

Arrhythmias and ECGs – What Not to Miss in the Office and An overview of Arrhythmias and Advances in Cardiac Electrophysiology



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No disclosures

Learning Objectives

- To review ECG interpretation
- To review common diagnoses and pitfalls with ECG interpretation
- To review common arrhythmias including supraventricular tachycardias and their management including indications for electrophysiology study and ablation
- To review specific treatments for atrial fibrillation including advances in ablation and left atrial appendage occlusion
- To review treatment options of wide complex tachycardias including ventricular tachycardia and premature ventricular contractions
- To review basics of pacing and defibrillation and recent advances in new techniques and technologies of cardiac devices

Outline

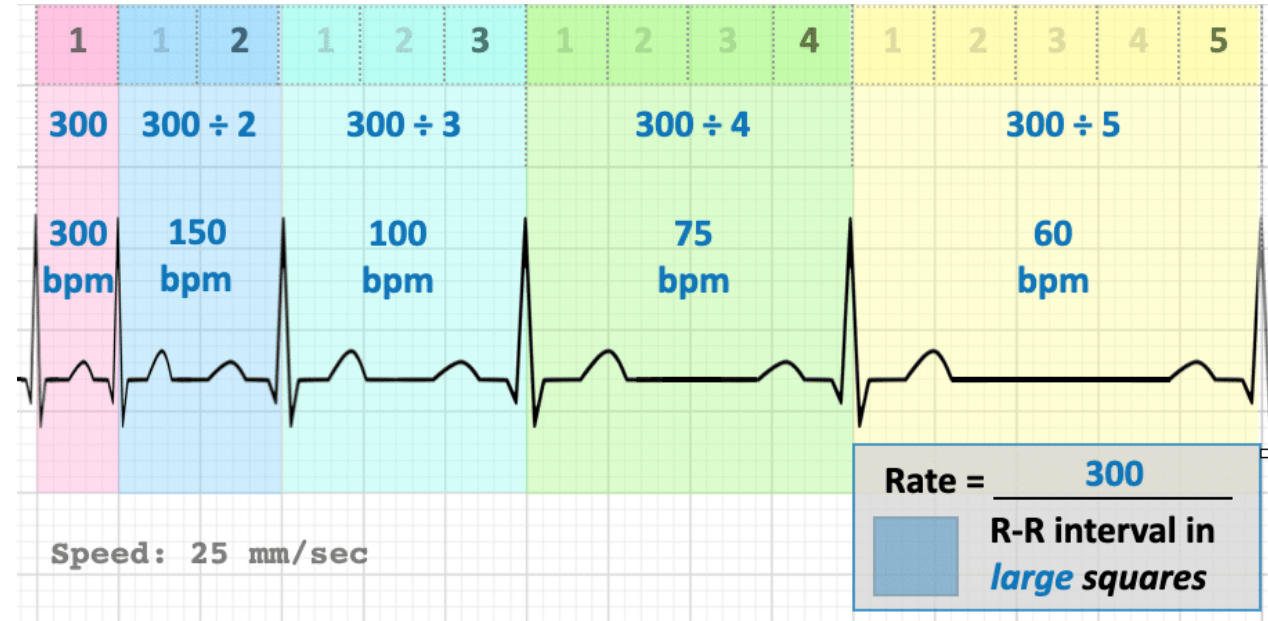
- ECG Review
 - Fundamentals of ECG interpretation
 - Common diagnoses and pitfalls
- Management of Arrhythmias
 - Basics of electrophysiology study and ablations
 - SVTs
 - AF/AFL
 - Watchman
 - Wide complex tachycardia/VTs, PVCs
 - Bradyarrhythmias
- Cardiac Implantable Devices
 - Pacemakers
 - Defibrillators
 - Monitoring devices/implantable loop recorders

ECG Review

- Fundamentals of interpretation
 - Rate
 - Rhythm
 - Axis
 - Intervals
 - ST changes
- Don't rely on the automated interpretation as better than yours!

Rate

- Each large box is 200 msec or 300 bpm
 - 60,000 divided by an interval in msec gives you rate in bpm
- Normal rate 60-100 bpm
- Common for resting rates to be in the 40s-50s for young pts, athletes
- For some, baseline HRs in the 100s in SR is not necessarily pathologic either



Rhythm

- Is it regular or irregular? Regularly irregular? Irregularly irregular?
 - Establish rate and relationship of p-waves and QRS complexes
- Do you see clear p-waves? Are they sinus p-waves? (+II/III and other leads except aVR, biphasic in V1)
- P waves before every QRS and QRS after every p-wave?



Mobitz I or Wenckebach



Mobitz II

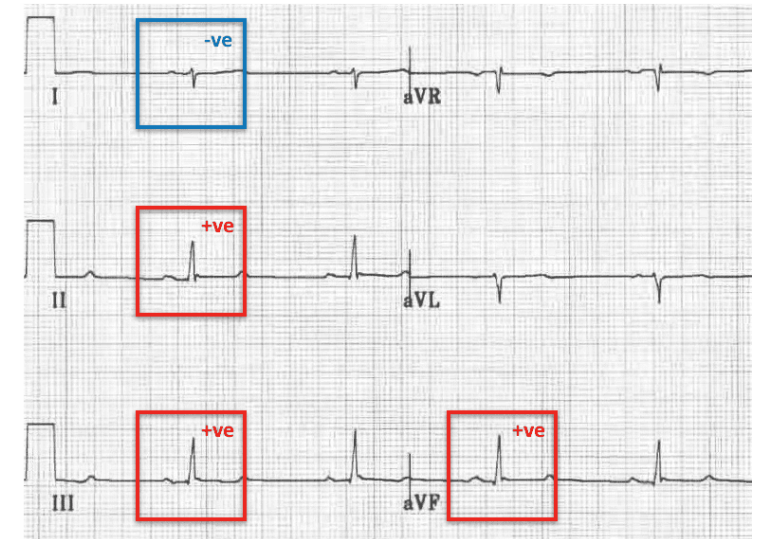
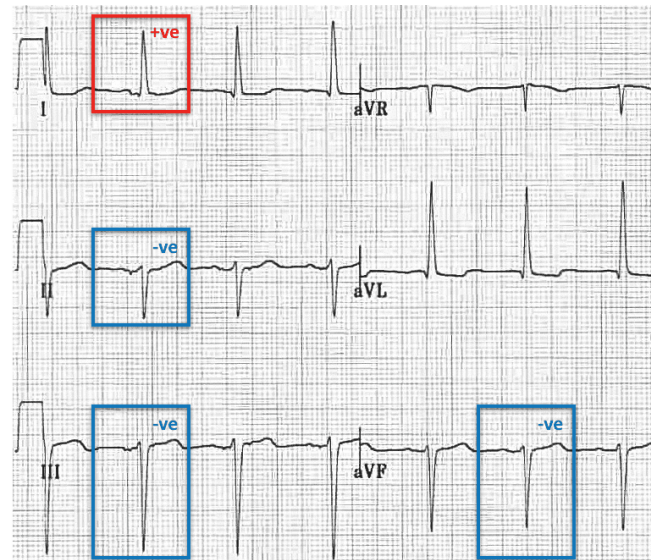
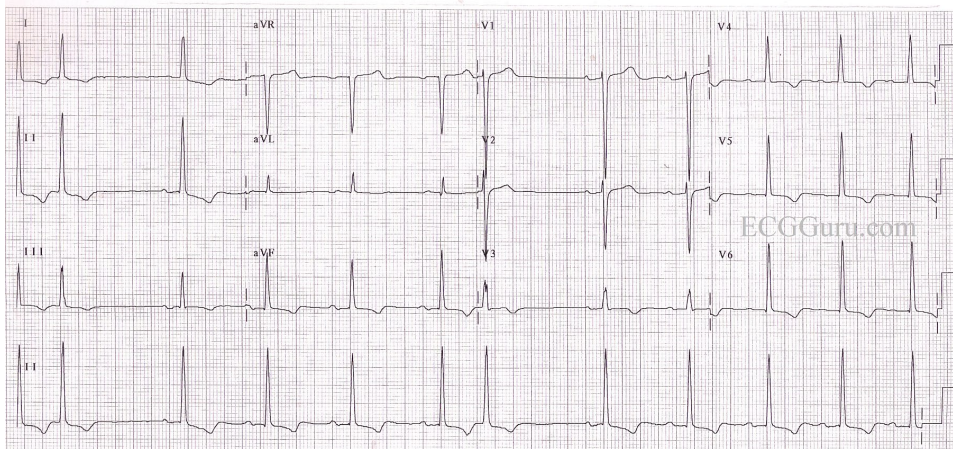
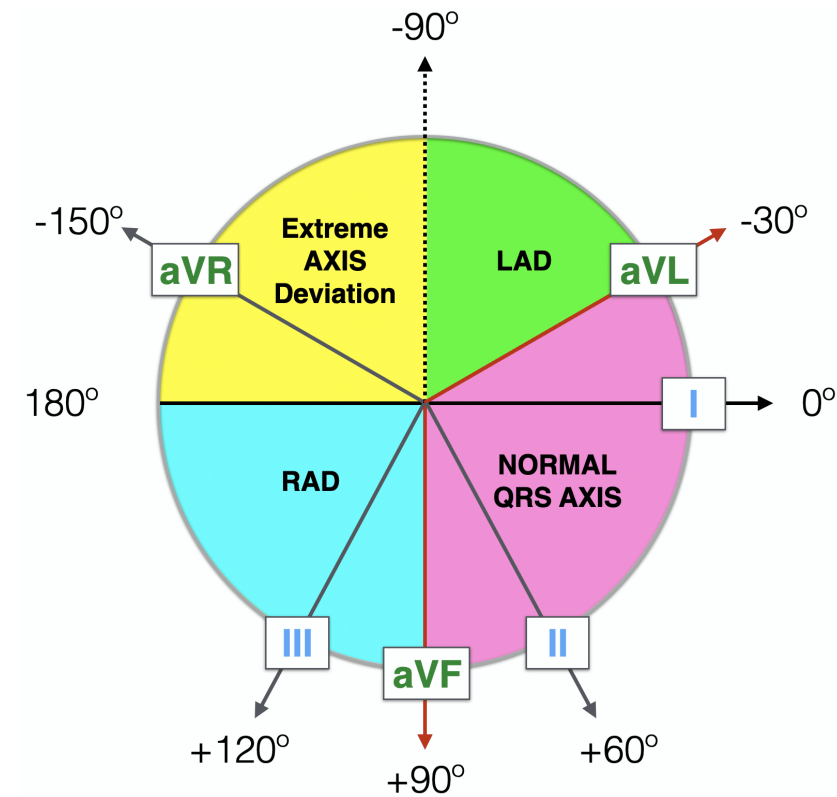


2:1 block



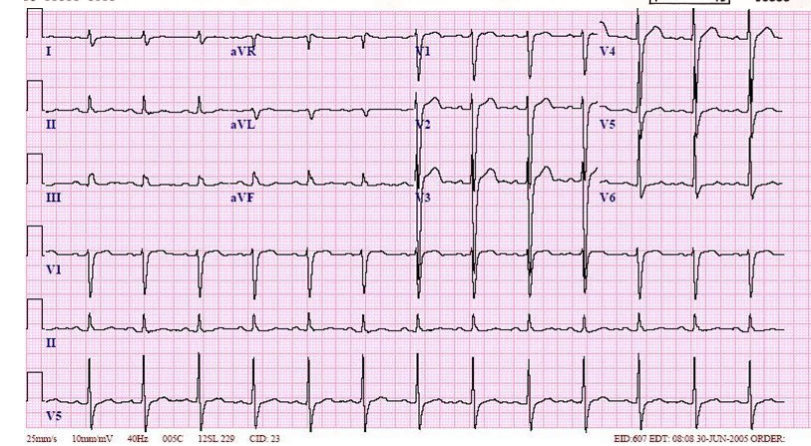
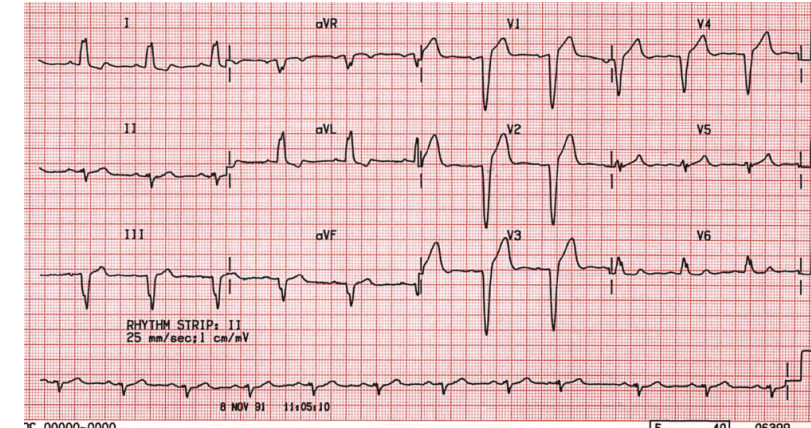
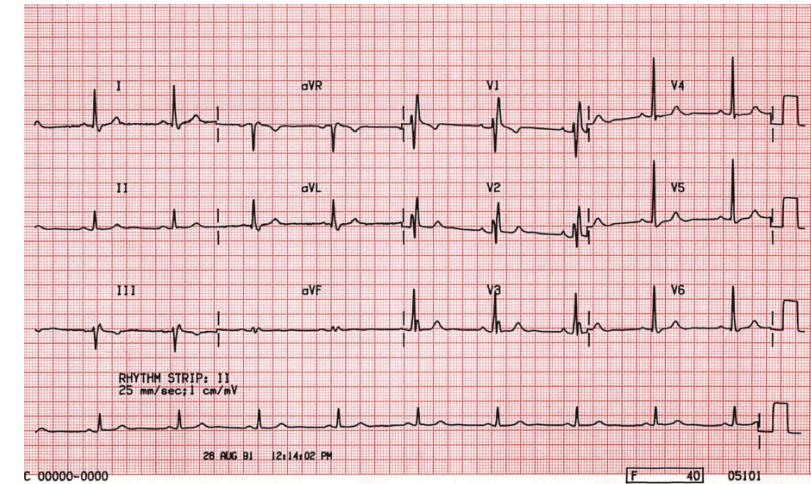
Axis

- Determined from limb lead vectors
- -30 degrees to 90 degrees
- Left axis deviation (eg LVH) is beyond -30 degrees
- Right axis deviation (eg RVH) is beyond +90 degrees
- Good time to assess for LVH (multiple criteria exist, but one good thing the automated reads are very good at)



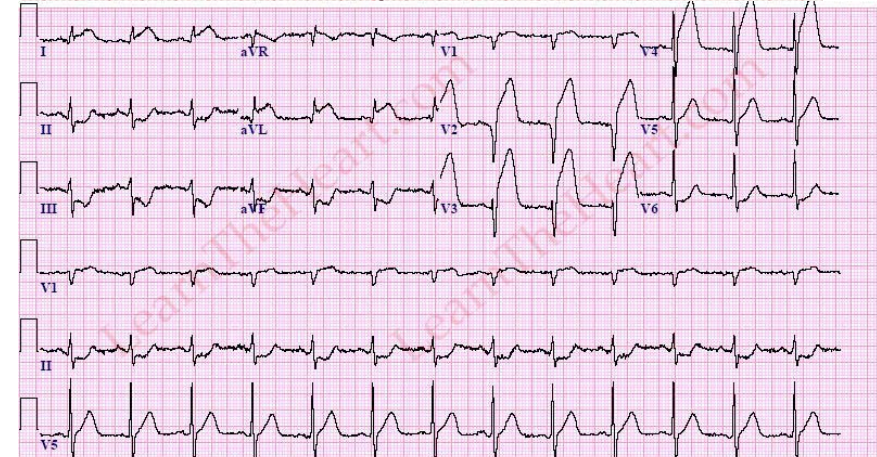
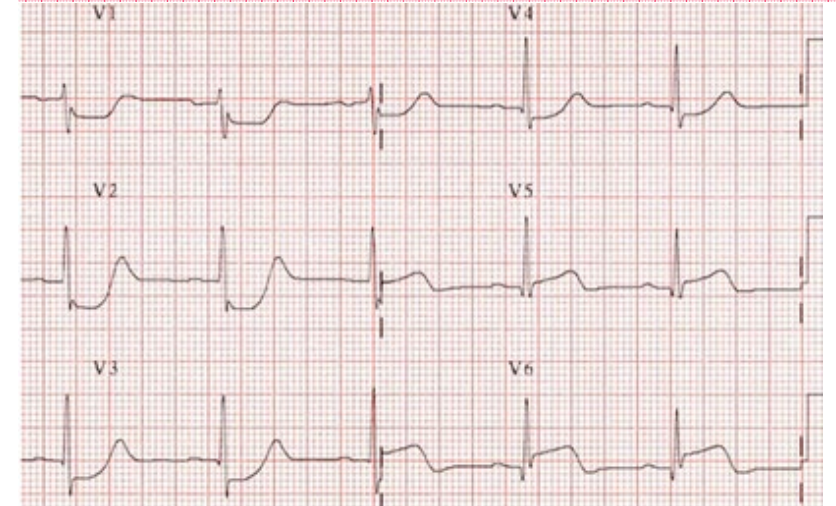
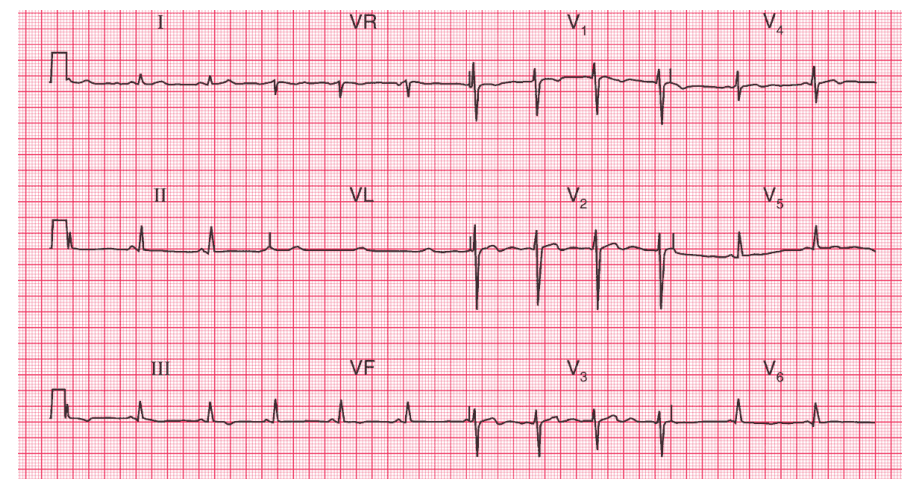
Intervals

- PR interval: 120-200 msec
 - Mild first degree AVB 200-220 msec is common
 - Short PR does not always mean WPW, commonly seen in young pts
- QRS duration: 80-100 sec
 - 100-120 msec: incomplete bundle branch blocks, nonspecific intraventricular conduction delays
 - >120 msec, bundle branch blocks, NIVCD, paced
 - Preexcitation?
- QT/QTc interval: 390-450/460 msec (men/women)
 - **Bazett's Formula:** $QTc = QT / \sqrt{R-R}$
 - Use QT interval for rates <50 bpm, >100 bpm
 - For paced rhythms, bundle branch block, generally can allow QT/QTc up to 550 msec or subtract difference in QRS to 100 msec from the QT/QTc
 - Ex: Paced QRS 160 msec, QTc 520 msec—could regard this as a QTc of $520 - (160 - 100) = 460$ msec



ST changes

- Insights into electrolyte issues/repolarization issues, ischemia/infarcts
- Nonspecific ST changes common (flattening)
- Evaluate for ST depressions, pattern of T-wave inversions, ST elevations
- Look for pathological Q waves here too



Case.

- 42 year old male with history of HTN, HLD, FHx of CAD presents for routine follow-up
- Trying to lose weight, BMI 27 so going to the gym, exercising so far without issue
- Mentions some atypical chest pains—sharp, lasting seconds, sometimes positional or with movement, doesn't think with exercise on treadmill, but he is worried because of his risk factors and family history
- You obtain an ECG

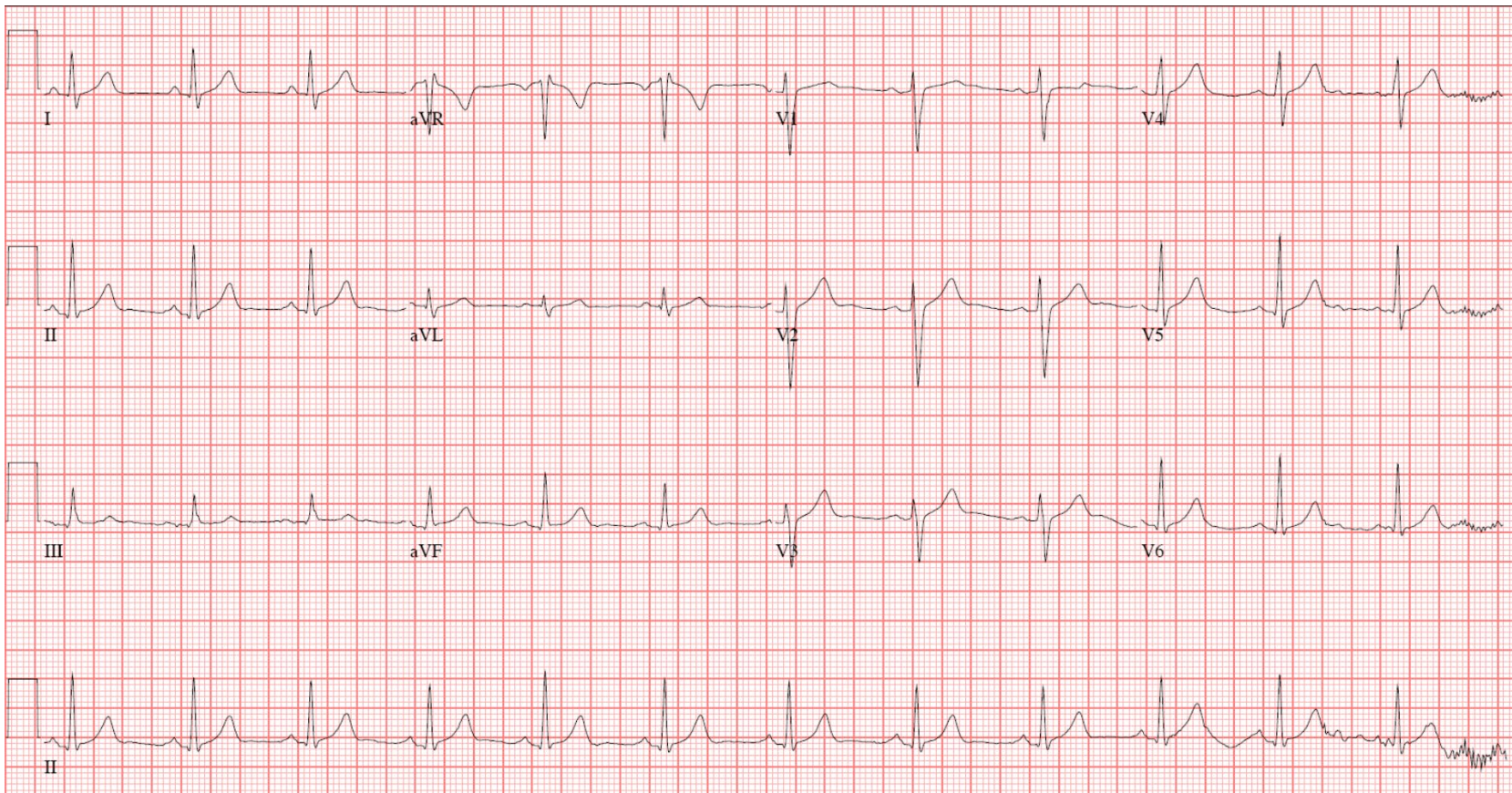
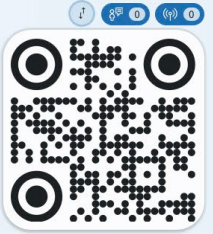
What's wrong with this ECG?

Concerning for ischemia

2:1 AV block

Nothing! Normal

Left ventricular hypertrophy



Reasonable to proceed with ETT, TEE, cardiology referral for routine f/u, but most likely MSK/noncardiac

Case.

- 65 year old male with HTN, HLD, DM2 who presents for annual wellness exam (and just started on Medicare)
- No complaints, HR and BP wnl
- You obtain an ECG

Automated interpretation:

Normal sinus rhythm, septal infarct age undetermined, abnormal ECG





Change the read—no septal infarct present

Send to ED

Check troponin

Obtain echo

Edit



☐ Choices

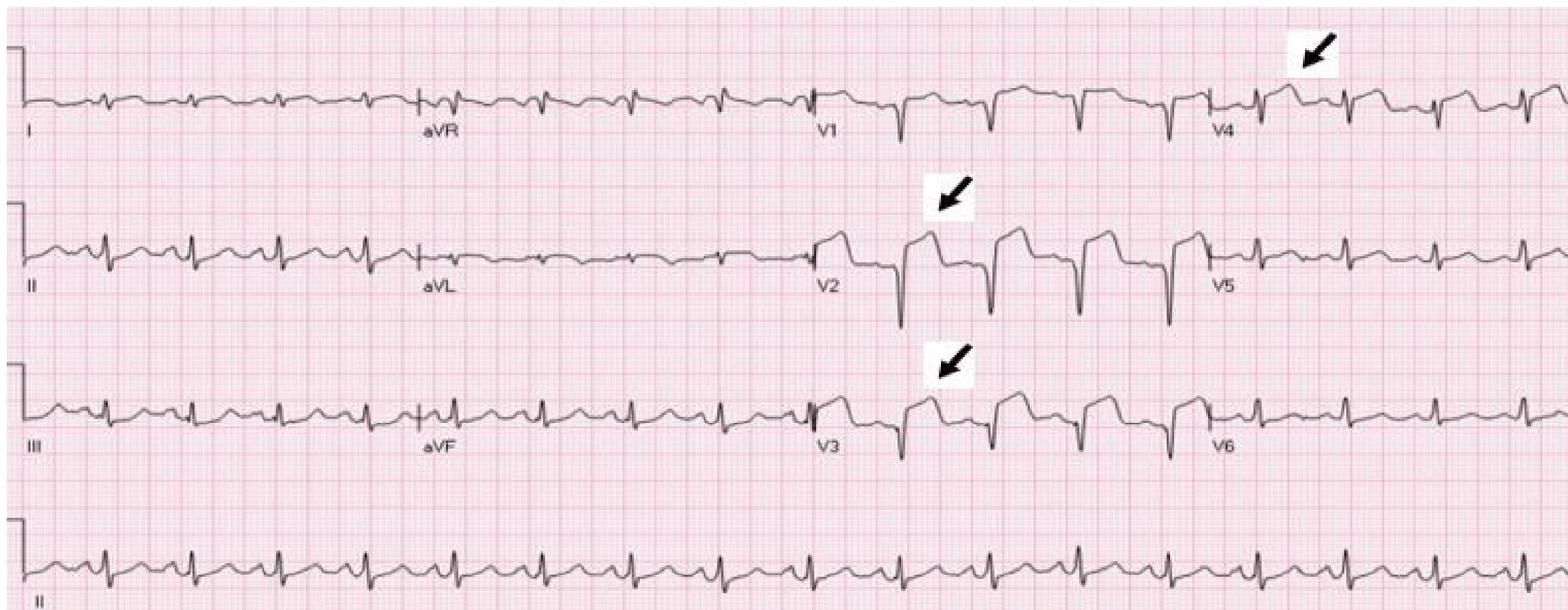
☒ Results

☐ Lock

☐ Correctness

Case.

- 64 year old male with HTN, HLD, DM2 who presents for routine follow-up
- Tells you he started having heart burn while on vacation last week, thought maybe had too much alcohol, still having it today
- Not going away though, thought about going to the ED but he had this visit scheduled previously so thought he'd wait to get checked out
- Looks uncomfortable, somewhat pale, diaphoretic on exam
- You obtain an ECG



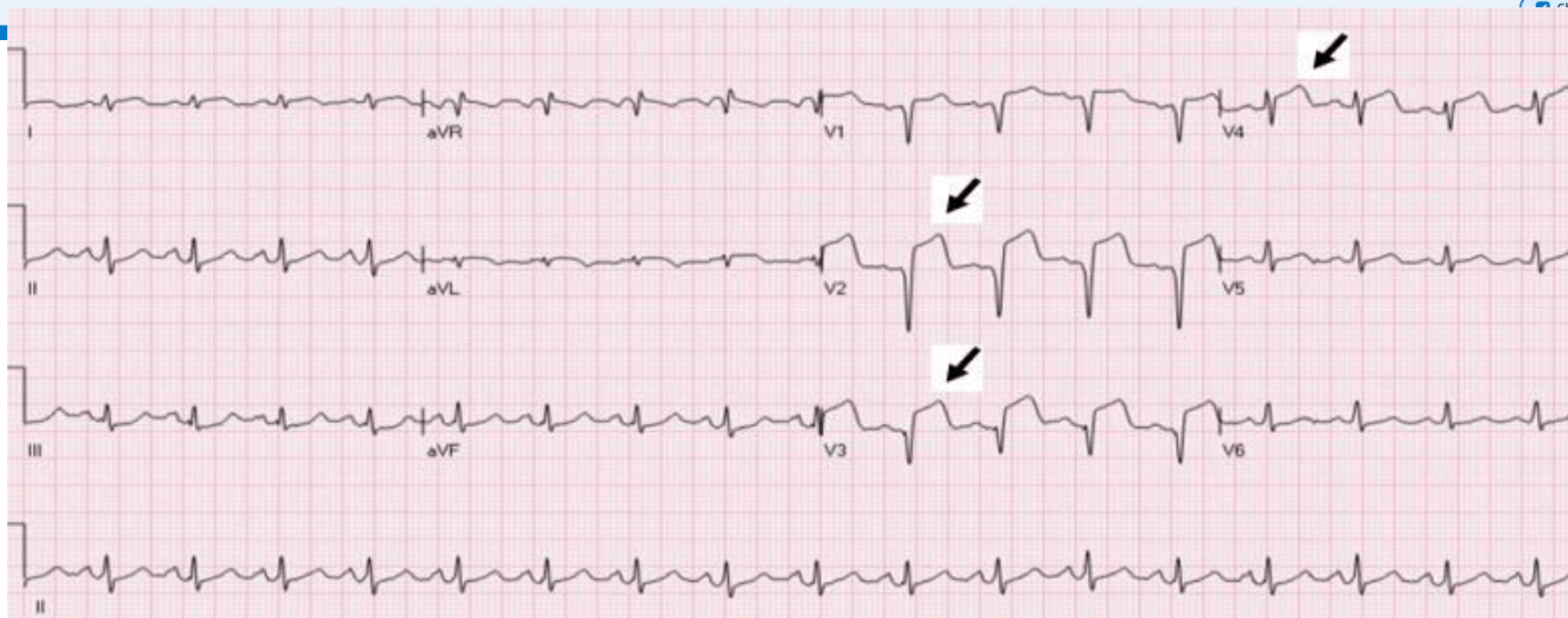
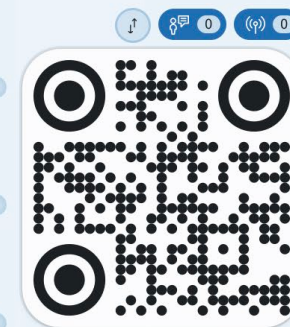
What do you do?

Refer to cardiology for urgent evaluation

Order a stress test, echo

Prescribe PPI, refer to GI

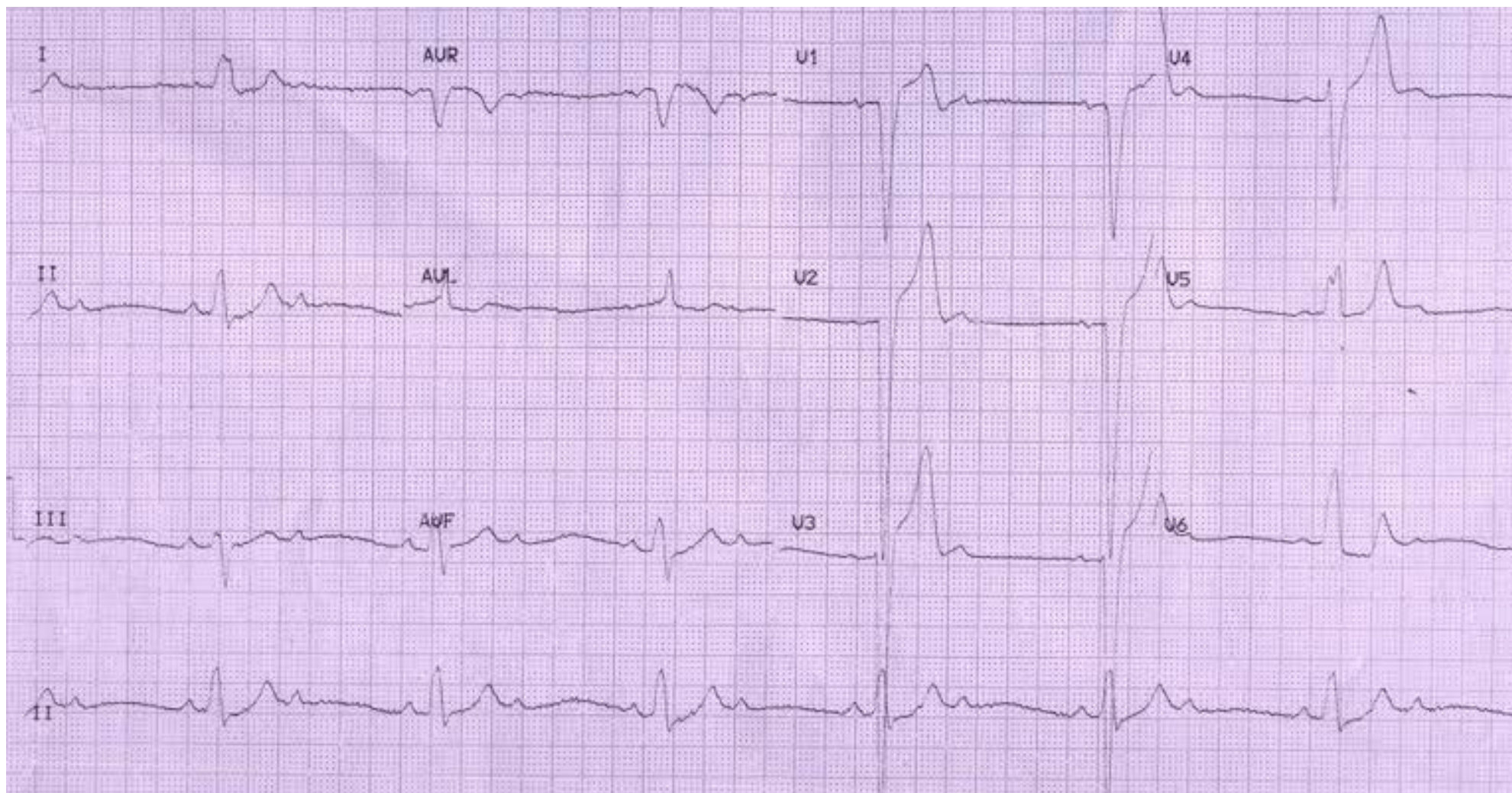
Call an ambulance for emergent ED transport and activation for emergent cardiac catheterization



Case.

- 72 year old female with HTN, HLD, DM2, known LBBB (followed by cardiology) presents for routine follow-up
- Mentions more fatigued recently though recently ill and somewhat deconditioned, has gained 10 lbs in the past few months
- BP 168/52, HR 48 bpm (although last HR in office was 54 bpm)
- You obtain an ECG

Sinus bradycardia, left bundle branch block, abnormal ECG



What do you do next?

Contact pt's cardiologist and have pt follow-up with them

Order Holter, stress test to evaluate chronotropic response

Send to ED for plan for inpatient pacemaker

Check labs, looking for hypokalemia (are those U waves?)

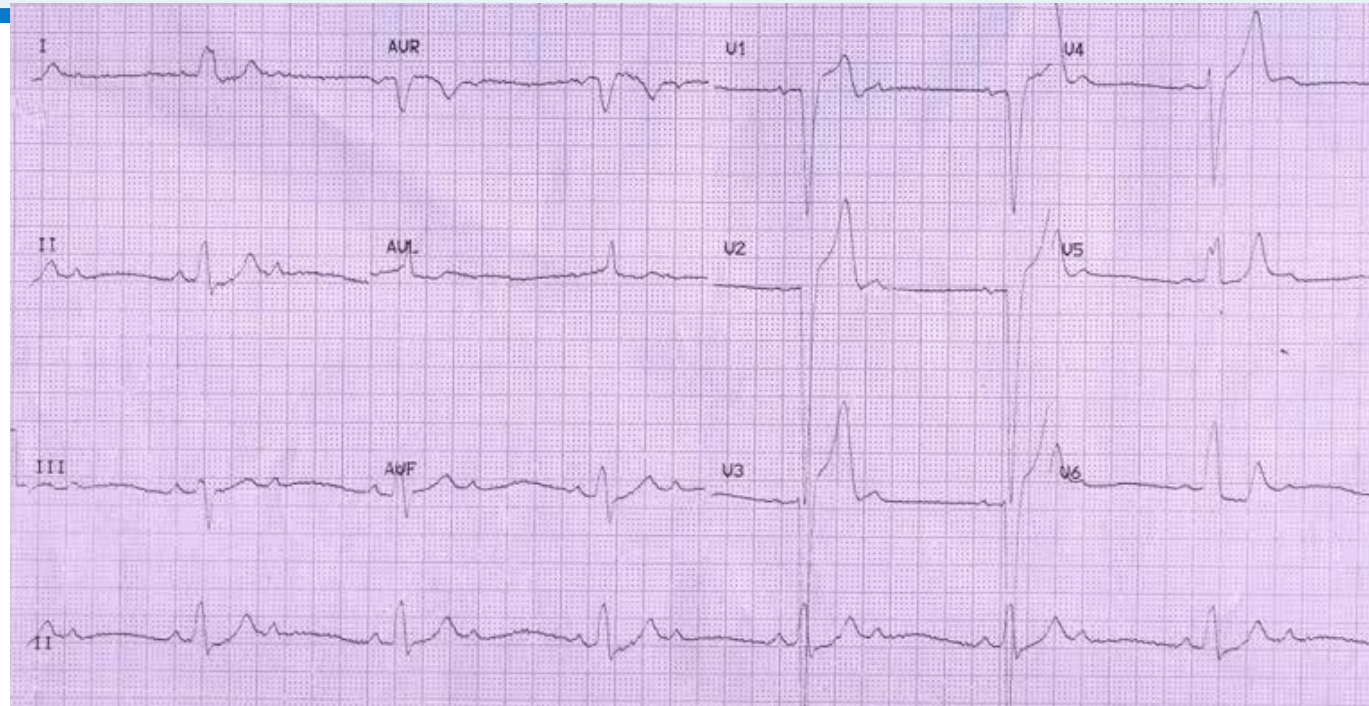
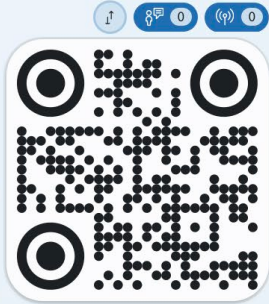
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Choices

Results

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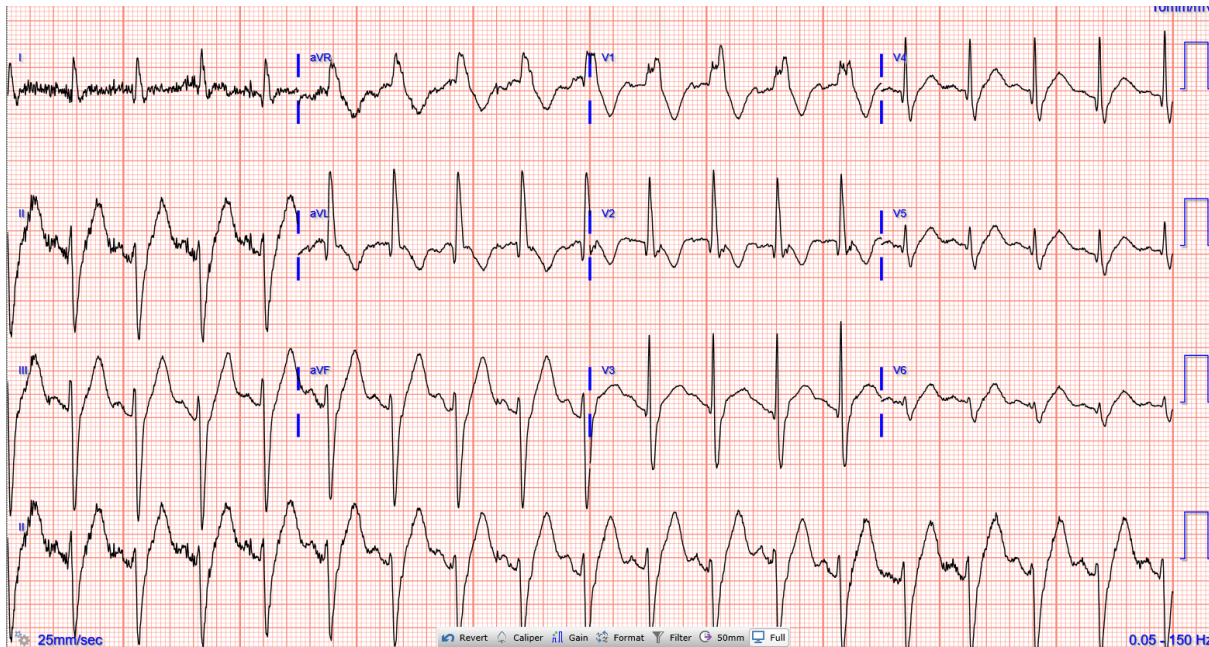
Correctness



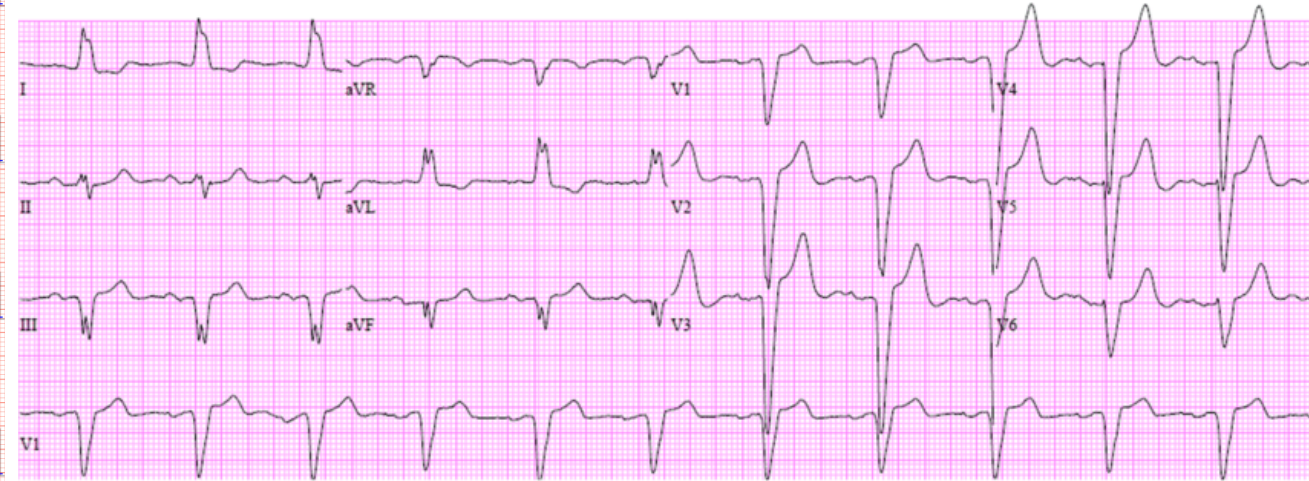
Case.

- 68 year old female with known LAFB/RBBB (followed by cardiology), HTN, HLD, OSA on CPAP, morbid obesity presents for routine follow-up
- Mentions some palpitations but no near-syncope/syncope, CP, or SOB
- Normal HR, BP. You obtain an ECG

Prior ECG:

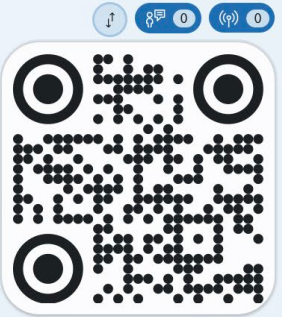


Current ECG:

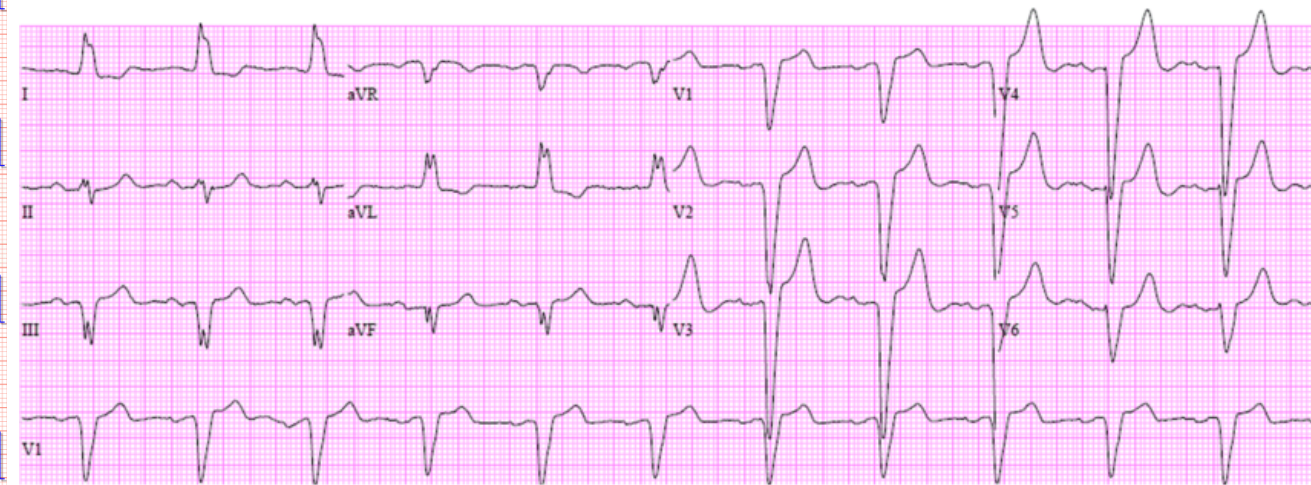
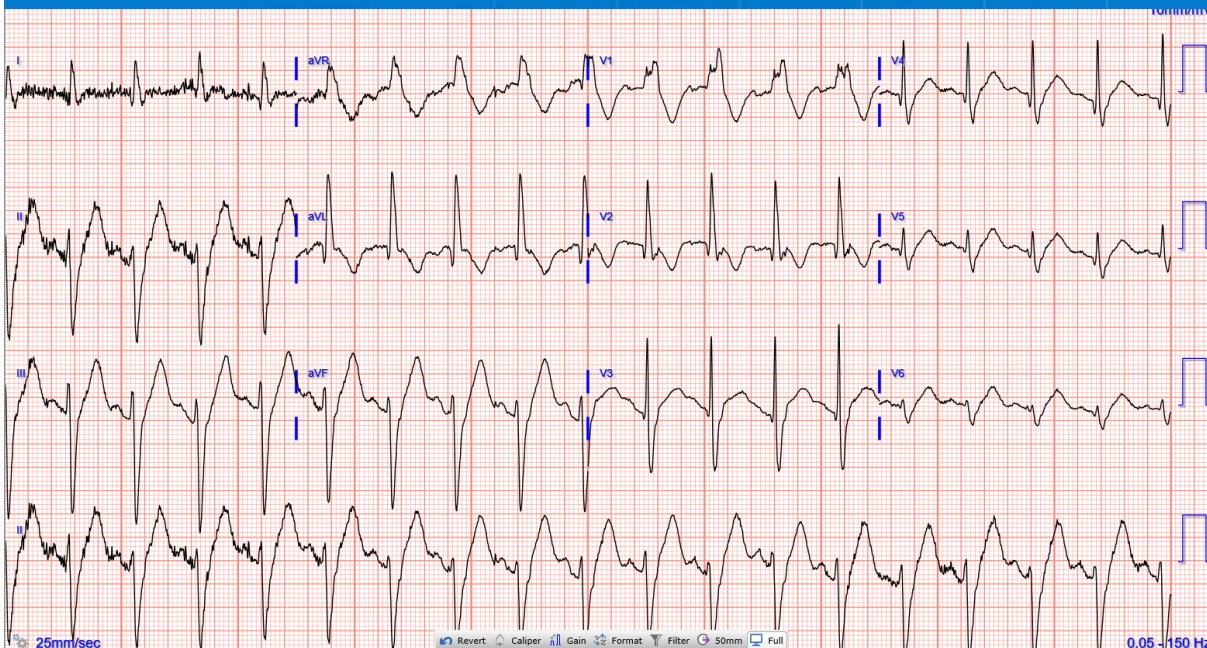


What's the next step?

- A. Obtain Holter to evaluate etiology of palpitations, screen for AF
- B. Contact the patient's cardiologist with your concerns, advice on next step (you think they might need a pacemaker)
- C. Refer to the ED for urgent pacemaker
- D. B or C



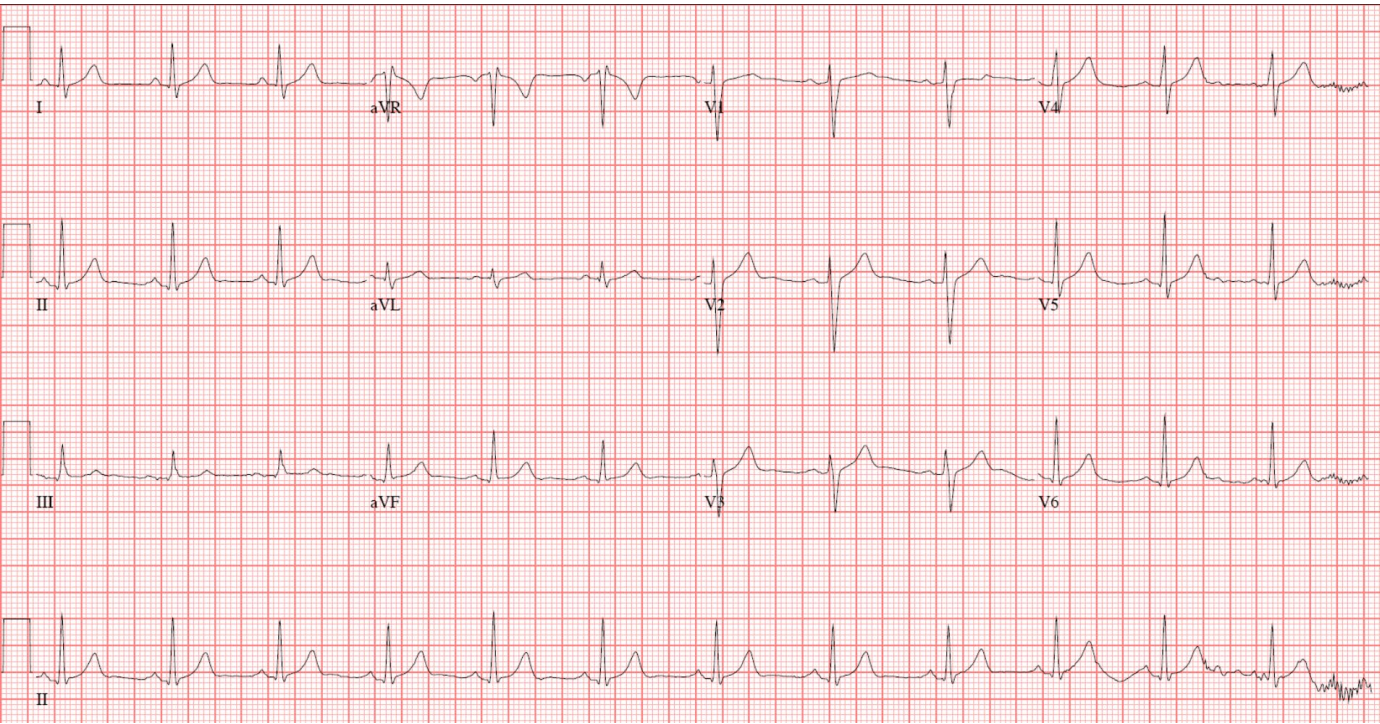
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Case.

- 32 year old male you have seen for anxiety who presents to you for follow-up after presented to ED with “panic attack”
- You review ED records and ECG
- Per report by EMS was in the 170s initially and by ED arrival, HR was in the 150s and gradually came down without intervention

Prior ECG:



Uploaded ED ECG:



What is the arrhythmia diagnosis?

Atrial tachycardia (AT)

AVNRT

Sinus tachycardia

Need more information

Edit



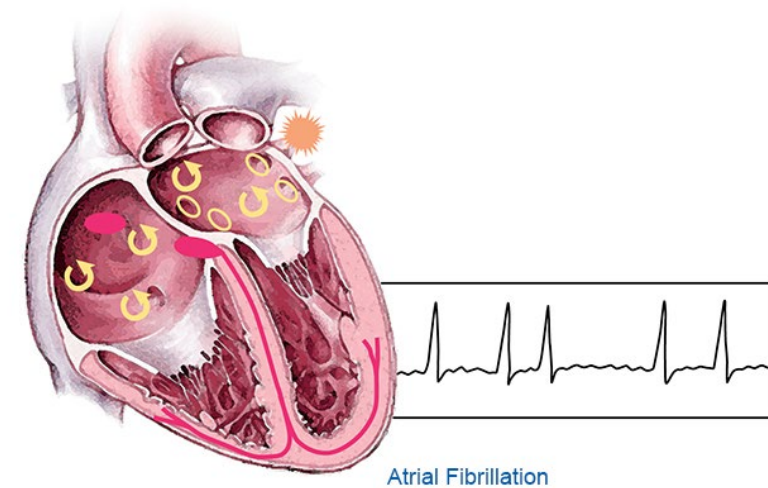
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Overview of Arrhythmias and Management

Arrhythmias

- Supraventricular tachycardias (SVTs)
 - Atrial fibrillation (afib), atrial flutters, atrial tachycardias, PACs, Wolff-Parkinson-White (WPW), AV node reentrant tachycardia (AVNRT)
- Ventricular tachycardias (VTs)
 - Idiopathic, fascicular, scar-mediated reentry
 - PVCs, nonsustained VT (NSVT)
- Bradyarrhythmias
 - Sinus node dysfunction
 - AV block



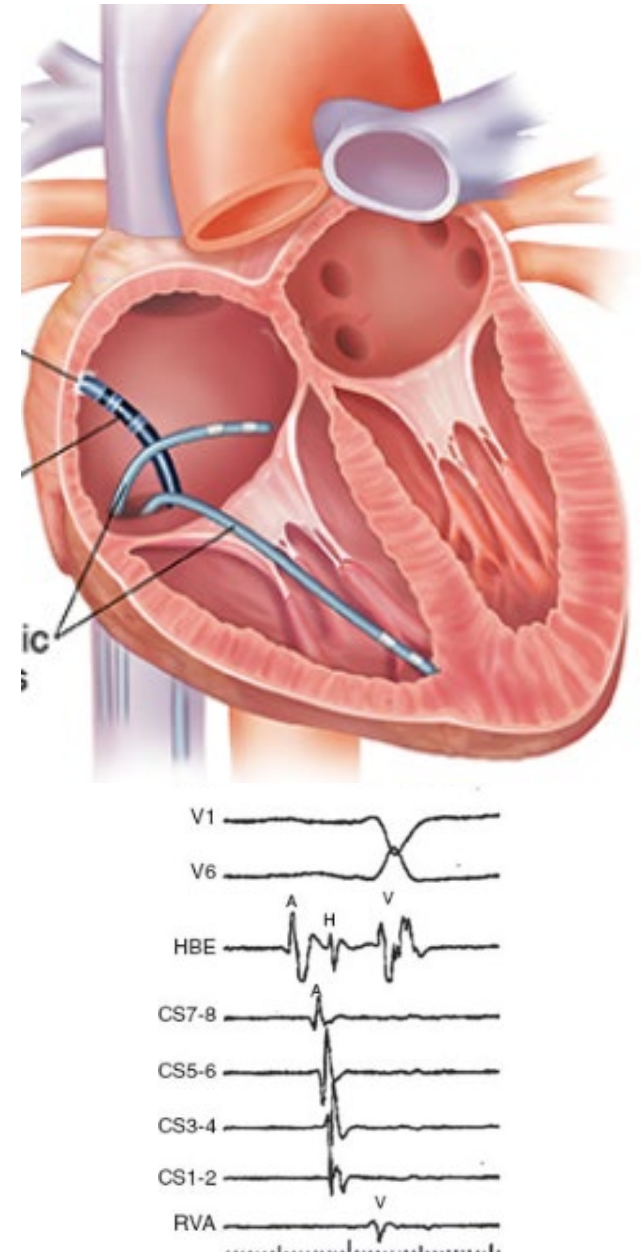
General Approach

- History—triggers, frequency, duration, severity of symptoms, course, ED visits/hospitalizations
- Review ECGs/telemetry, obtain echo, Holter
 - Stress testing can be helpful though generally not associated with ischemia (although screen for ischemic symptoms)
- Confirm diagnosis! Especially in the era of smart devices
- Trial medical therapy including nodal blockade—beta-blockers, calcium channel blockers
- Referral to consider additional treatment options including ablation



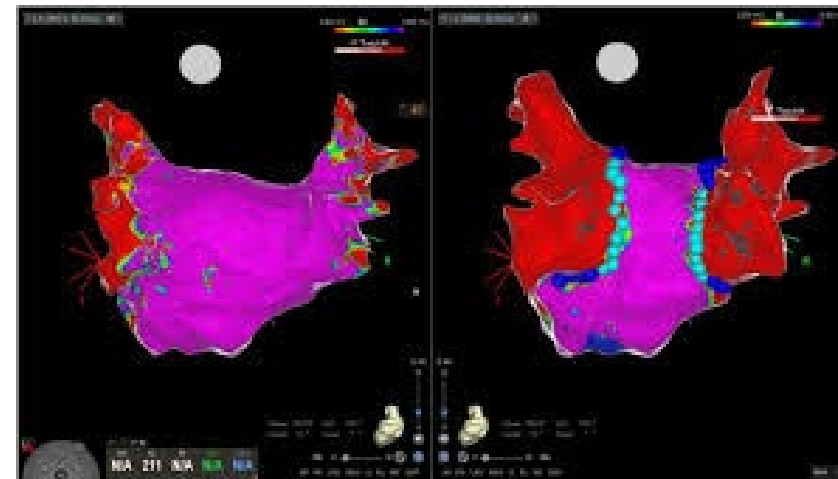
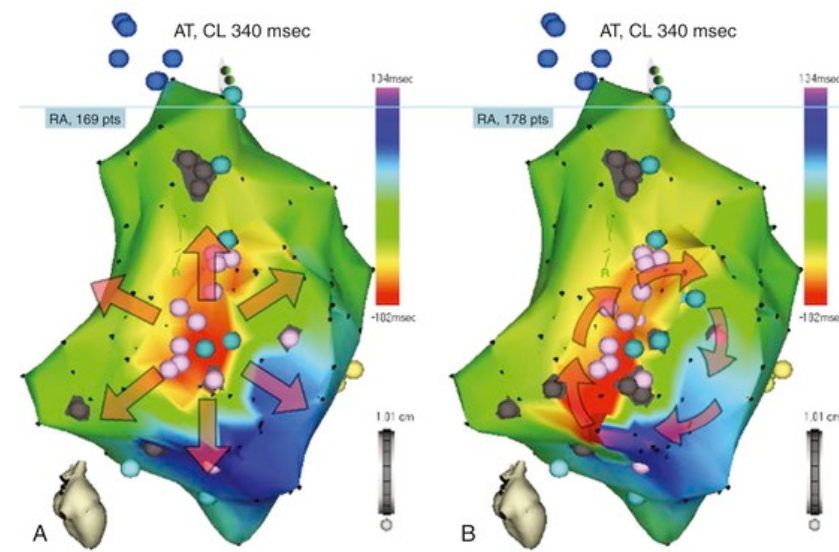
Electrophysiology Study

- The initial catheter study, to guide ablation
- Generally under light anesthesia (deep sedation or general can suppress arrhythmias, exception: AF)
- Femoral vein access, insertion of catheters
- Arrhythmia induced with pacing maneuvers, mimicking PACs, PVCs
- Generally requires induction of arrhythmia to confirm diagnosis with maneuvers prior to ablation (except for AF)



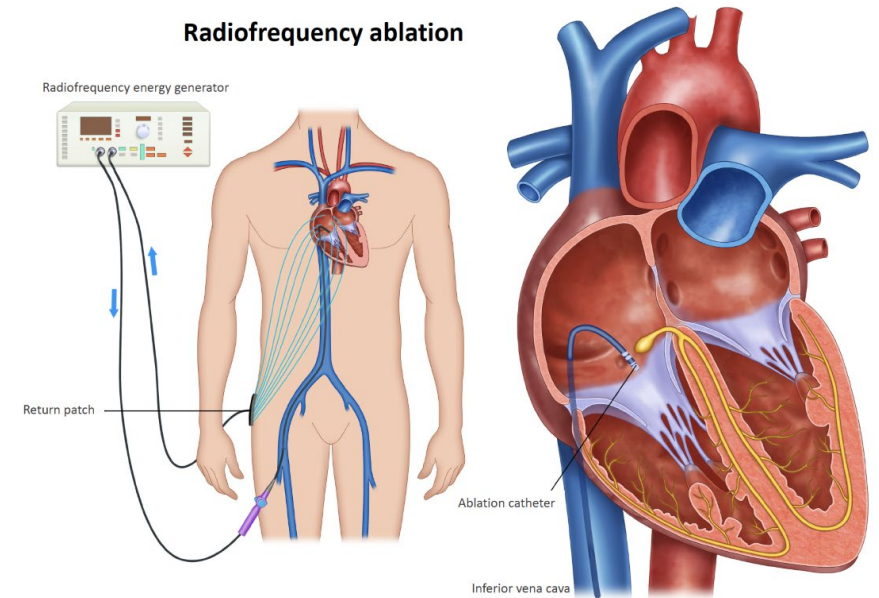
Intraprocedural Arrhythmia Mapping

- Mapping systems used during the ablation procedure create a 3D model of the chambers of the heart and visualization of the abnormal electrical activity or circuits
- Close collaboration with trained mappers who build the map based on catheter movement and facilitate analysis and ablation



Ablation

- Delivery of energy to treat an abnormal circuits or location that cause arrhythmias
- Different techniques and tools vary depending on the arrhythmia
 - Radiofrequency
 - Cryoablation
 - Pulsed field ablation
- Sophisticated catheters with irrigation, force-sensing, directionality, temperature/impedance monitoring



Supraventricular Tachycardias (SVTs)

Supraventricular Tachycardia Entities

- Sinus tachycardia (physiologic and “inappropriate”)
- Atrial tachycardia (and multifocal atrial tachycardia)
- Junctional tachycardia
- Sinoatrial nodal reentrant tachycardia
- AV nodal reentrant tachycardia (AVNRT)
- AV reentrant tachycardia (AVRT including antidromic and orthodromic)
- Atrial flutters (and intraatrial reentrant tachycardia)
- Atrial fibrillation

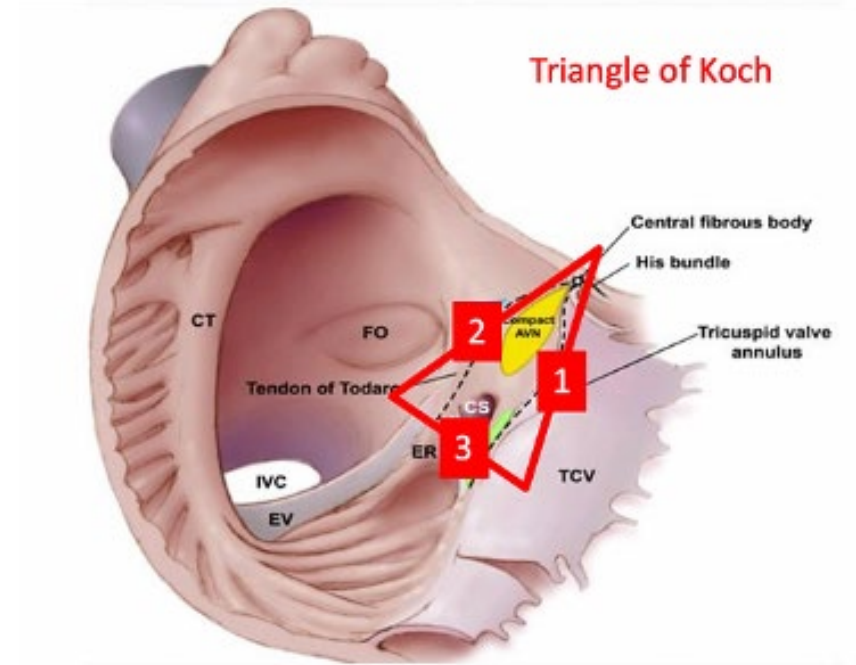
AVNRT (AV node reentrant tachycardia)

- Typical vs atypical versions
- Retrograde p-waves seen as pseudo r' in V1 and may see an negative deflection in the inferior leads
- Most common form of SVTs, generally about 60%
- More common in women and usually onset in young patients but can occur at any age
- Treatment w/ nodal blockade, ablation



Ablation (Slow pathway modification)

- Indicated primarily on patient preference—is first line therapy and generally helpful in patients with frequent, significant episodes particularly refractory to medical therapy
 - Practically speaking, this is a good option for anyone with diagnosed SVT
- Can offer definitive cure in >90-95% of cases
- Low rate of complication, historically 1% risk of pacemaker implant, but in era of more accurate mapping technology, likely now <1%





Who would you refer for SVT ablation?

A 20 year old male with longstanding history of palpitations, diagnosed with SVT after recent presentation to the emergency room with recurrent symptoms

A 82 year old female with HTN, HLD, COPD, baseline sinus bradycardia found to have bouts of asymptomatic SVT while admitted for a UTI?

A 54 year old male with known history of SVT with one episode every few years generally controlled on Metoprolol

A 36 year old female with well-managed hypothyroidism who was discharged from the ED after first documented episode of symptomatic SVT and no other prior history

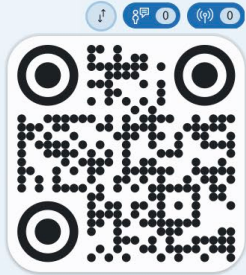
All of the above



Case.

- A 22 year old female presents to you for post ED follow-up after presenting with URI symptoms, diagnosed with flu
- They performed an ECG due to note of SOB and chest tightness with symptoms
- Advised pt to follow-up with you and they placed referral to cardiology

What is the arrhythmia diagnosis?

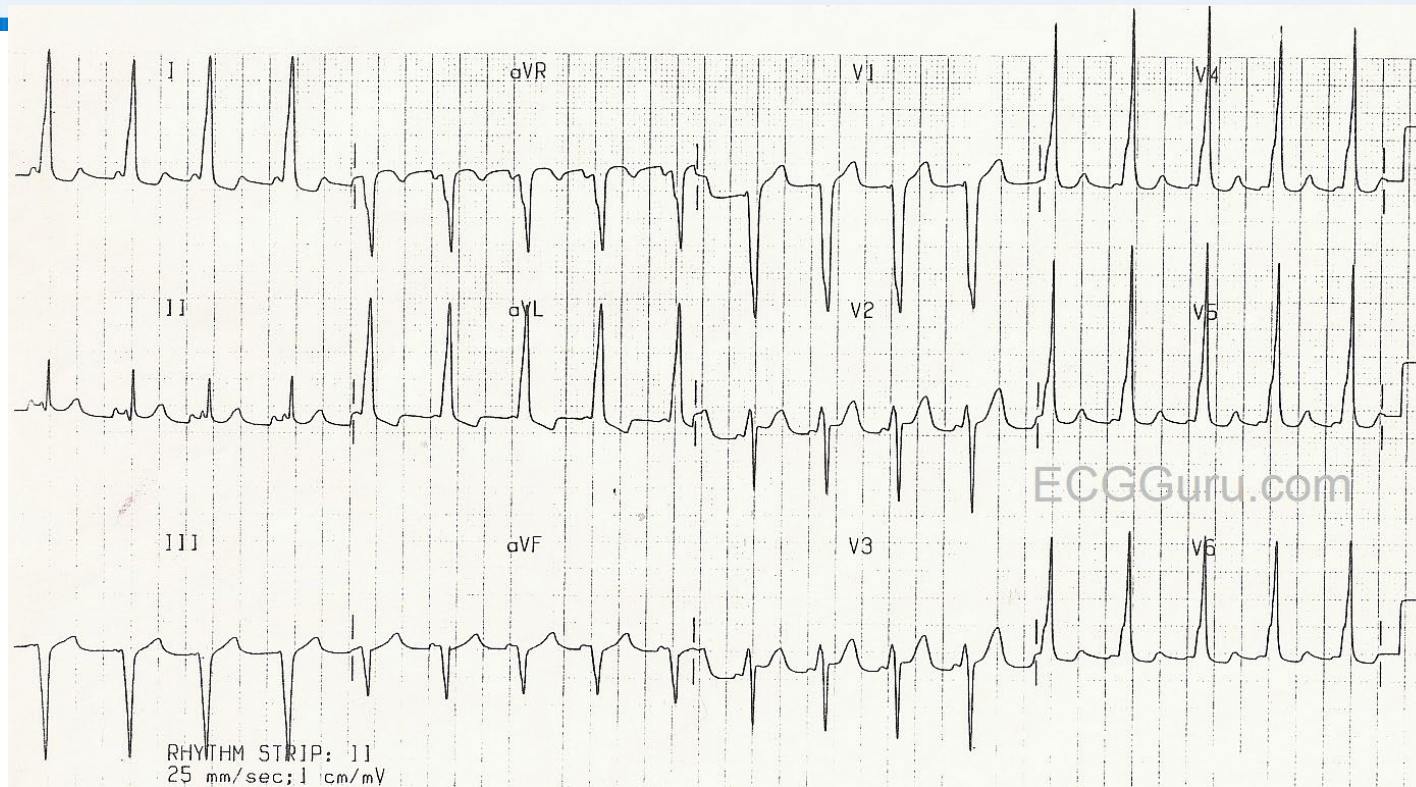


Left bundle branch block

WPW (Wolff-Parkinson-White)

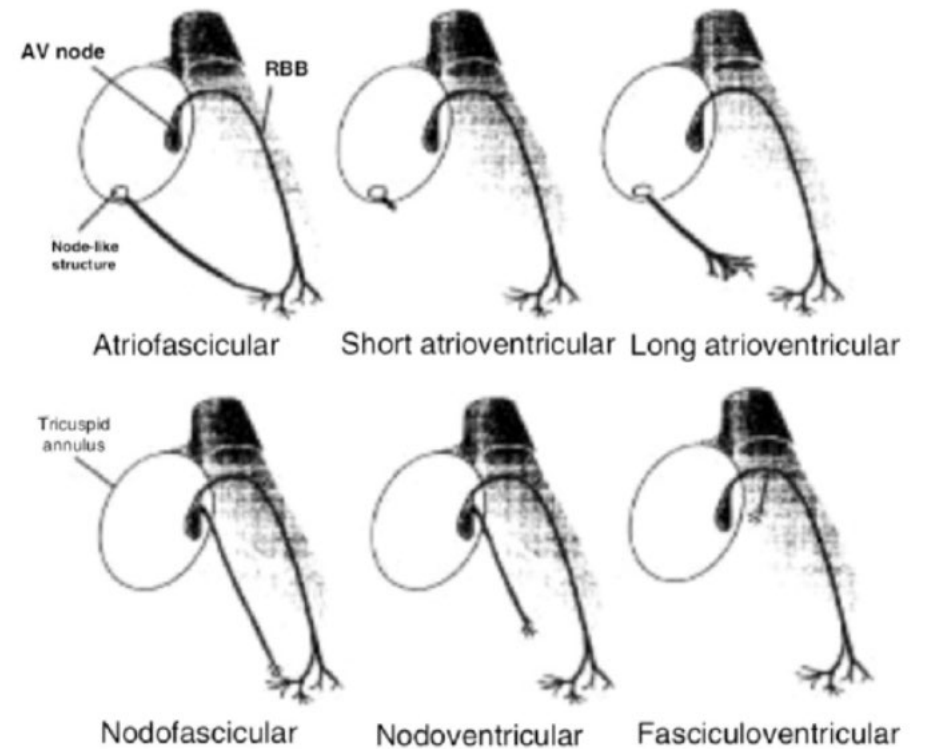
Ventricular paced rhythm

Aberrant conduction



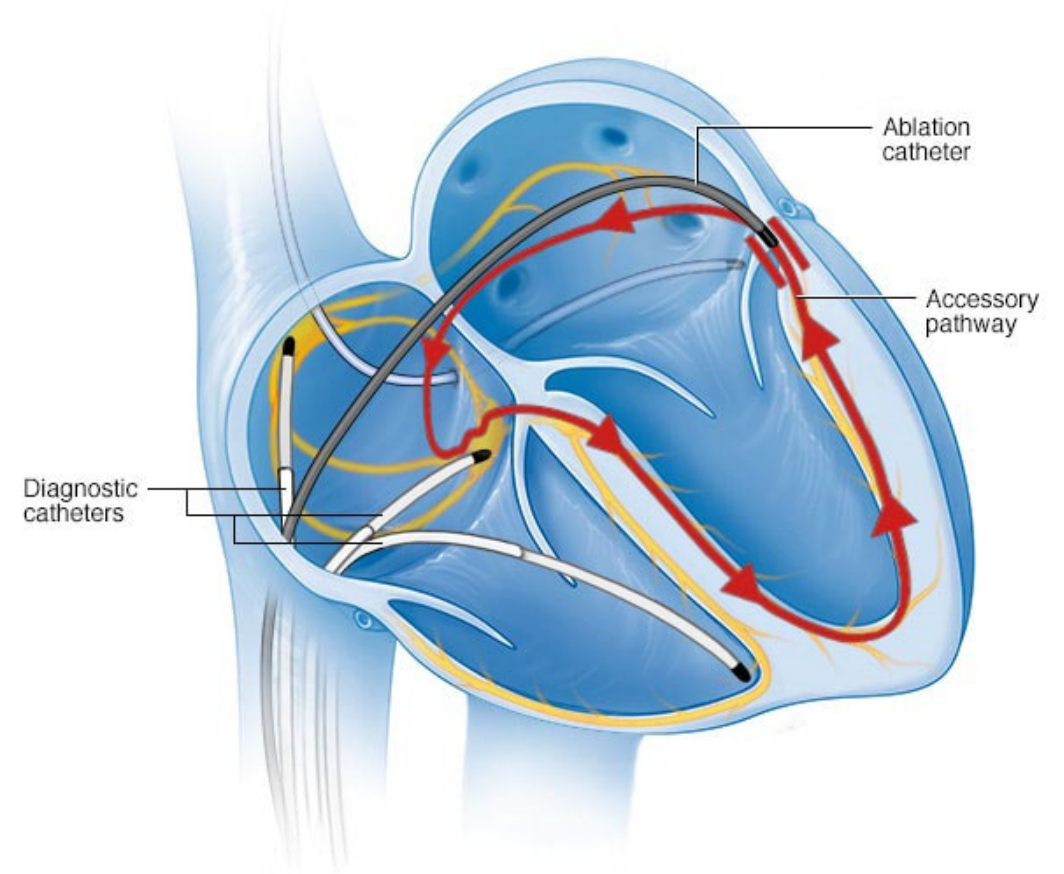
WPW and Accessory pathways (APs)

- Extranodal conduction generally connecting atrium and ventricle
- Fairly uncommon, less than 1% in the general population
- Assess for symptoms, documented arrhythmias—TTE, Holter, stress testing
- EP study if:
 - No clear loss of preexcitation on other studies (assess on ECGs, TTE, Holter, stress test)
 - High-risk occupations
- Purpose of risk stratification and ablation for high-risk pathways capable of rapid AV conduction and those associated with arrhythmias
- Risk of preexcited AT/AF that may induce VF and sudden death (risk is low, around 1%)



Accessory pathway ablation

- Mapping for fused A and V signals and “pathway potential”
- Radiofrequency (RF) energy delivery
- Look for loss of preexcitation or termination of arrhythmias

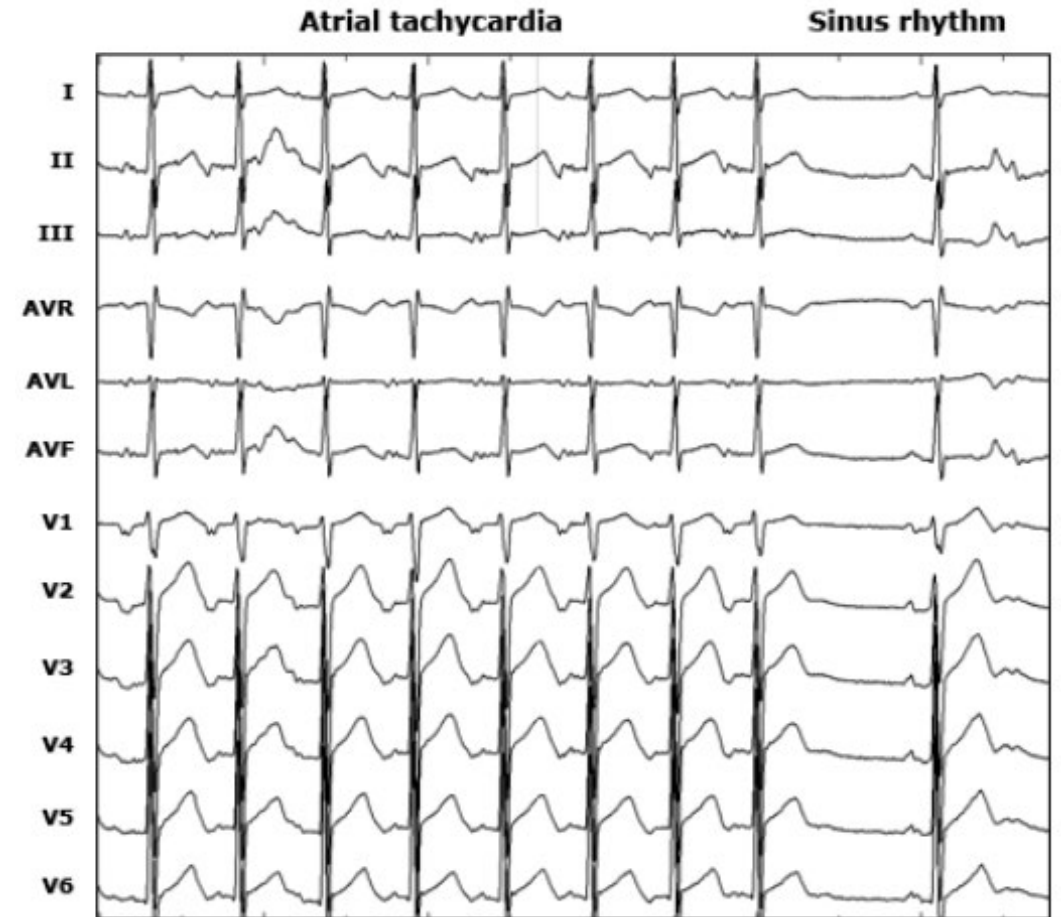


Case.

- 38 year old female with no significant medical history who presents for evaluation of frequent, but brief palpitations
- ECG normal
- You order Holter that shows SR, HR range 42-136 bpm in sinus rhythm, 5% PACs and note of multiple paroxysmal SVT episodes lasting 10-30 seconds correlating with symptoms

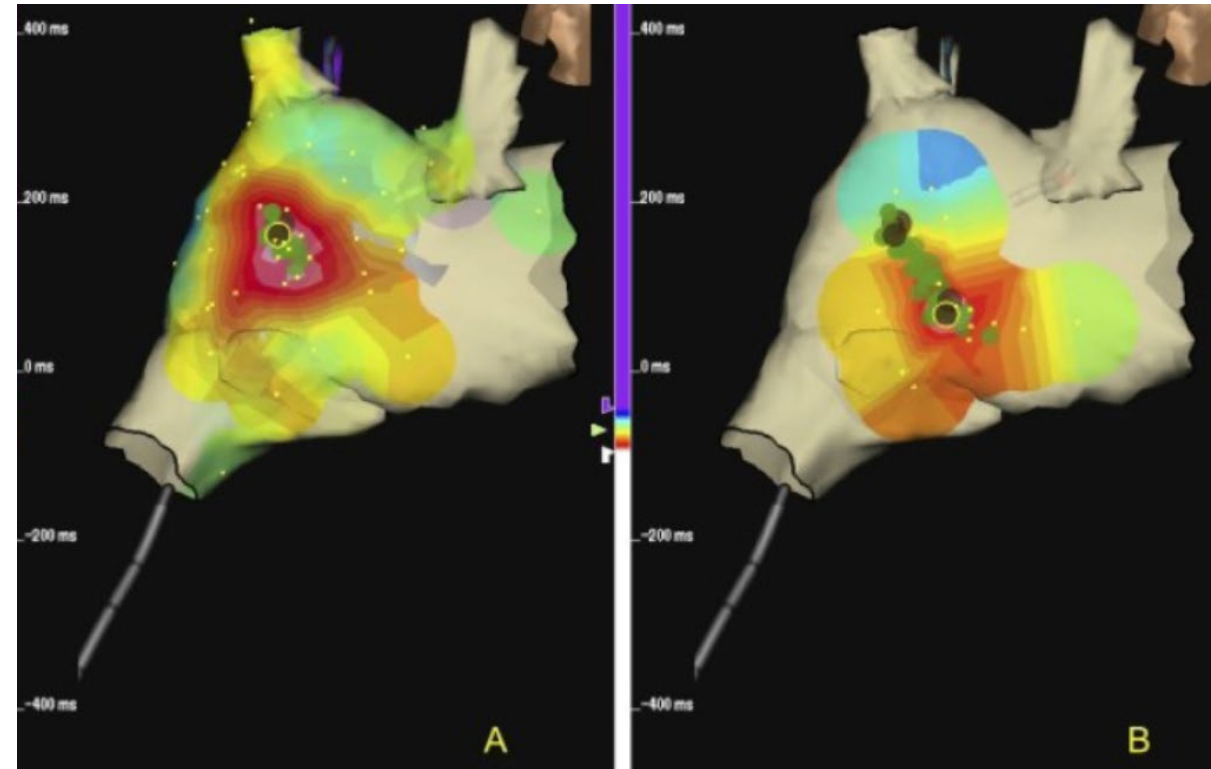
Atrial tachycardias

- Less common, 5-15% of sustained SVTs at EP study but PACs/atrial runs are very common
- Most are right atrial (tricuspid annulus, crista terminalis), though can also arise from the PVs
- Can see in short salvos without PAC, PVC trigger
- Similar treatments—nodal blockade, AAD, ablation



Ablation via activation mapping

- Method of tracking down earliest activation to point of origin
- Characteristic centrifugal from a solitary point
- Ablation performed at this point



Case.

- 62 year old male with HTN, obesity, OSA who presents for evaluation
- Noted his HR has been running high, registered as “tachycardia” on Apple Watch
- You obtain an ECG

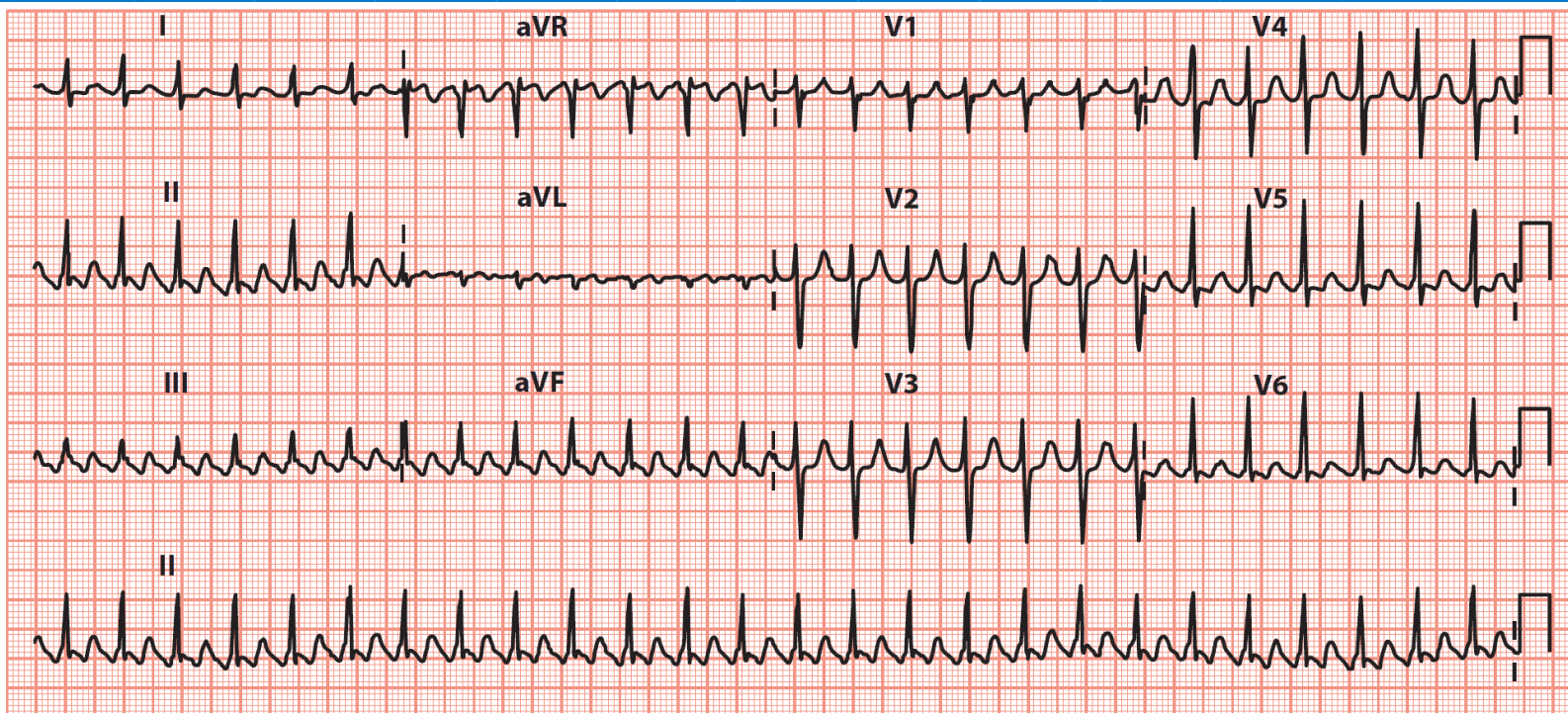
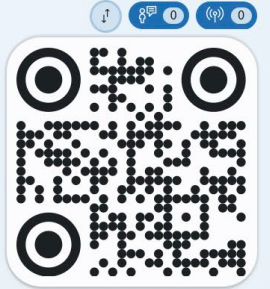
What is the arrhythmia diagnosis?

Atrial tachycardia

Sinus tachycardia

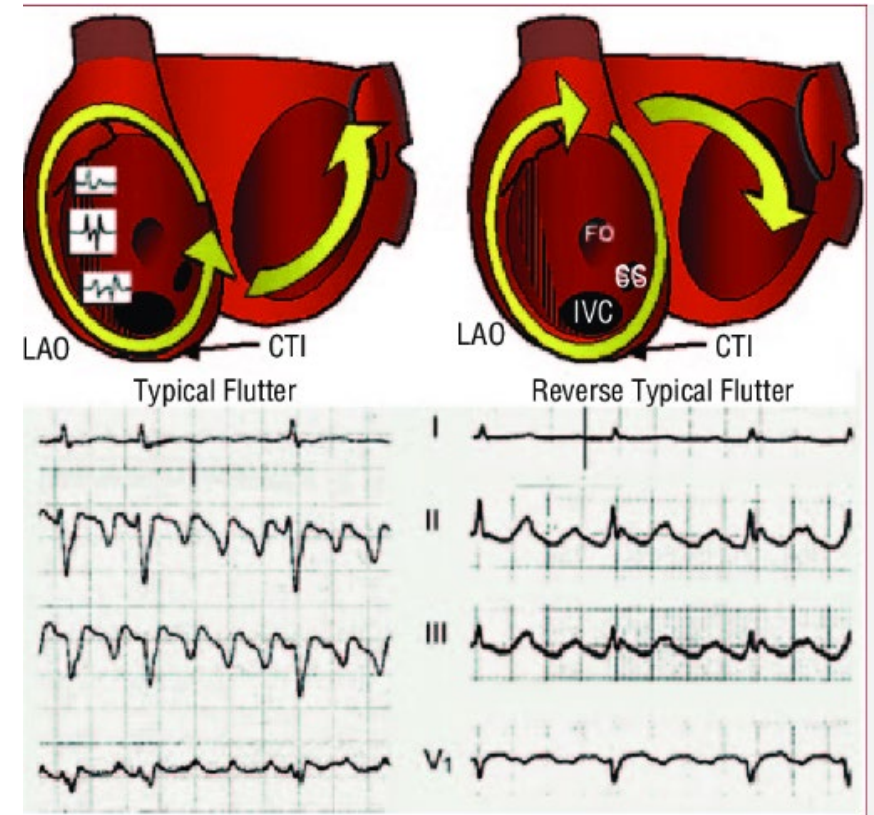
Atrial flutter

Atrial fibrillation



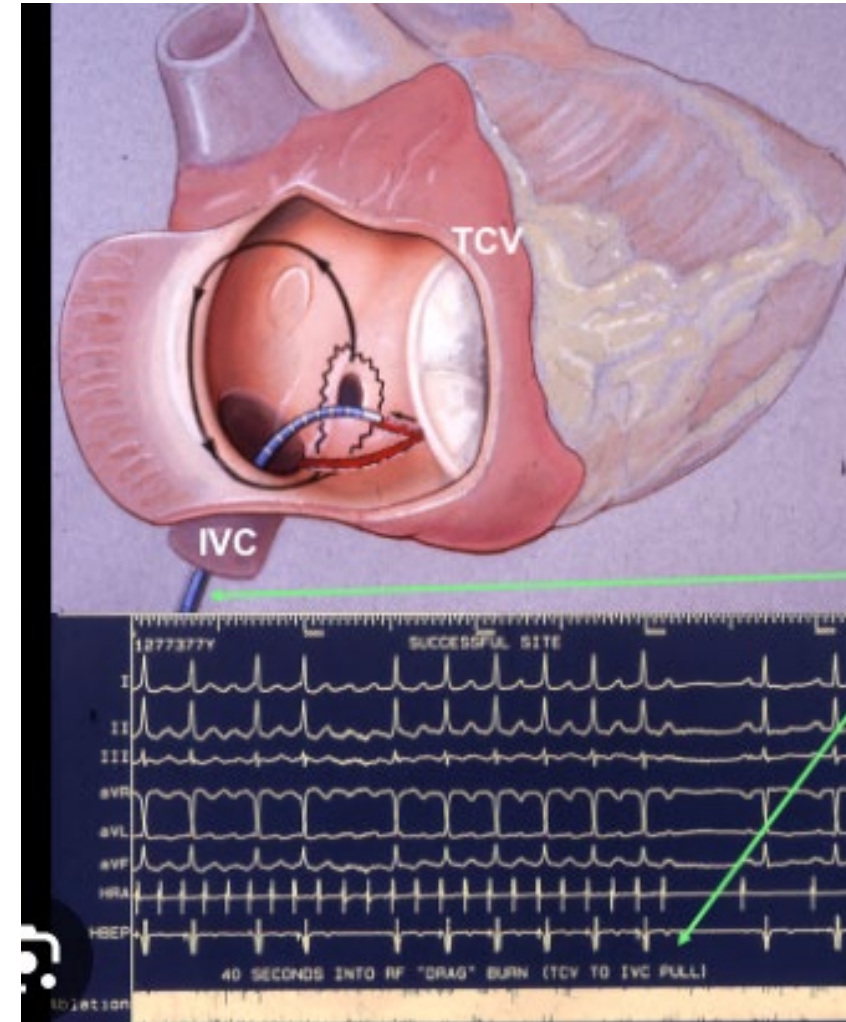
Atrial flutters

- Typical atrial flutter—most commonly an arrhythmia circuit around the tricuspid annulus
- Atypical atrial flutters—anything else. Commonly in left atrium, associated with AF
- Can be 2:1 but commonly variable block. Can be 1:1 with slow flutters
- Can lead to CHF/tachycardia/arrhythmia induced cardiomyopathy



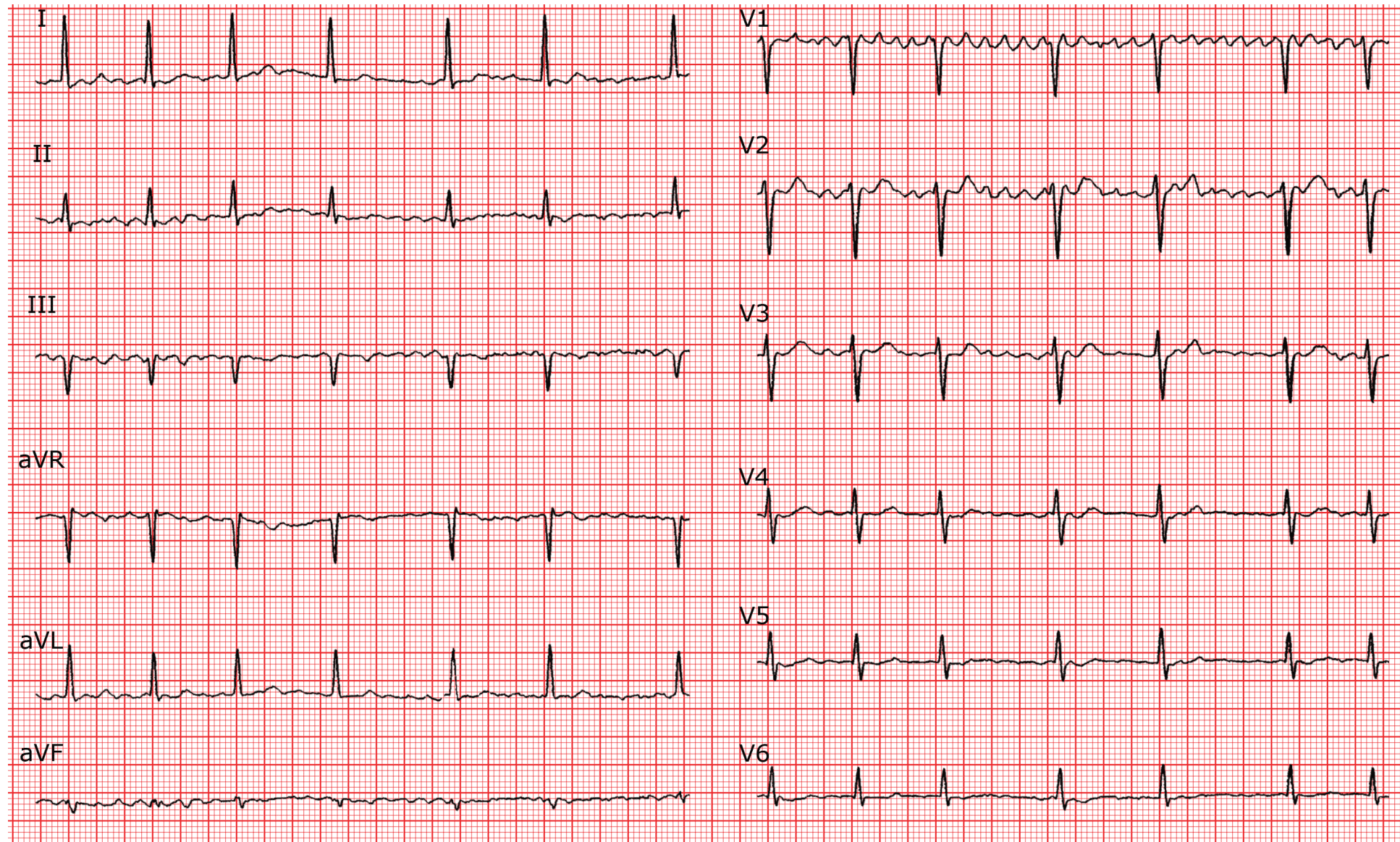
Treatment

- Anticoagulation per CHA2DS2-VASc score
- AV nodal blockade or class III antiarrhythmic agents
- Catheter ablation (90-95%) success rate
- Generally can discontinue anticoagulation post ablation (recent IIb indication to consider anticoagulation if felt to be high risk for AF—LA dilation, COPD, CHF, very elevated CHA2DS2-VASc score)
- This makes ablation a very good option for anyone with diagnosed AFL (though primarily typical) even if asymptomatic and rate-controlled



Case.

- 72 year old male with HTN, HLD, obesity, OSA on CPAP who presents for routine evaluation
- No complaints
- On exam, you think his HR seems a little faster in the 80s-90s bpm and irregular
- You obtain an ECG



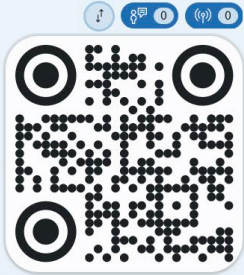
What's the next step?

Start on low dose Metoprolol, anticoagulation, check labs (TSH), echo, refer to cardiology

Likely artifact, repeat the ECG

Send to the ED

Refer to cardiology



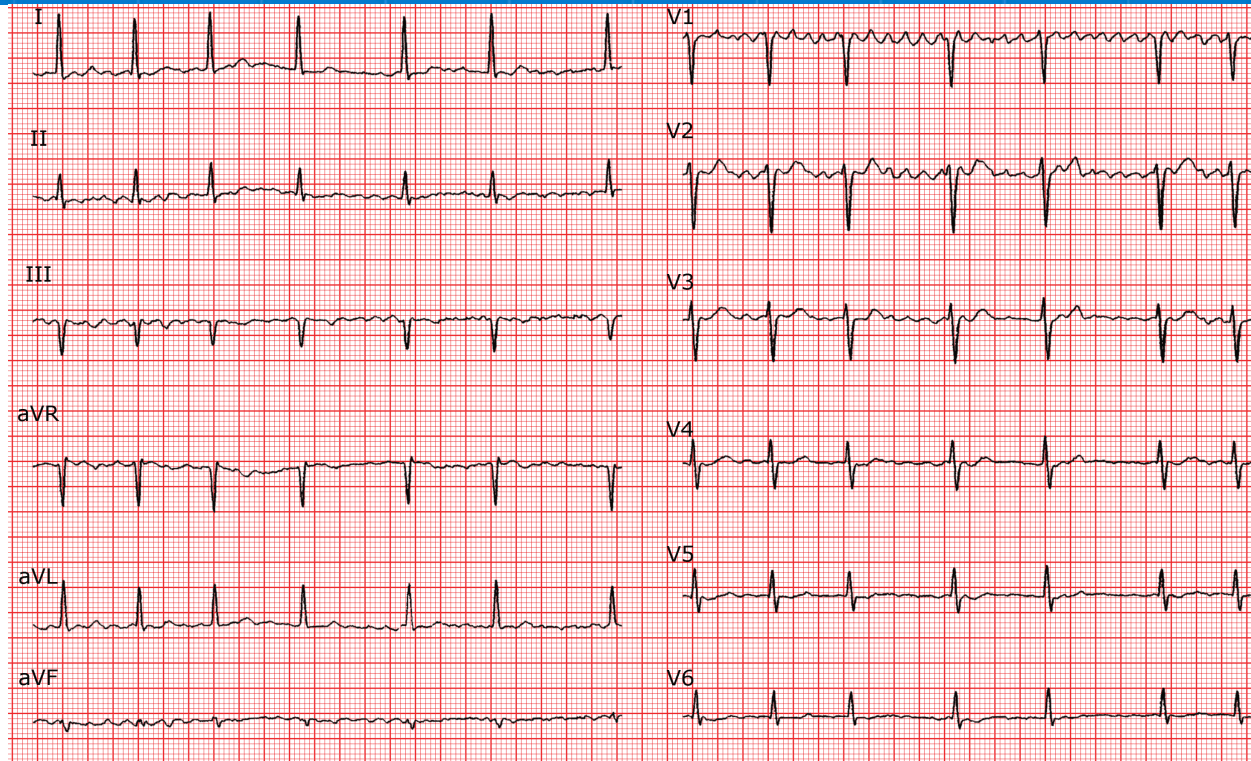
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Choices

Results

Lock

Correctness



Atrial fibrillation

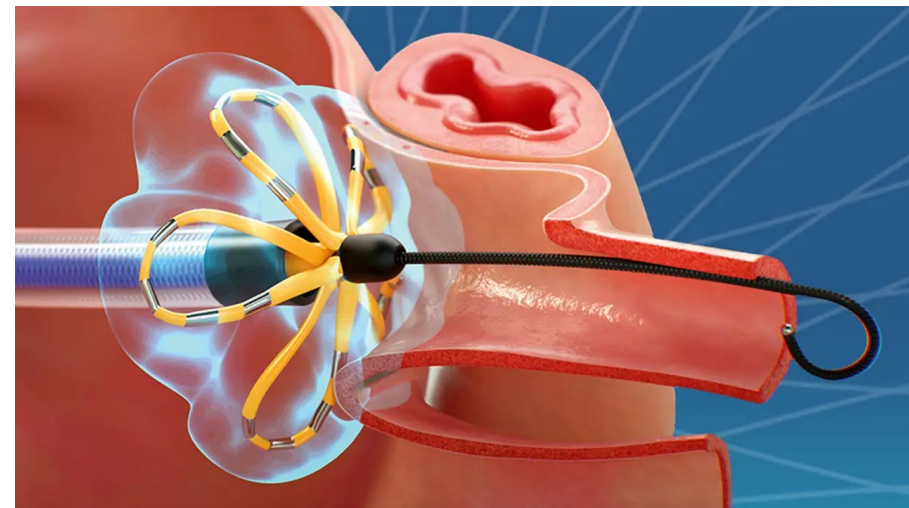
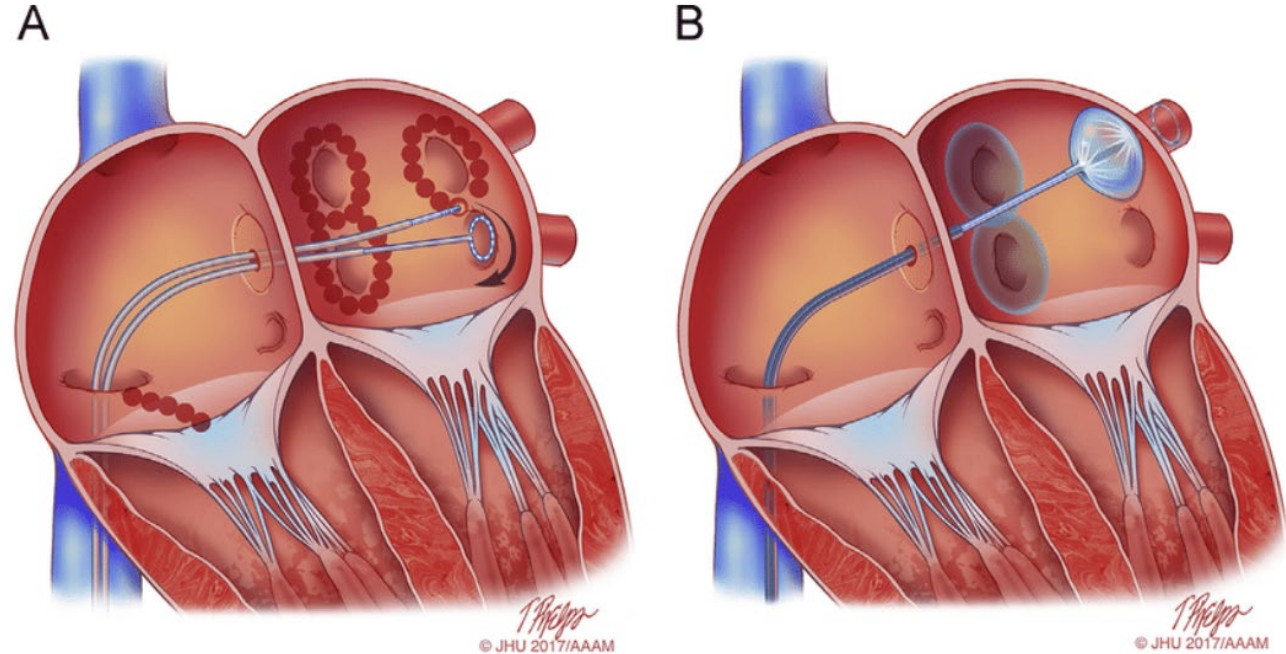
- Irregularly irregular rhythm due to chaotic electrical activity of the atria
- Multiple risk factors with resultant atrial myopathy<->scar<->dilation<->electrical remodeling
 - “afib begets afib”
- Paroxysmal, persistent, longstanding-persistent, chronic subtypes
- Variety of symptoms—asymptomatic to subtle symptoms (deceased stamina) to severe
- Rate vs rhythm control strategies (DCCV, AADs, ablation)
- Commonly seen with SND (tachy-brady syndrome) requiring PPM

Treatment

- Anticoagulation per CHA2DS2-VASc score; screen for bleeding concerns
- AV nodal blockade
- Antiarrhythmic therapies—class Ic and class III agents
- Catheter ablation (60-80% suppression at 1-2 years)
- Role of AVN ablation/PPM (AVJ/CRT) for refractory AF including w/ RVR or HF

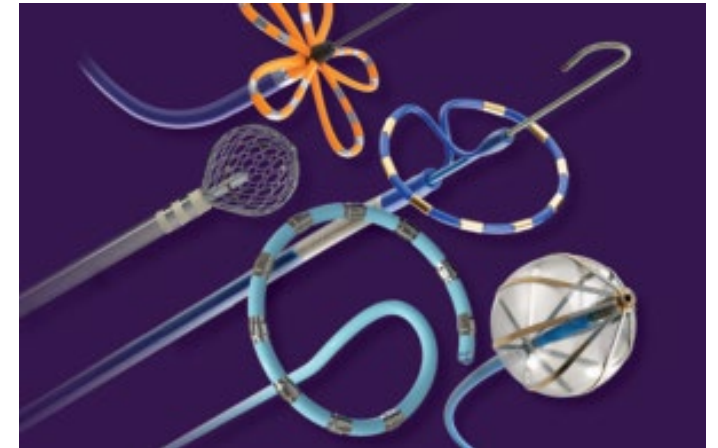
AF Ablation overview

- Pulmonary vein isolation (PVI) targeting triggers
- Posterior wall isolation (PWI) also commonly pursued
- Cryoballoon vs radiofrequency ablation
- **Pulsed field ablation (PFA)**
- Higher success in pAF, lower success in persistent AF often requiring AAD
- Decrease burden of AF
- Role in arrhythmia/tachycardia-induced cardiomyopathies (improved mortality) and with congestive heart failure
- Emerging data suggesting lower risk of CHF, stroke, and dementia
- Overall, we have become more aggressive with pursuing AF ablation as first line therapy, even prior to use of antiarrhythmic therapy (supported in 2023 guidelines)



AF Ablation details

- Generally about 1-2 hours duration under general anesthesia
- Bilateral femoral vein access, use of intracardiac echo, minimal to no fluoro at some centers, venous closure devices
- Low risks, 1% risk of bleeding (done on uninterrupted anticoagulation), <1% of serious complication
- Most (~75%) are same day discharge, groin precautions x1 week
- Exclusively done with PFA at most centers now
- Role for radiofrequency ablation for empiric typical AFL (CTI) ablation
- May have some recurrent pAF in the blanking/healing period x1-3 months
- Some patients do require further antiarrhythmic therapy or redo procedures—subsequent procedures with variable findings of reconnections vs new substrate





Who would you refer for AF ablation?

A 67 year old female with HTN, HLD, DM2 with recurrent symptomatic pAF despite beta-blockade

A 52 year old male with HTN and asymptomatic pAF with 25% burden on 2 week Holter

A 82 year old female with diastolic HF, HTN, CKD, COPD and persistent AF with recurrence despite cardioversion

A 42 year old obese male (BMI 35) recently discharged from the hospital after presenting with progressive SOB and found to be in AF w/ RVR, s/p TEE/DCCV to SR but finding of LVEF 35%, however now feeling back to baseline in SR. Repeat TTE pending from general cardiologist

All of the above





Who would you refer for AF ablation?

A. A 87 year old male with mild dementia, chronotropic incompetence, COPD, HTN, HLD, CKD, with paroxysmal AF

B. A 32 year old male with history of alcohol abuse and recurrent pAF, having difficulty abstaining from alcohol

C. A 56 year old male with longstanding persistent AF of at least 6 years but now with dyspnea and note of LVEF of 45% on last echo

D. A 67 year old female with DM2, CKD, COPD incidentally found to be in newly diagnosed persistent AF at time of hospitalization for PNA w/ early recurrence s/p cardioversion. Rate-controlled, normal LVEF, and asymptomatic

All of the above

None of the above



Edit

☒ Choices

☒ Results

☐ Lock

☐ Correctness



Periprocedure Anticoagulation

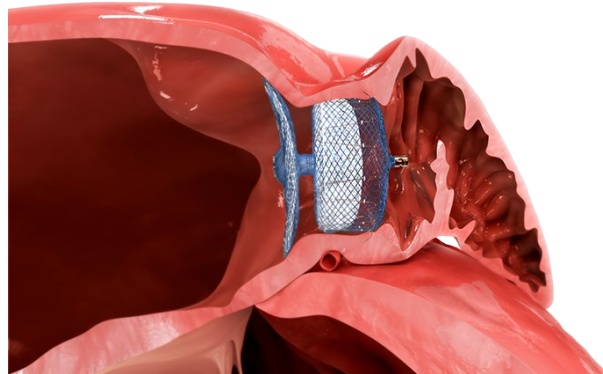
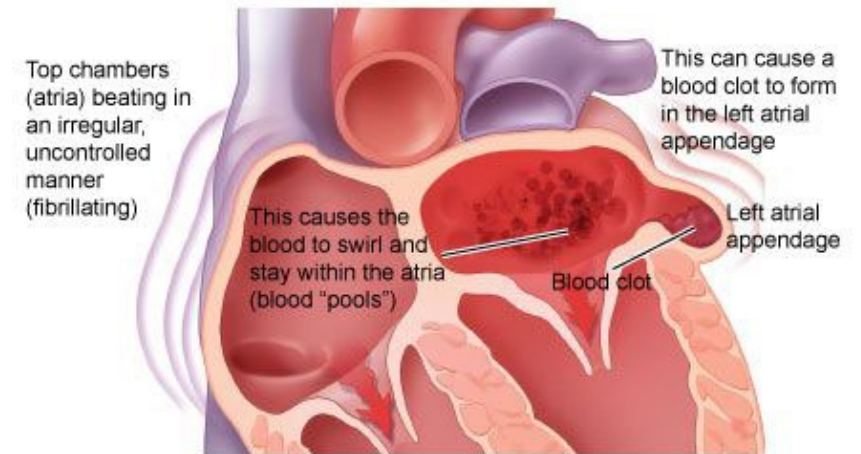
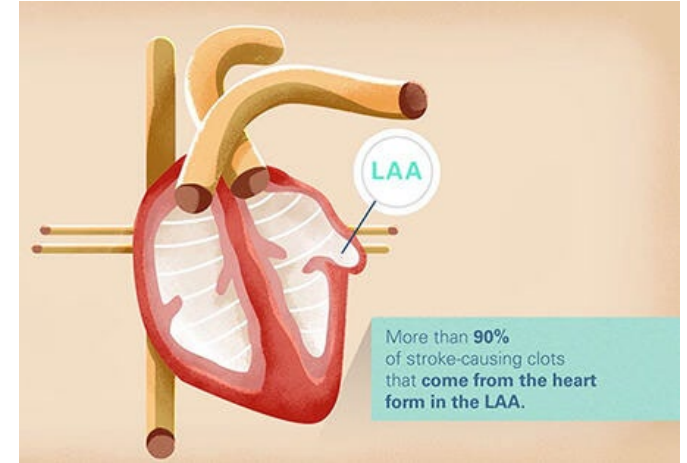
- Must be on uninterrupted anticoagulation periprocedurally regardless of CHA2DS2-VASc score
- Generally continued uninterrupted for 2-3 months post procedure (ideally should not have elective procedures requiring temporary discontinuation at the time)
- Generally continued longterm even if AF suppressed if CHA2DS2-VASC score 2 or greater
- Controversy regarding discontinuation if AF proven to be suppressed or closely monitored, pt can reliably tell when in AF and if CHA2DS2-VASc score “relatively low”, ie 1-3 with short term ASA

Practical points for AF management

- Determination of stroke risk with CHA2DS2-VASc and bleeding risk, though unless actively bleeding, most should initiate on anticoagulation with appropriate counseling
- More aggressively pursue rhythm control—the sooner the better. If has early recurrence, may need more aggressive treatment
- Early consideration for ablation and trending away from antiarrhythmic therapy
 - Paroxysmal pts may still be treated according to symptoms and episodes but if noting escalation of episodes/duration, may be best to intervene before becomes persistent
 - Even rate-controlled, “asymptomatic” pts with persistent AF may go on to develop symptoms and CHF years later at which point it will be more difficult to treat
 - Many patients are intolerant to antiarrhythmic therapy or do not wish to be on them longterm

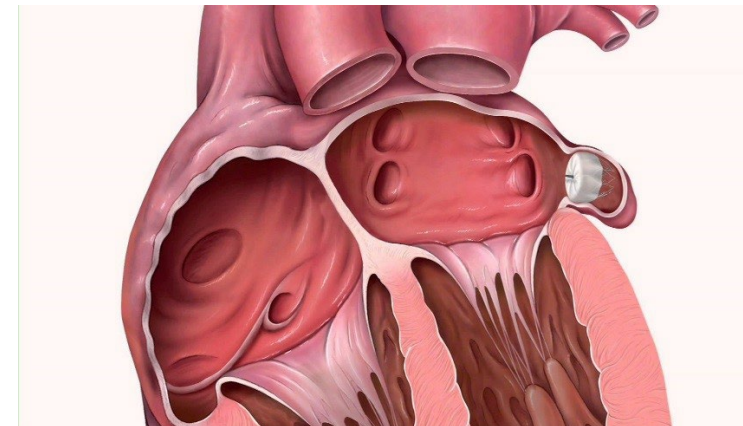
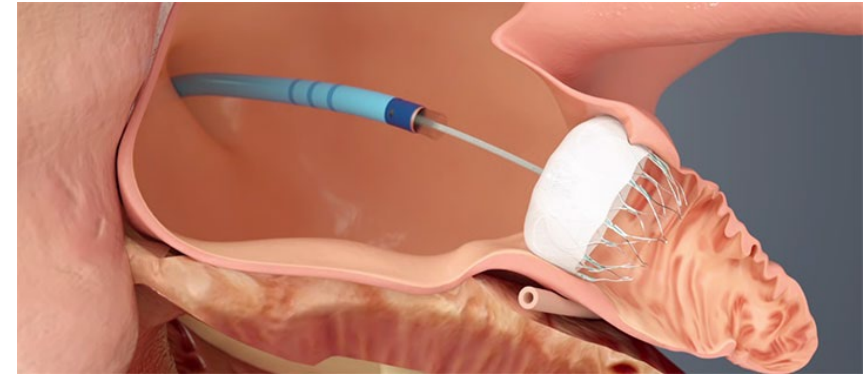
Left Atrial Appendage Occlusion Devices (eg Watchman, Amulet)

- Anticoagulation is generally well-tolerated but pts often encounter bleeding issues and frequent falls
- LAAO occlusion is a reasonably alternative to stroke risk reduction in patients who cannot safely tolerate anticoagulation
- Only indicated for non-valvular AF, not AFL, CHA2DS2-VASc score 2 or greater



Watchman implant

- Similar catheter-based approach to AF ablation and can be done concomitantly during ablation
- Done under general anesthesia (a consideration for the very elderly)
- Requires short term blood thinners during the healing period
 - Generally DOAC/Warfarin +/- ASA for 6 weeks
 - TEE at 6 weeks. If no significant leak or thrombus, anticoagulation stopped, continued on DAPT x 6 mo total (4.5 more months)
 - ASA 81 mg daily indefinitely
 - Ideally continued without interruption during 6 mo healing period
 - High risk protocol of 6 mo of DAPT
- Once healed, offers similar stroke risk reduction as compared to blood thinners but without the bleeding risk
- High success rates (generally >95%) with very low complication rates (similar to ablation), DRT (device-related thrombosis) rate about 2-5%



Wide-complex tachycardias

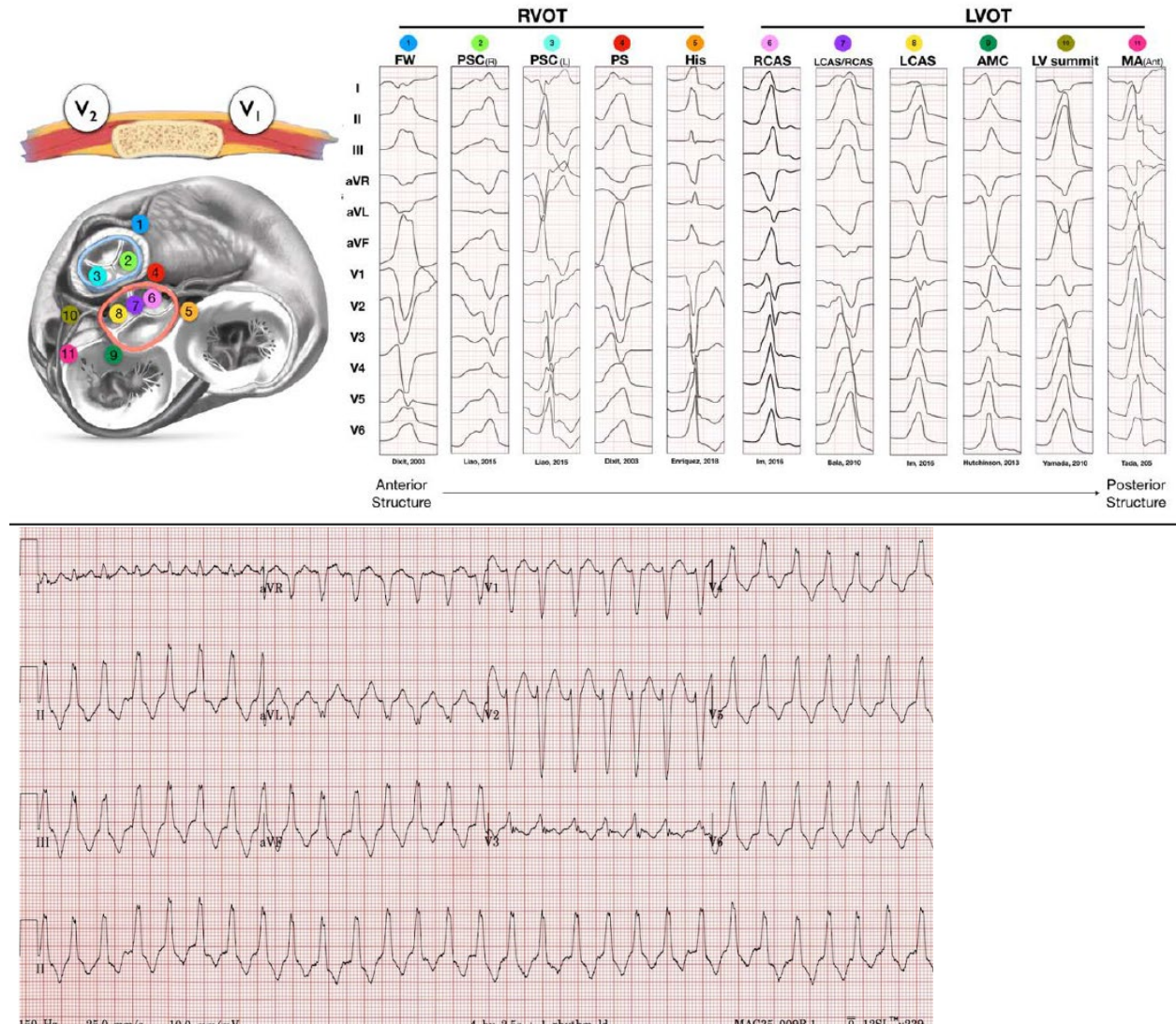
Ventricular tachycardias

Wide Complex Tachycardias

- PVCs and Ventricular tachycardia
- Others:
 - SVT with Aberrancy
 - Preexcited SVT, Antidromic AVRT
 - Paced rhythm
 - Artifact

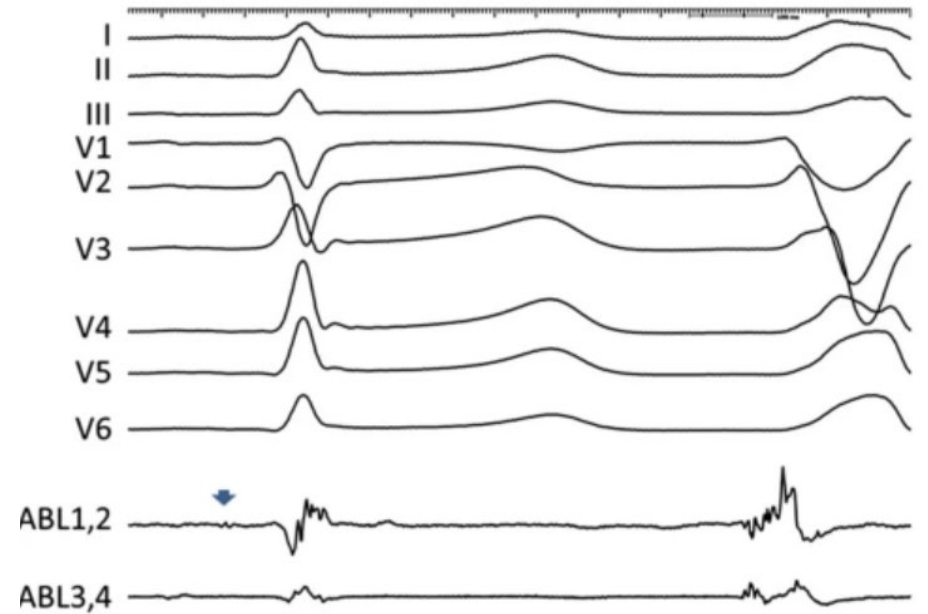
Outflow Tract PVC/VTs and Automaticity

- Generally outflow tract or papillary muscle
 - RVOT (70-80%) more common vs LVOT (15-25%)
 - Includes aortic cusps, or papillary muscles (anterolateral or posteromedial paps)
- Can occur without structural heart disease
- Not pathological but can cause symptoms, anxiety
 - Syncope rare w/ outflow tract VT but can occur
- High burden >15-20% correlated with cardiomyopathy, eg PVC induced cardiomyopathy in a minority of pts (“chicken or egg?”)
- Can be responsive to nodal blockade
- Otherwise consideration for antiarrhythmic therapy or ablation



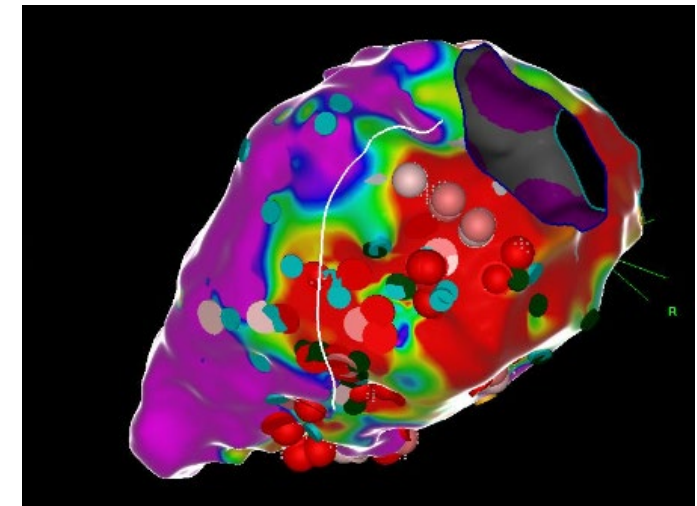
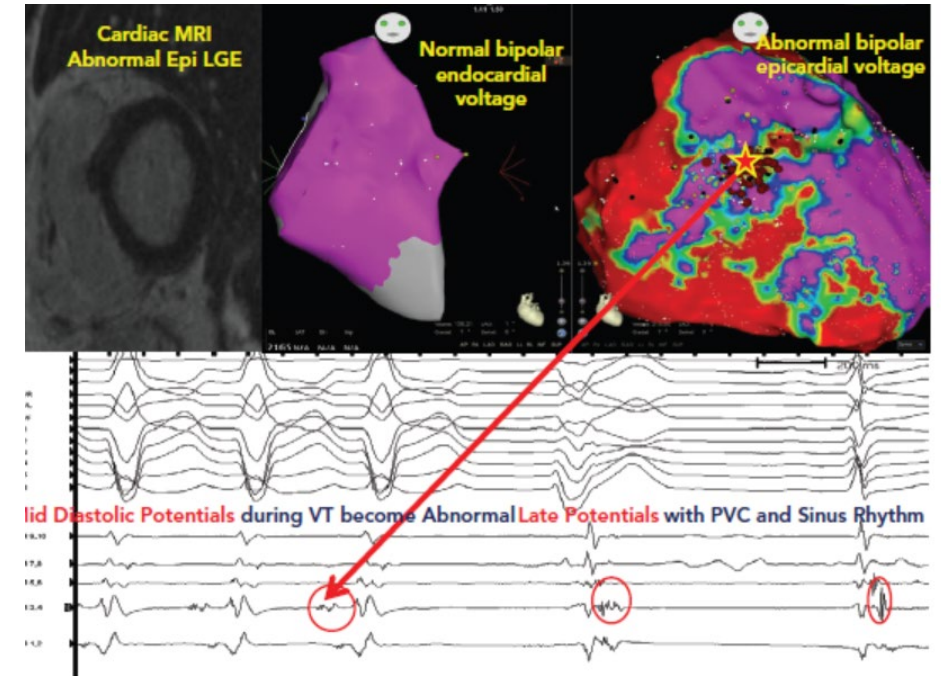
PVC/Outflow tract VT Ablation

- Set up depending on suspected location—RV vs LV and if LV, consider antegrade transmitral approach or retrograde aortic approach
- Target early pre-QRS signals
- Higher burden PVCs aide mapping and success of ablation
- Generally success rates of at least 70-75% but depending on site/frequency and more practical than focal ablation of PACs



Scar-mediated VTs

- Occurs with structural heart disease, including ischemic and nonischemic cardiomyopathies
- Pathologic and can result in cardiac arrest
- Even “slow” hemodynamically stable VTs require ICDs given chance of developing faster pathologic VT from the same scar substrate
- Managed with antiarrhythmic therapies or ablation



Bradyarrhythmias

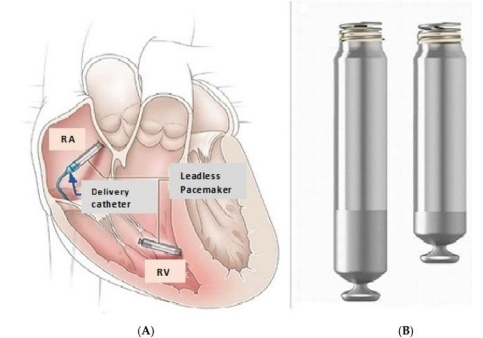
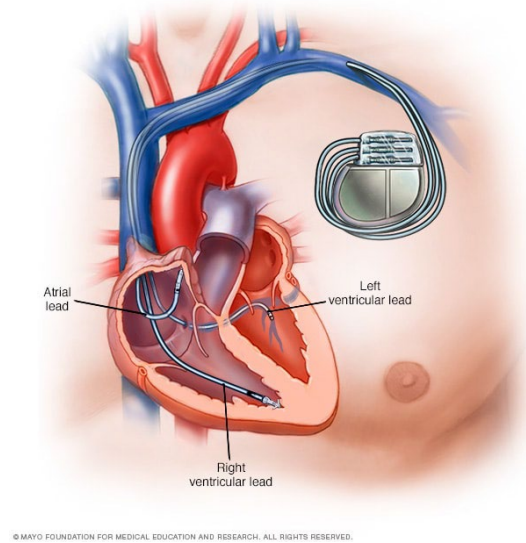
Types of Bradyarrhythmias

- Sinus node dysfunction/sick sinus syndrome
 - Pacemaker indications:
 - Symptomatic sinus bradycardia
 - Chronotropic incompetence
 - Tachy-brady syndrome
- AV block
 - Pacemaker indications:
 - Symptomatic Mobitz I second degree AV block
 - High degree AV block: Mobitz II, CHB
 - Alternating bundle branch blocks
 - Cardiac resynchronization therapy indications in CHF

Implantable Cardiac Devices

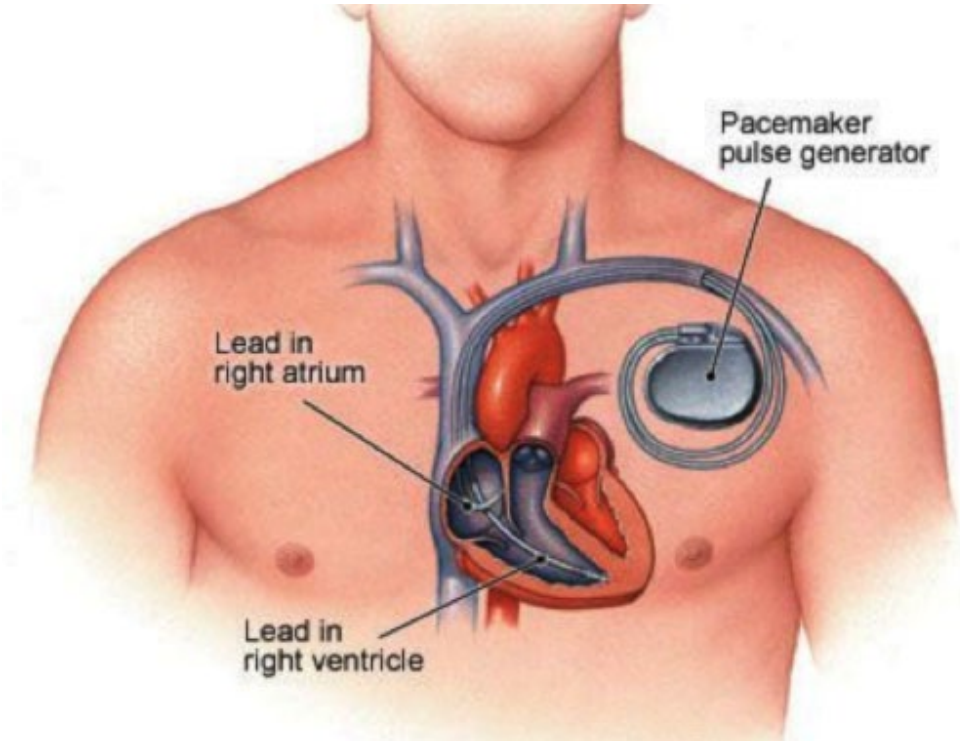
Pacemakers

- Implanted cardiac devices to treat bradyarrhythmias (SND/SSS, chronotropic incompetence, tachy-brady, AV block)
- Traditional transvenous or leadless options depending on indications and patient factors
- Requires close follow-up for device function, battery longevity (generally at least 10 yrs now), arrhythmia monitoring



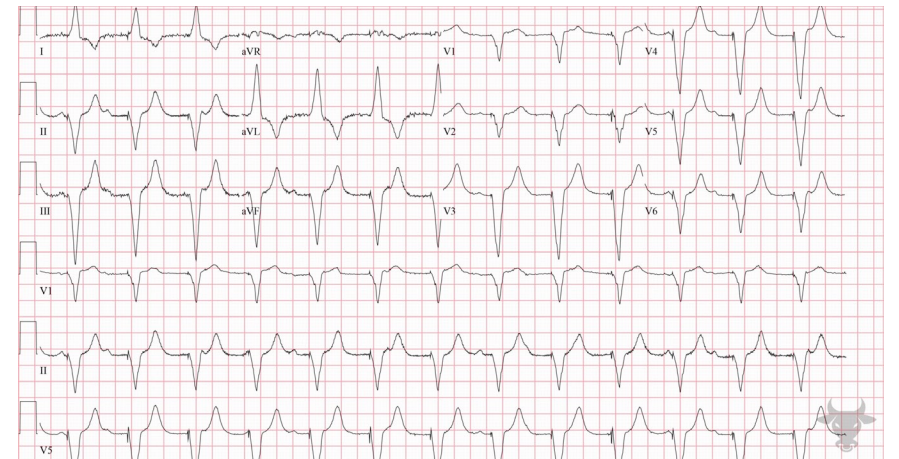
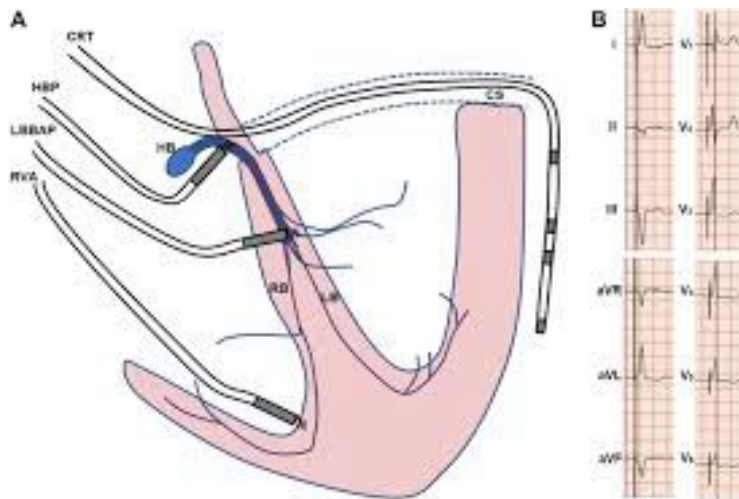
Transvenous Pacemakers

- Generally performed under conscious sedation, left infraclavicular incision and single chamber vs dual chamber implant
- Subclavian/axillary vein access or cephalic vein cut-down for access
- Biventricular pacemaker implants (CRT-P) for LV dysfunction with LBBB not otherwise meeting criteria for ICD/CRT-D
- Low risks, but include bleeding, infection, rare risk of serious adverse events
- Generally arm restrictions x4 wks though afterward no restrictions
 - Avoid placing magnets over device
 - MRI compatible/conditional
- Remote monitoring for alerts and routine checks
 - Bedside monitor or phone app



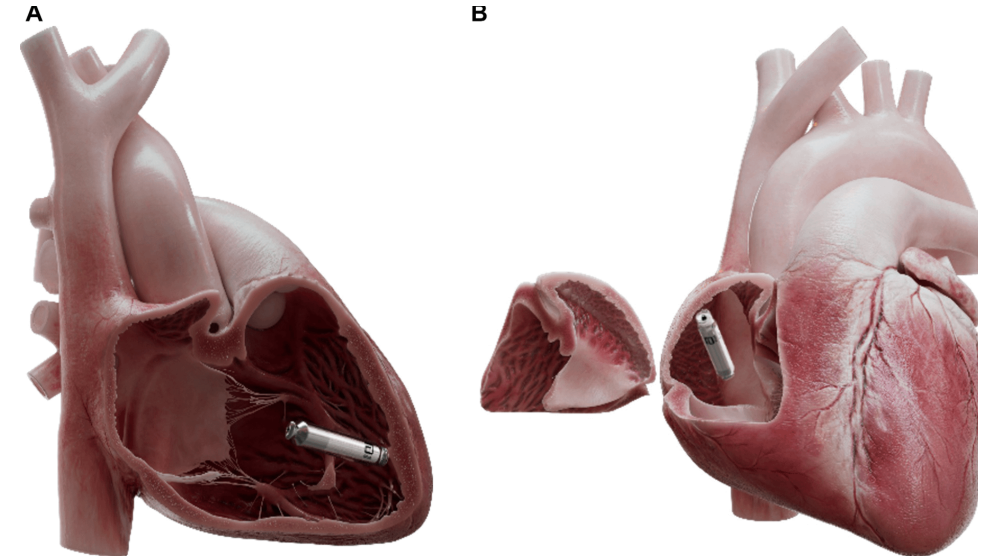
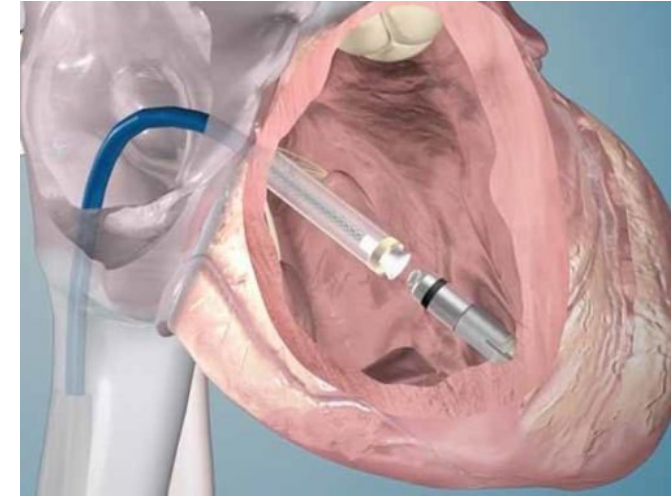
Left Bundle Branch (area) Pacing (LBBAP)

- Increasingly adopted for conduction system pacing which offers more physiologic pacing
- 10-20% risk (some studies up to 40%) of developing a pacing induced cardiomyopathy with chronic traditional RV pacing requiring CRT upgrade
- Mitigated with conduction system pacing
 - Parahisian pacing—high thresholds, unstable lead
 - LBBAP—more stable parameters, thresholds
- Benefits in CHF and as back-up option for coronary sinus lead if not feasible for CRT



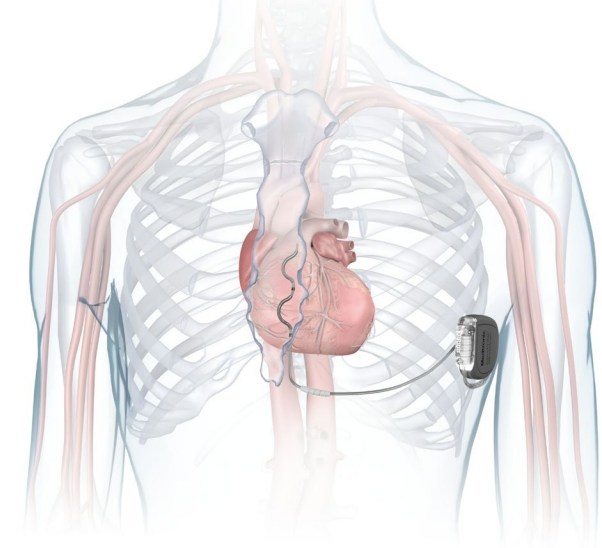
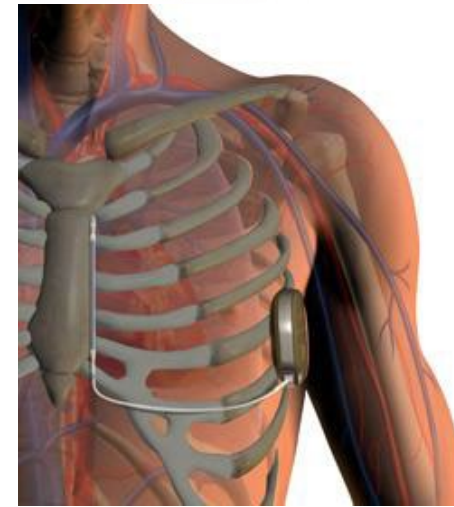
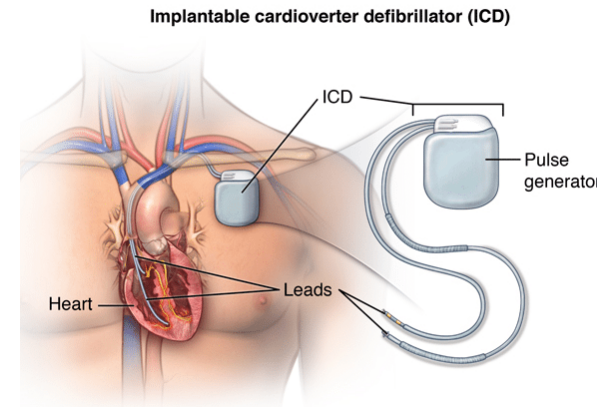
Leadless Pacemakers

- Medtronic Micra
 - RV implant only
 - Senses mechanical contraction of the atrium for AV synchrony
- Abbott Aveir
 - Dual chamber implant
 - Removable/exchanged at time of replacement
- Similar approach as ablations—catheter-based delivery from the R femoral vein
- Helpful for patients at high risk for infection, prior lead/device infections s/p extraction, vascular access issues (eg dialysis, ports), advanced age/dementia, young pts



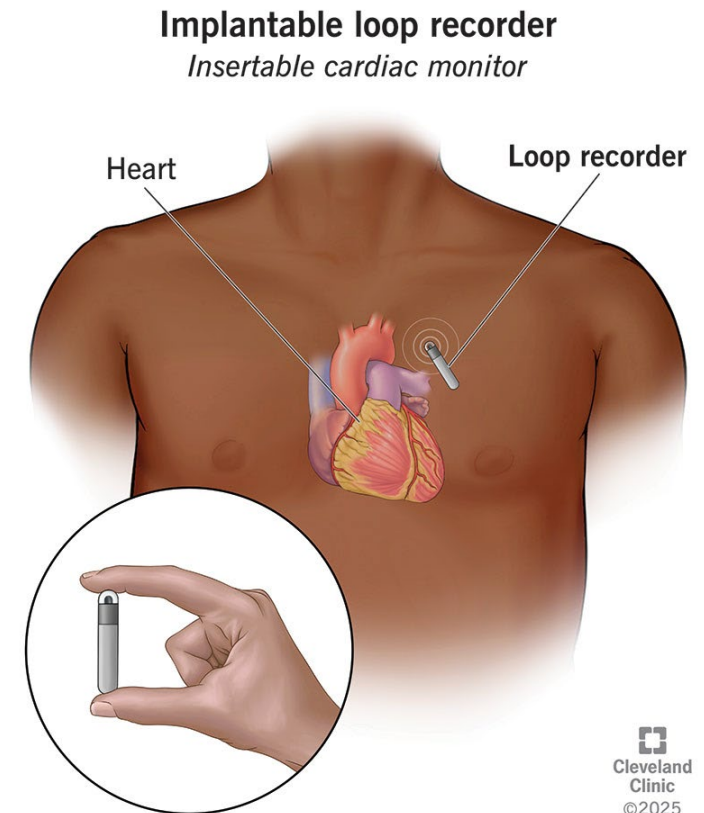
Defibrillators (ICDs)

- Similar to pacemakers, but intended to provide high energy shocks to terminate VT/VF
 - Transvenous devices can provide pacing
- Primary and Secondary prevention Indications
- Transvenous single chamber, dual chamber, biventricular devices
- Subcutaneous defibrillators (S-ICD)
- Extravascular defibrillators (EV-ICD)
- Wearable external defibrillator (LifeVest)



Implantable Loop Recorders (ILRs)

- Ambulatory monitoring devices inserted under the skin of the left chest for longterm arrhythmia monitoring (3-4 years)
- Indicated for evaluation of recurrent syncope, palpitations, or for occult AF in cryptogenic strokes in pts w/ unremarkable monitoring
- Quick, minimally invasive procedure done with local
- Similar monitoring process as with pacemakers
- ~10-15% AF detection rate at 6-12 mo, ~20% at 3 years



Main Take Aways

- EP is an evolving field with improving techniques and technology to treat arrhythmias more safely and effectively
- SVTs are very common and ablation is a good option for any patient with bothersome SVT
- More data to support aggressive treatment for AF including earlier rhythm control with catheter ablation
- Watchman implant remains a safe and effective alternative to anticoagulation for stroke risk reduction in AF, but patient selection and shared-decision making paramount
- Pacemaker techniques and technology continue to improve with widespread adoption of LBBAP and additional leadless pacing options
- Several defibrillator options exist, selection depending on clinical scenario
- Don't hesitate to refer directly to EP!

QUESTIONS?

Appointments and other inquiries:

Danbury

25 Germantown Road
Danbury, CT 06810
Phone: (203) 794-0090
Fax: (203) 830-4614
[Map & Directions](#)

Milford

20 Commerce Park
Milford, CT 06460
Phone: (203) 292-2000
Fax: (203) 255-5212
[Map & Directions](#)

Shelton

2 Ivy Brook Road, Suite 205
Shelton, CT 06484
Phone: (203) 292-2000
Fax: (203) 255-5212
[Map & Directions](#)

Trumbull (Silver Lane)

999 Silver Lane
Trumbull, CT 06611
Phone: (203) 292-2000
Fax: (203) 255-5212
[Map & Directions](#)

Fairfield

1305 Post Road
Fairfield, CT 06824
Phone: (203) 292-2000
Fax: (203) 255-5212
[Map & Directions](#)

Ridgefield

30 Prospect St. Ste 200
Ridgefield, CT 06877
Phone: (203) 438-9621
Fax: (203) 830-4614
[Map & Directions](#)

Trumbull (Park Ave.)

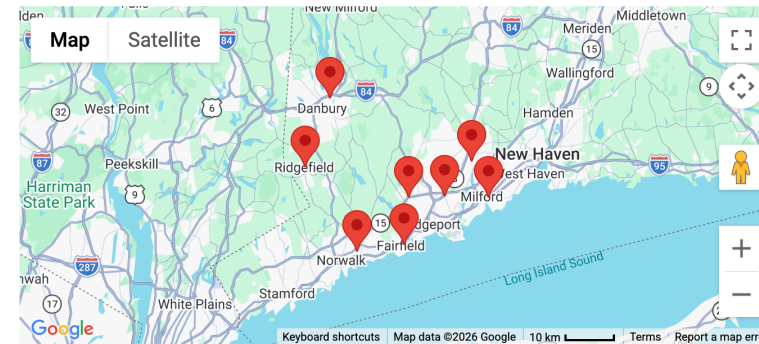
5520 Park Avenue
Trumbull, CT 06611
Phone: (203) 292-2000
Fax: (203) 255-5212
[Map & Directions](#)

Westport

327 Riverside Avenue
Westport, CT 06880
Phone: (203) 292-2000
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☐	TITLE	AUDIENCE SIZE	DATE CREATED	LAST RESPONSE	↑↓
☐	<i>Untitled question</i>	0	Jul 19, 2026 at 9:57pm	No responses	⋮
☐	What's the next step?	0	Jul 19, 2026 at 9:10pm	No responses	⋮
☐	What do you do next?	0	Jul 19, 2026 at 9:04pm	No responses	⋮
☐	What do you do?	0	Jul 19, 2026 at 8:54pm	No responses	⋮
☐	What's the next step?	0	Jul 19, 2026 at 8:43pm	No responses	⋮
☐	What's wrong with this ECG?	0	Jul 12, 2026 at 9:54pm	No responses	⋮
☐	<i>Untitled question</i>	0	Jul 12, 2026 at 9:54pm	No responses	⋮
☐	<i>Untitled question</i>	0	Jun 26, 2026 at 10:49am	No responses	⋮
☐	Who would you refer for Watchman?	0	Jun 24, 2026 at 4:26pm	No responses	⋮