inferior	V3 Anterior	V6 Lateral

Anterior/Lateral:

- Hypotension d/t LV ischemia
- Pulmonary edema
- AV blocks (necrosis)
- Arrhythmia

May need intra-aortic balloon pump

Caution with B blockers

High Yield ECG Pearls for the Internal Medicine Boards 2024

Answer Key

Question 1 – C) Pacemaker Placement

Question 2 – C) EP study and ablation

Question 3 – D) NSAIDs

Question 4 – A) Patient received haloperidol

Question 5 – D) IV magnesium

Question 6 – B) Trans-esophageal echocardiogram then cardioversion

Question 7 – B) Brugada Syndrome

Question 7 – A) Emergent cardiac catheterization

Question 8 – D) Adenosine

Question 9 – C) Diltiazem

Question 10 – C) Heart Block

Question 11 - E) administer IV calcium

Question 12 – E) digoxin immune fab

Question 13 – C) nuclear medicine stress test

Question 14 – D) repeat ECG with right sided leads

Thank you and Good Luck!

krugm@uw.edu