HKCC
Certificate Course

Bradyarrhythmia: Diagnosis and Workup for Underlying Cause

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2 Dec 2018

Brady

- Definition
- Clinical Manifestation
- Causes
- Initial Evaluation
- Investigation

Types of Brady

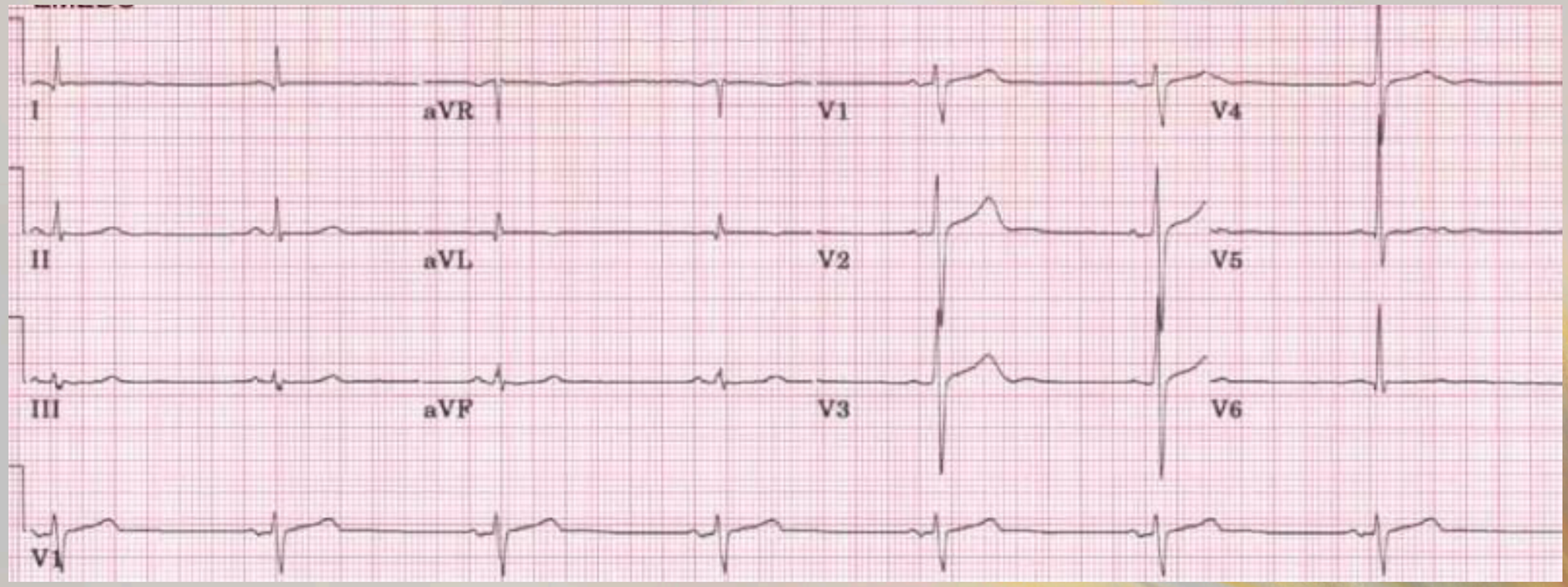
- Sinus node dysfunction (SND) and AV block

SND

AV block

Sinus node dysfunction

SND



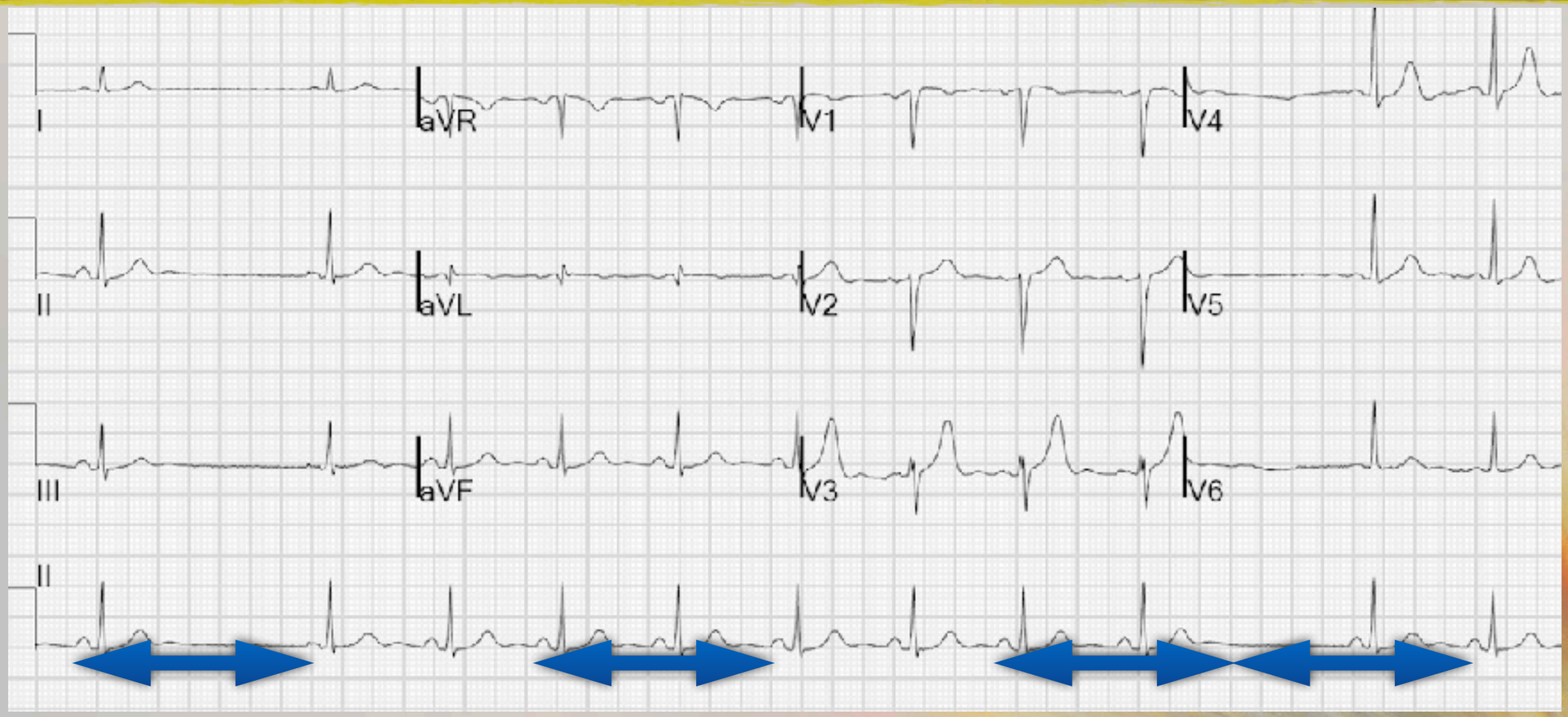
- Sinus bradycardia: regular P-wave followed by QRS at a rate of <50 bpm

Sinus node dysfunction

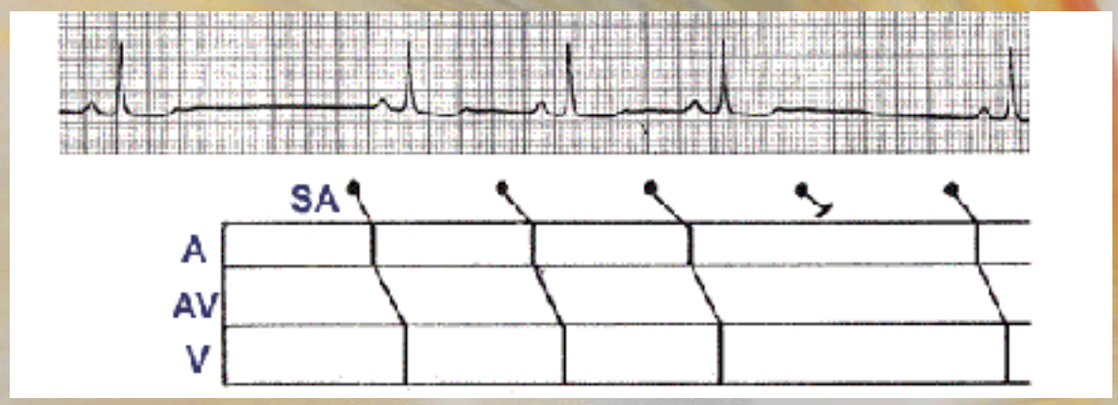
SND

- Sinus nodal pauses / arrest: long RR cycle length, longer than the RR interval of the underlying sinus rhythm.

SND



- Sinus nodal exit block: an absent P-wave and prolongation of the RR cycle length, usually twice the underlying sinus RR interval.



Sinus node dysfunction

SND

- Tachycardia-bradycardia syndrome: episodic periods of tachycardia (usually atrial flutter, atrial fibrillation, or atrial tachycardia), followed by termination of the tachycardia leading to sinus arrest or long sinus pauses, or followed by sinus bradycardia.

Definition

SND

- Sinus rate <50 bpm and/or a sinus pause >3 seconds as potential components

- *Chronotropic incompetence:*
  - failure to reach a target HR with exertion relative to expected for age that is inadequate to meet metabolic demand
  - 80% of the expected HR reserve
  - Expected HR reserve = age-predicted maximal HR (220 – age) - resting HR
  - 220 – 0.7 x age

Tanaka et al. Age-predicted maximal heart rate revisited. J Am Coll Cardiol. 2001;37:153-6
Ahmed HM et al. Med Sci Sports Exerc. 2017;49:1704-10.
Kusumoto FM et al. Cardiac pacing. N Engl J Med. 1996;334:89-97

AV block

AV block

First degree AV block

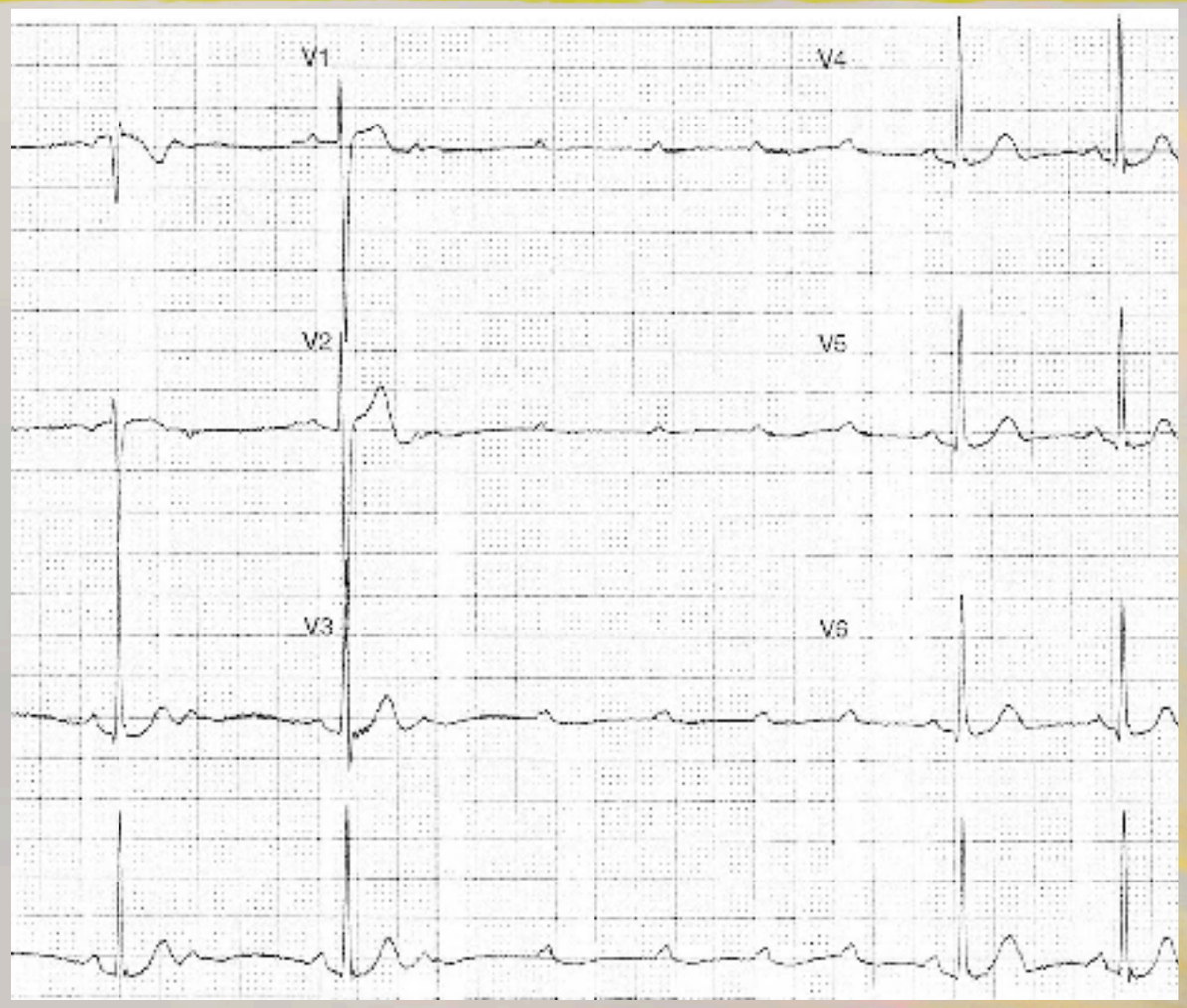
Second degree AV block (Mobitz I or Wenckebach)

Second degree AV block (Mobitz II)

Second degree AV block (2:1 block)

Third degree AV block with junctional escape

AV block



- Advanced, high-grade or high-degree atrioventricular block:
  - ≥2 consecutive P waves at a constant physiologic rate that do not conduct to the ventricles with evidence for some atrioventricular conduction

Clinical Manifestations

- Insidious symptoms to episodes of frank syncope
- Sinus bradycardia or atrial depolarization from a subsidiary pacemaker other than the sinus node (i.e., ectopic atrial rhythm, junctional rhythm, or ventricular escape), intermittent sinus pauses, or a blunted heart rate response with exercise (chronotropic incompetence)
- depend on whether the AV block is fixed or intermittent and the ventricular rate or duration of ventricular asystole associated with AV block
- depend on underlying cause and timing. eg, patients with vagally mediated AV block can be asymptomatic if the periods of AV block occur at night while sleeping when parasympathetic tone is increased

Clinical Manifestations

- Symptomatic bradycardia
  - Syncope
  - Presyncope
  - Transient dizziness
  - Lightheadedness
  - Heart failure symptoms
  - Confusion

Intrinsic causes

- Cardiomyopathy
- Congenital abnormalities
- Degenerative fibrosis
- Infections/inflammation
  - Chagas disease
  - Diphtheria
  - Infectious endocarditis
  - Lyme disease
  - Myocarditis
  - Sarcoidosis
  - Toxoplasmosis

Intrinsic causes

- Infiltrative disorders
  - Amyloidosis
  - Hemochromatosis
  - Lymphoma
- Ischaemia/infarction
- Rheumatological conditions
  - Rheumatoid arthritis
  - Scleroderma
  - Systemic lupus erythematosus
- Surgical or procedural trauma
  - Cardiac procedures such as ablation or cardiac catheterization
  - Congenital heart disease surgery
  - Septal myomectomy for HOCM
  - Valve surgery (including percutaneous valve replacement)

Extrinsic causes

- Autonomic perturbation
  - Carotid sinus hypersensitivity
  - Neurally-mediated syncope/presyncope
  - Physical conditioning
  - Situational syncope
    - Cough
    - Defecation
    - Glottic stimulation
    - Medical procedures
    - Micturition
    - Vomiting
  - Sleep (with or without sleep apnea)

Extrinsic causes

- Metabolic
  - Acidosis
  - Hyperkalemia
  - Hypokalemia
  - Hypothermia
  - Hypothyroidism
  - Hypoxia
  - Poisoning/overdose

Mangrum and DiMarco
Vogler et al.

Cause

Medications That Can Induce/Exacerbate Bradycardia or Conduction Disorders

Antihypertensive	Antiarrhythmic	Psychoactive	Other
Beta-blockers	Amiodarone	Donepezil	Anesthetic drugs
Clonidine	Dronedarone	Lithium	Cannabis
Methyldopa	Flecainide	Opioid analgesics	Digoxin
Calcium blockers	Sotalol	Phenothiazine	Ivabradine
		Phenytoin	
		SSRI	
		Tricyclic antidepressants	

Initial Evaluation

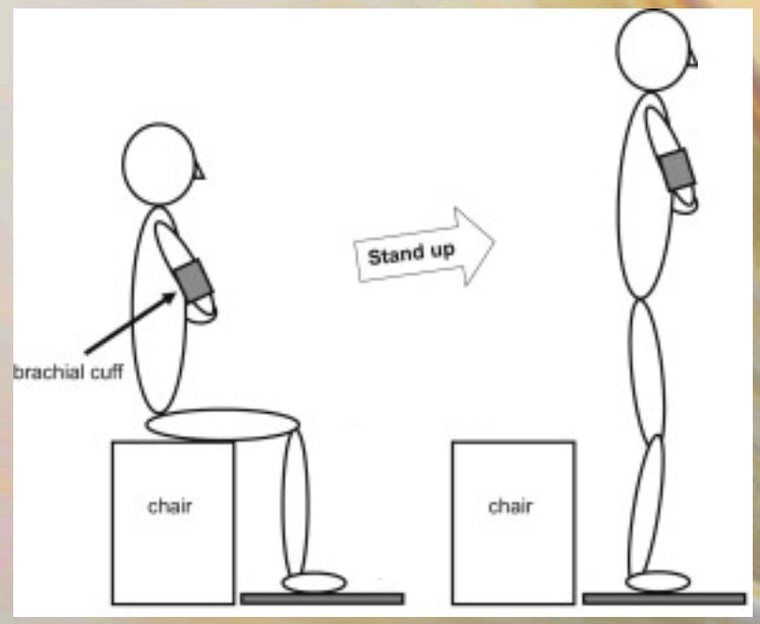
- History
- Frequency
- Timing
- Duration
- Severity
- Circumstances
- Triggers and alleviating factors
- Relationship to medications, meals, medical interventions, emotional distress, physical exertion, positional changes, and triggers (e.g., urination, defecation, cough, prolonged standing, shaving, tight collars, and head turning)

- Cardiovascular risk assessment, family history, travel history, and review of systems

Physical exam

- Signs of underlying structural heart disease
- Systemic disorders

- Postural BP/P
- Carotid massage

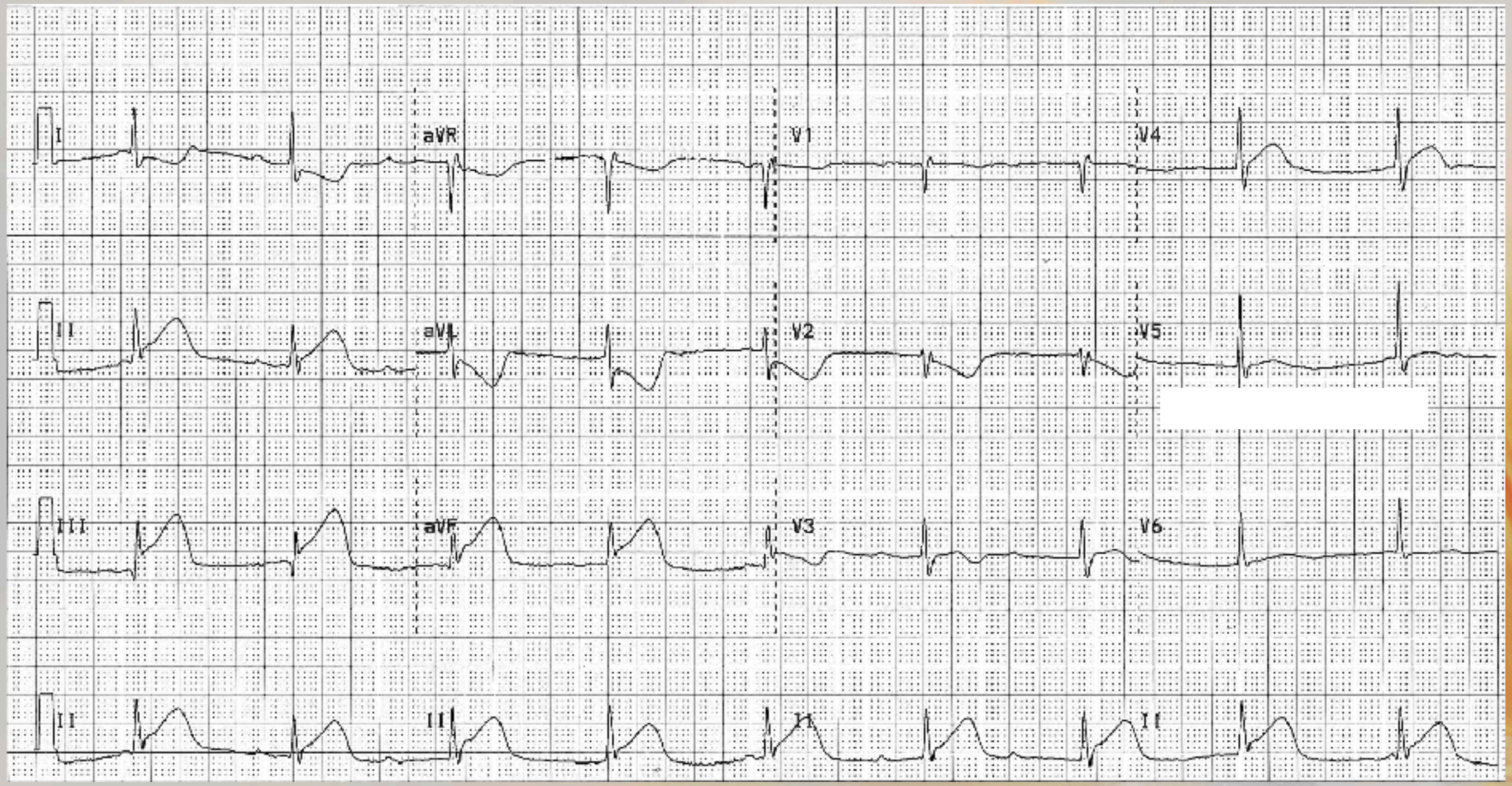


Blood test

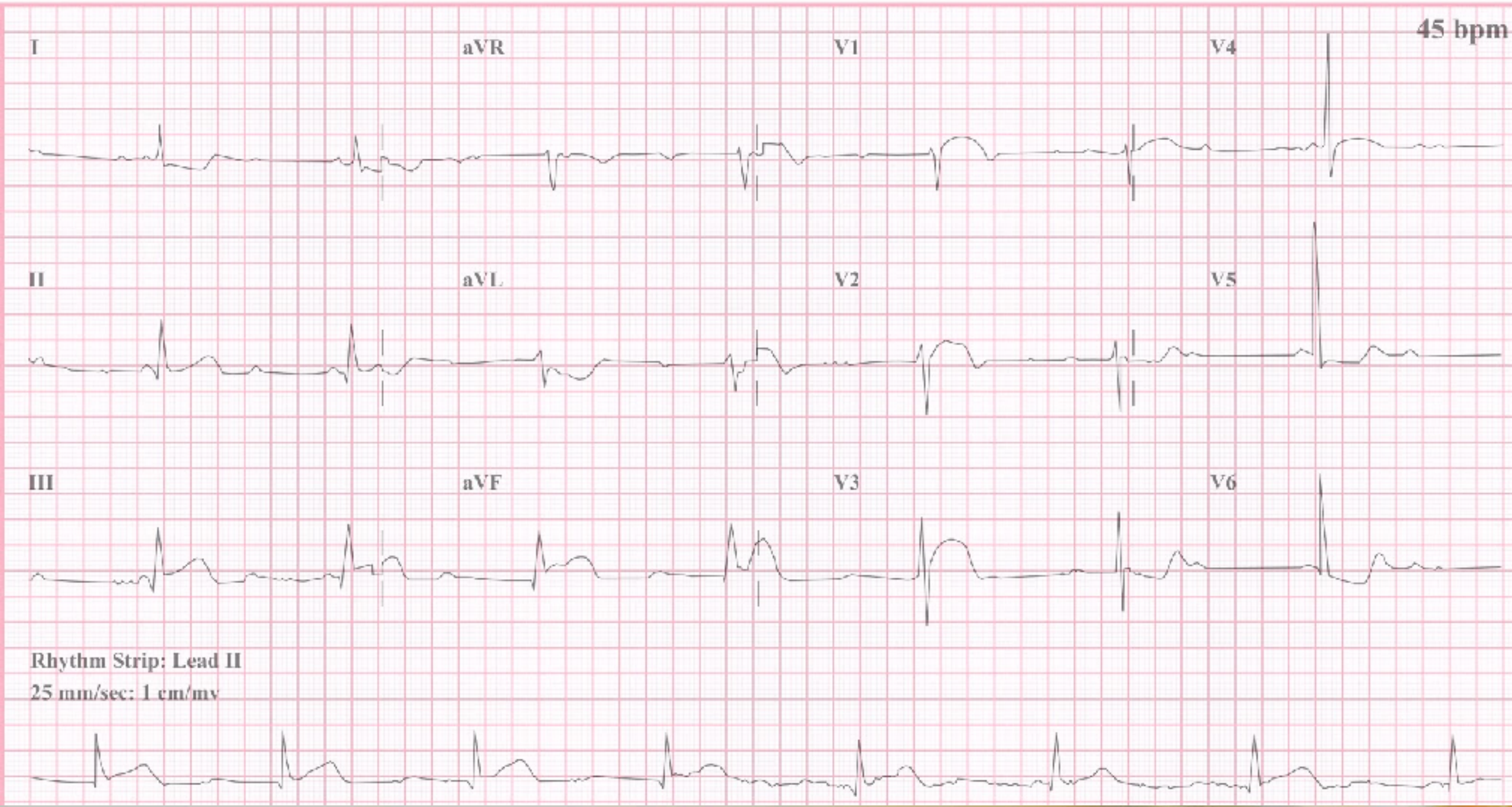
- Thyroid function tests
- Potassium
- pH

- Based on clinic suspicion

- F/70



inferior wall M.I. , third-degree AV block with a junctional escape rhythm.



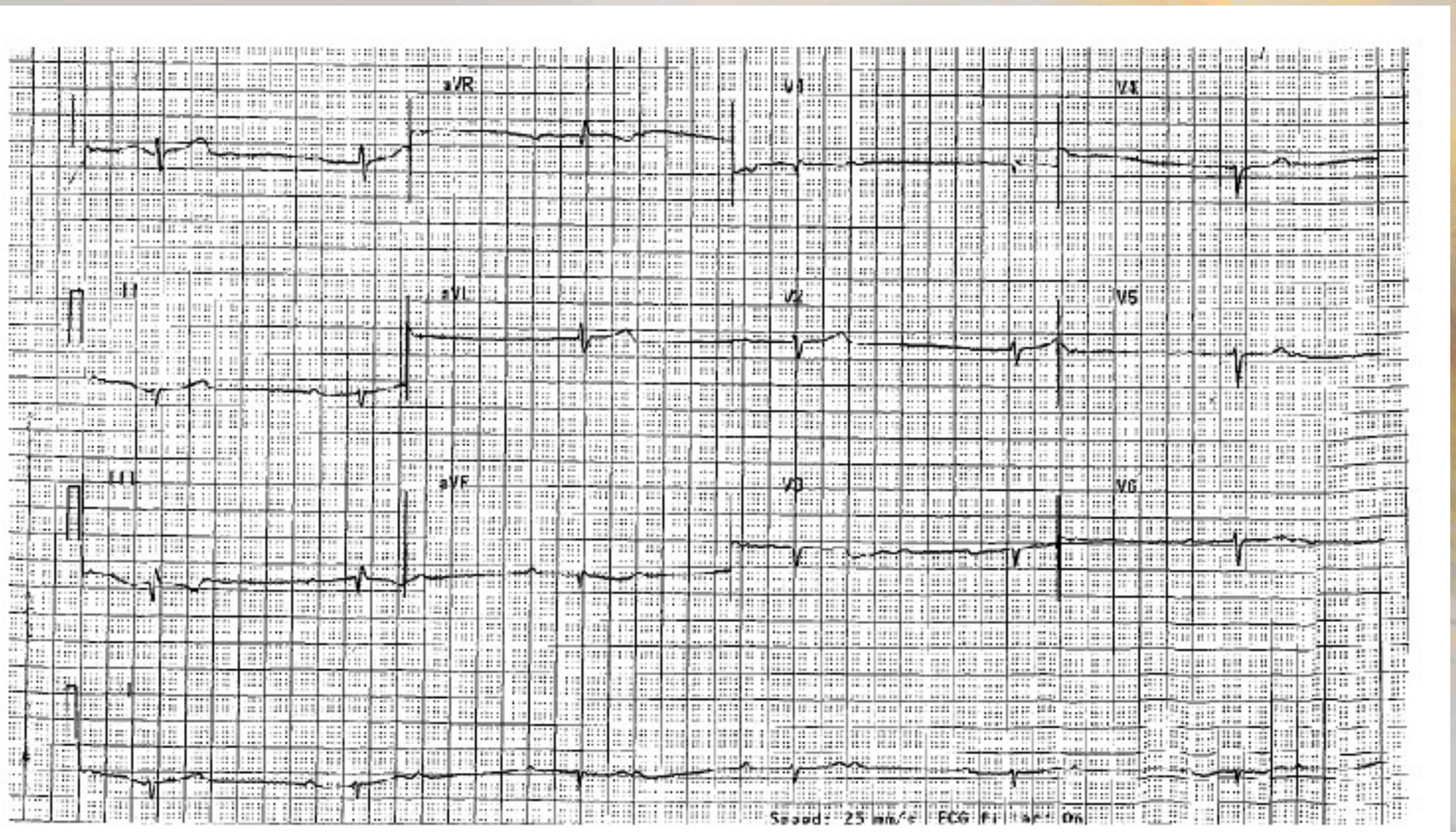
Acute Anterior MI with AV Dissociation

Ischaemic

- Transient vs nonreversible SND/AV block in acute MI
- Inf MI
  - Transient increase in vagal tone or decreased blood supply to the AV node or less commonly the sinus node
- Temporary pacing does not by itself constitute an indication for permanent pacing.
- Long-term prognosis for survivors of MI who have had AV block is related primarily to the extent of myocardial injury and the character of intraventricular conduction disturbances rather than the AV block itself
- Ant MI - poorer prognosis

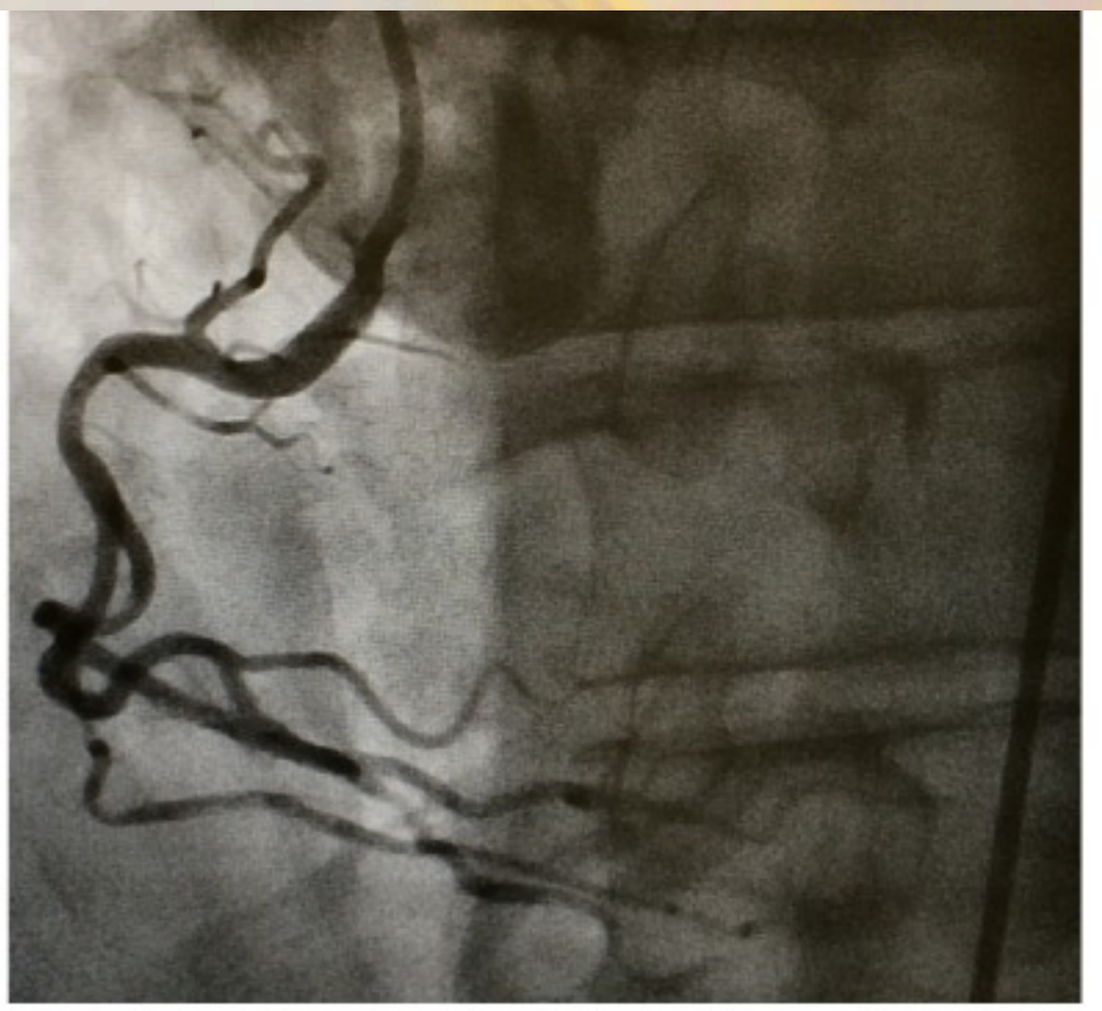
Case

- M/85 old inf MI for years with EF 40%
- p/w 1 week of lightheadedness
- Previously, symptoms of stable angina were well controlled with medication

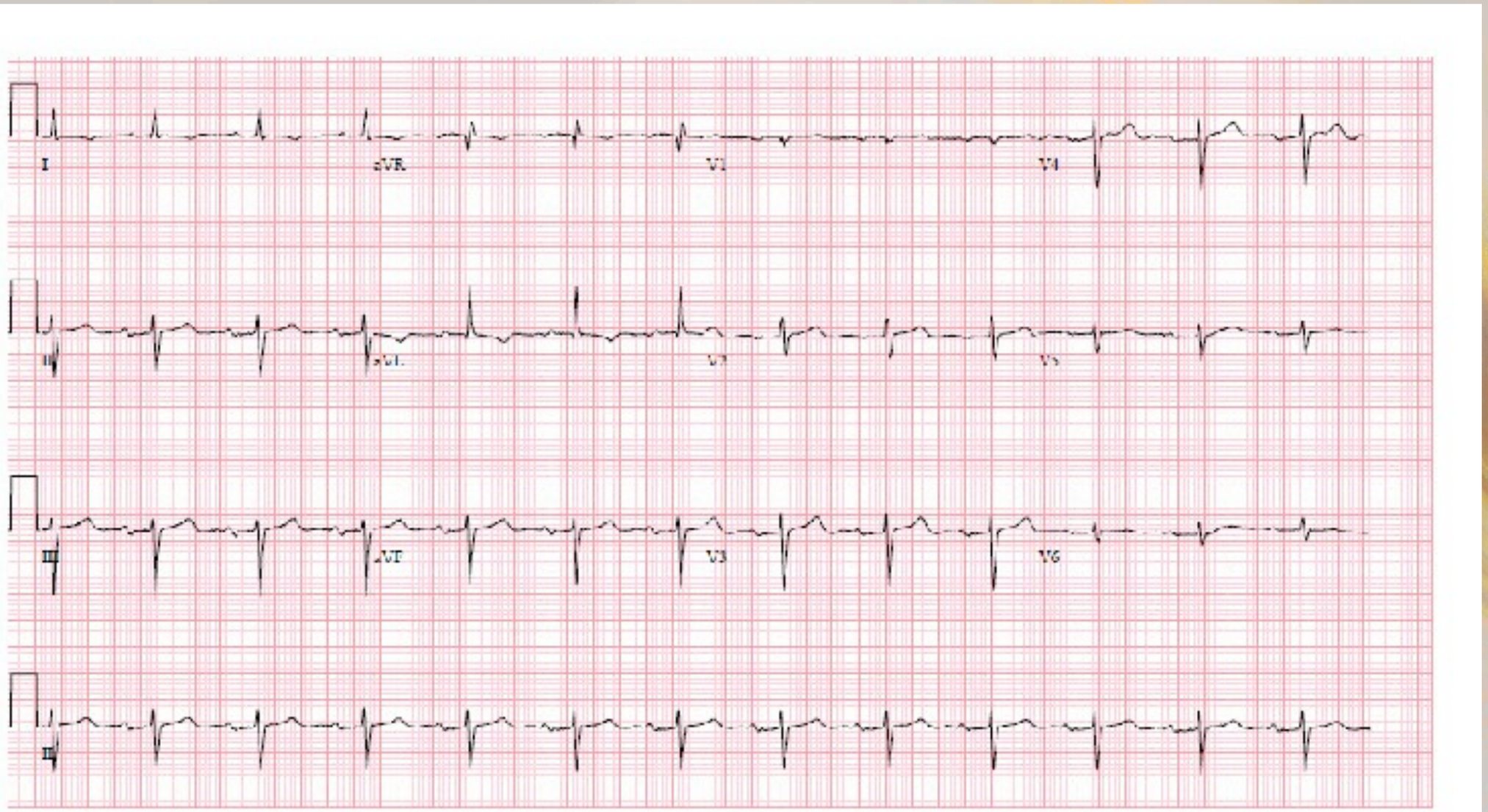


Cardoso R, et al. Case Rep Cardiol. 2016

- RCA 80% ostial stenosis
- PCI performed

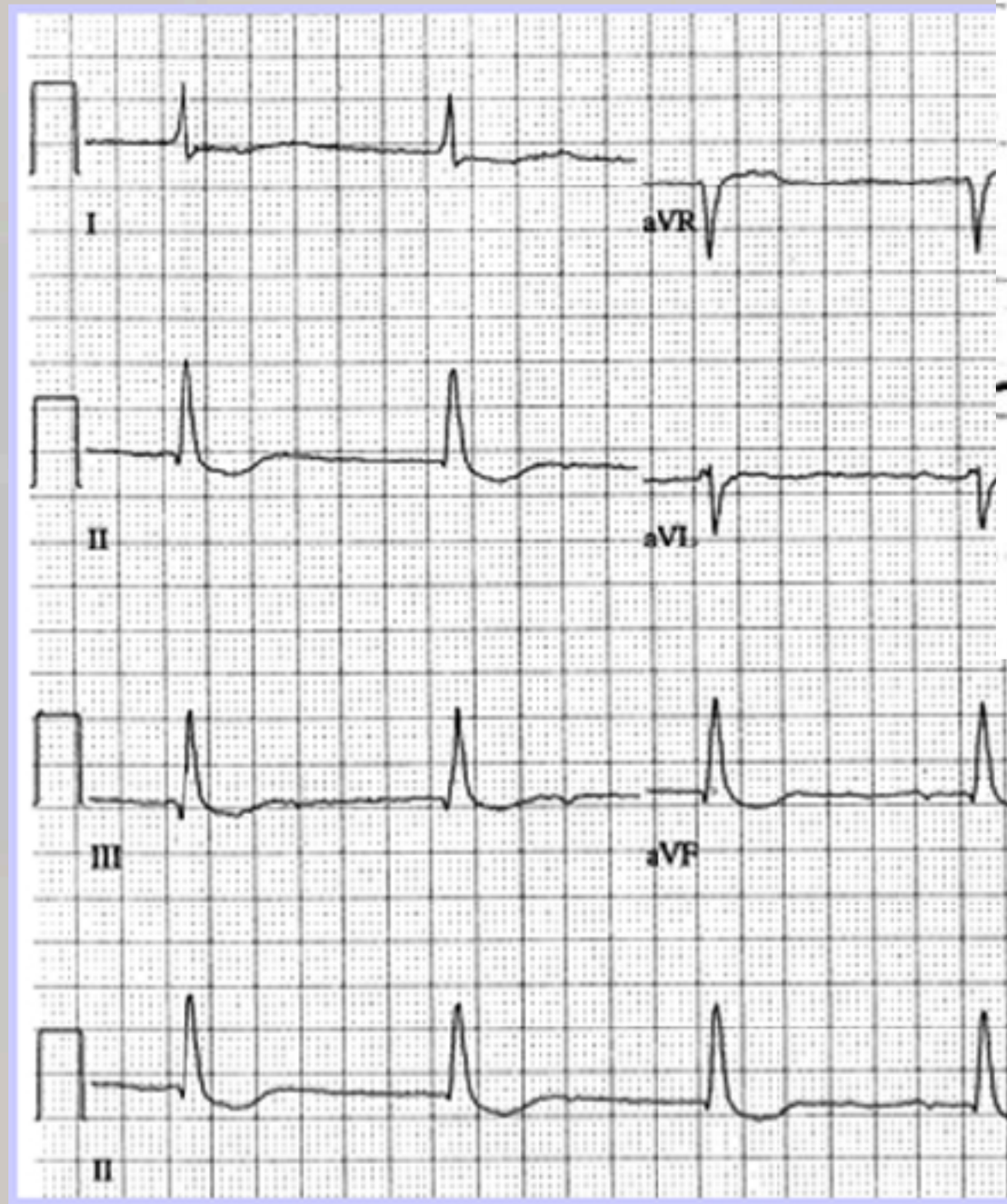


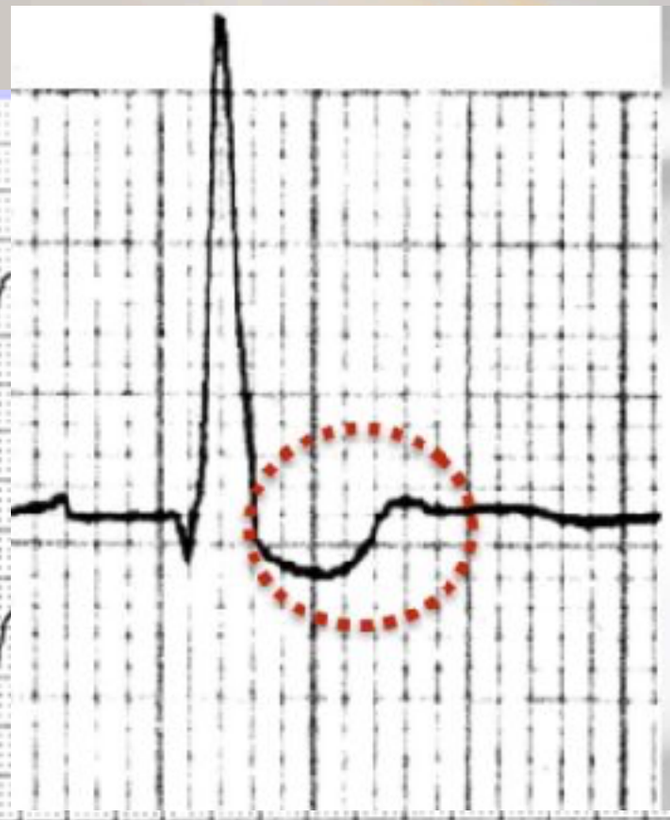
- Upon revascularization, immediately reverted to 1 : 1 AV conduction

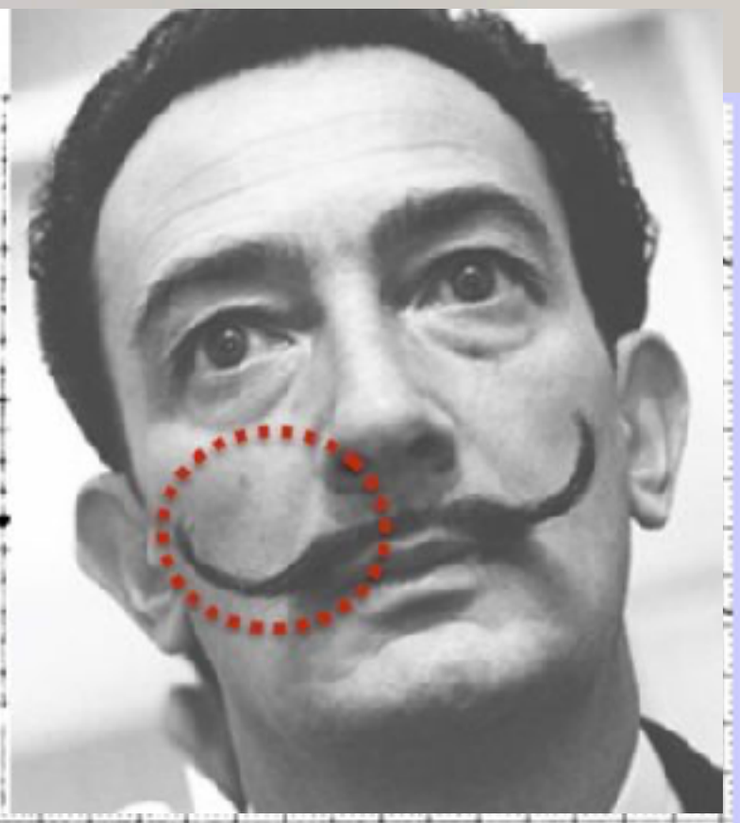


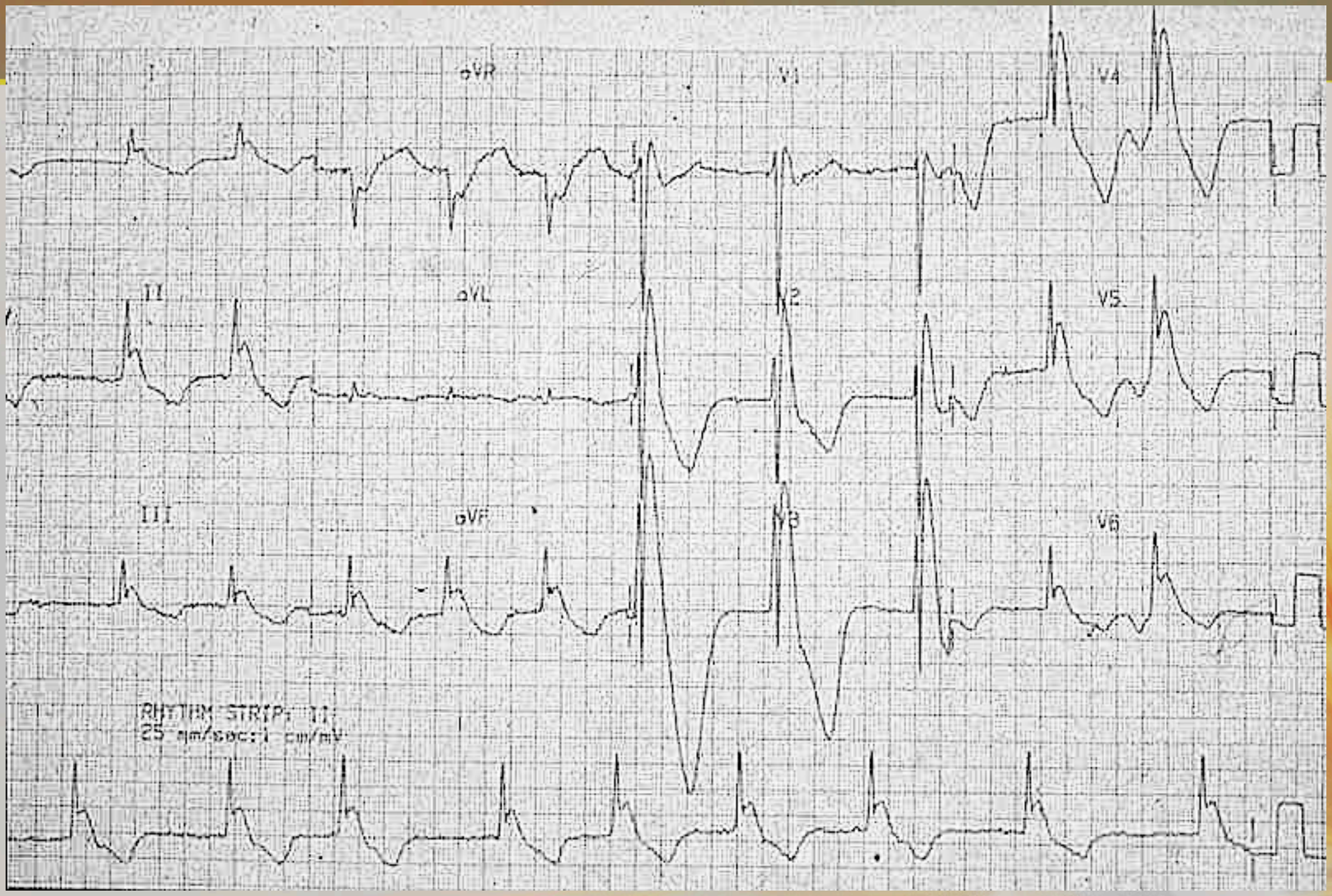
Cardoso R, et al. Case Rep Cardiol. 2016

56-year-old man with PMHx of atrial fibrillation presents with generalized weakness and near-syncope



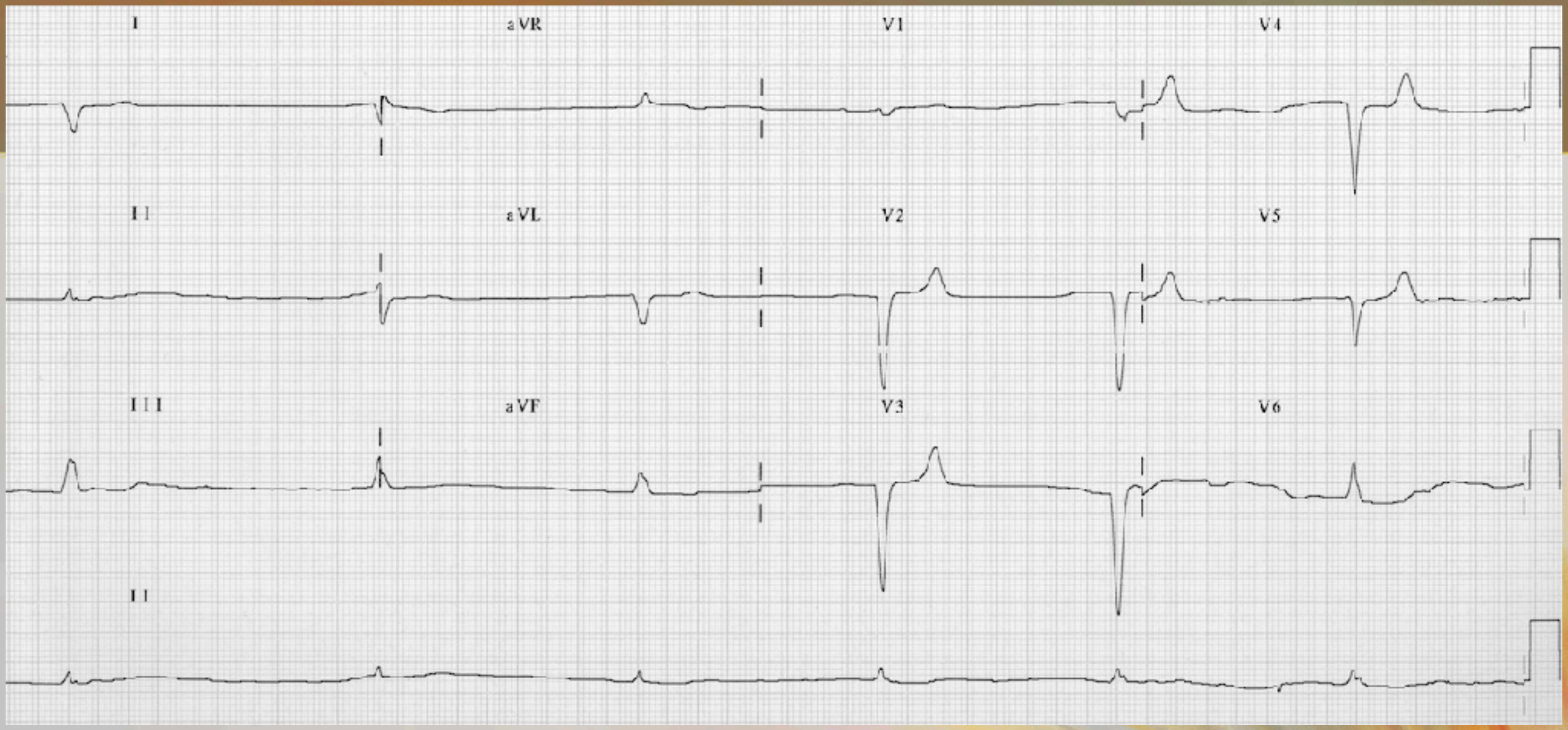





aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
RHYTHM STRIP: II
25 mm/sec; 1 cm/mV

Hypothermia

- Bradyarrhythmias
  - Sinus bradycardia (may be marked)
  - Atrial fibrillation with slow ventricular response
  - Slow junctional rhythms
  - Varying degrees of AV block (1st-3rd)
- Osborne Waves (= J waves)
  - positive deflection at the J point (negative in aVR and V1)
  - usually most prominent in the precordial leads
- Prolonged PR, QRS and QT intervals
- Shivering artefact
- Ventricular ectopics
- Cardiac arrest due to VT, VF or asystole



- Slow junctional
- Intravent conduction delay
- Peaked T
- Prolong PR
- ->Hyperkalaemia

ECG

- Intermittent -> more prolonged form of ECG monitoring
- Correlate rhythm disturbances with symptoms
- Daily symptoms - 24- or 48-hour Holter
- may help identify the presence or absence of chronotropic incompetence
- Less frequent symptoms
  - Event recorder, external loop recorder, ILR

Holter

- Distinguish the location of the block (i.e., AV node versus His-Purkinje system) in 2:1 and high-degree AV block
- A long-monitored strip should be run because 2:1 AV block is unlikely to persist
- Other forms of AV block (Mobitz I or II) should then become apparent
- Monitoring while the patient does some form of exertion (e.g., arm exercise, standing, and walking) may also help to demonstrate the level of block
- Block at the level of the AV node should improve with the adrenergic stimulation
- Block below the AV node in the His-Purkinje system may worsen as AV nodal conduction improves and increases the frequency of inputs to the His-Purkinje system.

Imaging

- No direct diagnostic role for bradycardia
- Underlying heart disease
- Reduced left ventricular systolic function -> ICD

COR	LOE	Recommendations
I	B-NR	1. In patients with newly identified LBBB, second-degree Mobitz type II atrioventricular block, high-grade atrioventricular block, or third-degree atrioventricular block with or without apparent structural heart disease or coronary artery disease, transthoracic echocardiography is recommended (S4.2.4-1–S4.2.4-10).
IIa	B-NR	2. In selected patients presenting with bradycardia or conduction disorders other than LBBB, second-degree Mobitz type II atrioventricular block, high-grade atrioventricular block, or third-degree atrioventricular block, transthoracic echocardiography is reasonable if structural heart disease is suspected (S4.2.4-3, S4.2.4-11–S4.2.4-13).
IIa	C-LD	3. In selected patients with bradycardia or bundle branch block, disease-specific advanced imaging (e.g., transesophageal echocardiography, computed tomography, cardiac magnetic resonance imaging [MRI], or nuclear imaging) is reasonable if structural heart disease is suspected yet not confirmed by other diagnostic modalities (S4.2.4-14–S4.2.4-22).

Kusumoto FM, et al. Circulation 2018

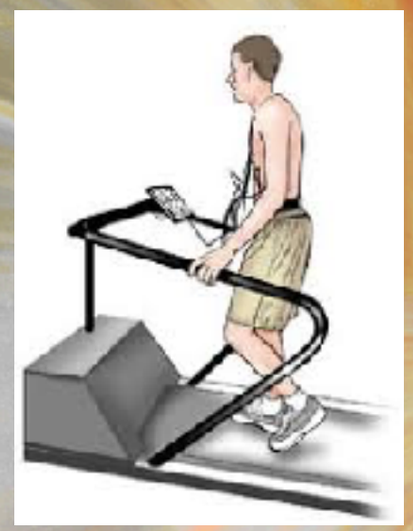
Sleep study

- Nocturnal bradyarrhythmias are common in both health and disease
- Sinus bradycardia is the most common bradyarrhythmia encountered during sleep
- Sinus arrest, sinus exit block, all degrees of atrioventricular block, junctional rhythm, and periods of asystole also occur on occasion
- Sleep apnea syndrome -> higher prevalence of sleep-related bradycardia and conduction disorders (primarily during apneic episodes)
- Episodes is decreased with continuous positive airway pressure
- Treating the underlying sleep apnea
  - alleviates apnea-related symptoms
  - improves cardiovascular outcome
  - eliminates the need for pacemaker implantation

Harbison J, et al. Chest. 2000;118:591-5.

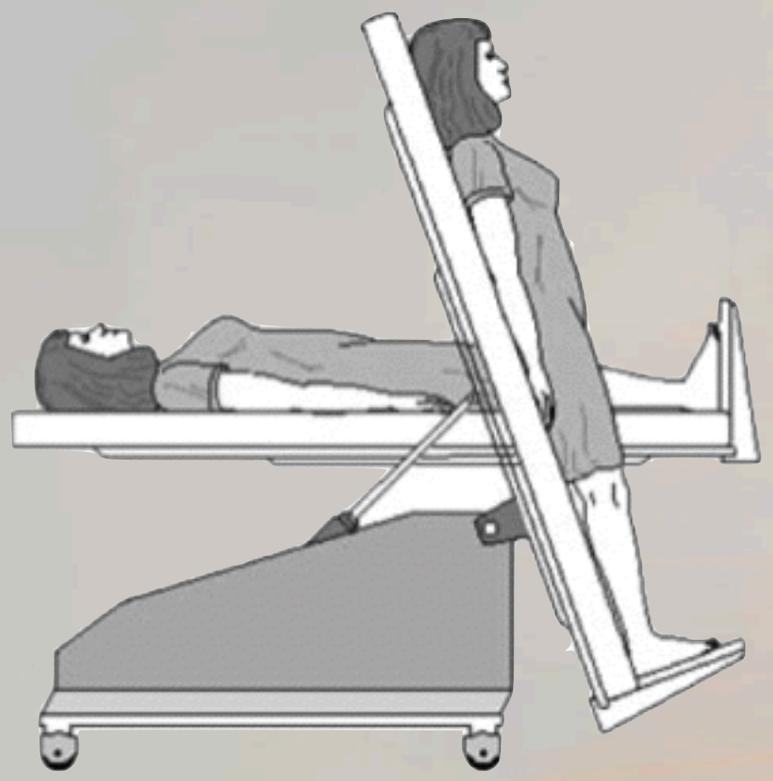
Exercise testing

- A subnormal increase in heart rate after exercise (chronotropic incompetence) can be useful in diagnosing SSS.
- Exercise-induced AV block, even if asymptomatic, can be significant and suggests disease of the His-Purkinje system.
- Useful in determining level of block in second-degree AV block.
- Useful for exercise-induced symptoms where AV block is suspected.



Tilt-table testing

- Evaluate adequacy of the autonomic system
- esp suspicion of neurocardiogenic syncope
- Head-upright tilting, which causes dependent venous pooling and thereby provokes the autonomic response.



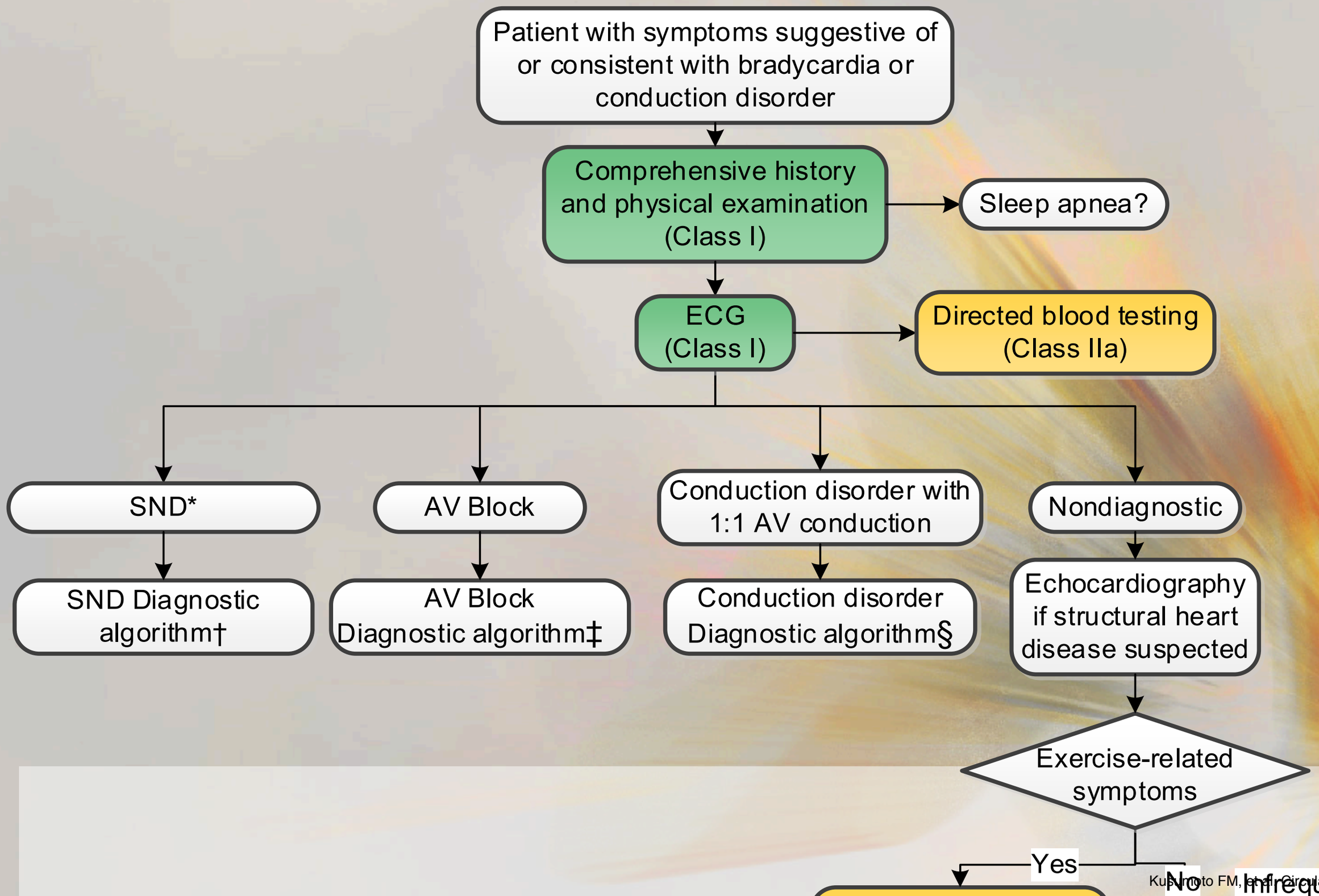
EPS

- Bradyarrhythmias are suspected but cannot be diagnosed by noninvasive modalities.
- Little utility in documented second- and third-degree AV block
- AV block and no clear symptom association; in patients with symptoms of bradycardia in whom AV block is suspected but not documented; and when the site of AV block cannot be determined reliably by surface tracings.
- His-ventricle interval of >70-100ms, even in the absence of symptoms, is a high-risk finding.
- Low sensitivity and specificity. Positive findings may not be the reason for patient symptoms.
- May be used if severe sinus node dysfunction is suspected but cannot be documented.
- Atrial pacing at progressively shorter cycle lengths during an electrophysiology study can manifest Mobitz type I in subjects with normal or abnormal AV node conduction.
- Asymptomatic patients with Mobitz II AV block may benefit from this test to localize the site of block and to guide therapy.
- Useful to demonstrate the location of the block (i.e., AV node versus His-Purkinje system) in 2:1 and high-degree AV block.

COR	LOE	Recommendation
IIb	C-LD	1. **In patients with symptoms suspected to be attributable to bradycardia, an electrophysiology study (EPS) may be considered in selected patients for diagnosis of, and elucidation of bradycardia mechanism, if initial noninvasive evaluation is nondiagnostic (S4.3.2-1–S4.3.2-5).**

Krol RB, et al. J Am Coll Cardiol. 1987;10:358-63.

Evaluation of Bradycardia Algorithm



Kusumoto FM, et al. Circulation. 2018

c

AV Block
Diagnostic algorithm‡

Conduction disorder
Diagnostic algorithm§

Echocardiography if structural heart disease suspected

Exercise-related symptoms

Yes

No

Exercise ECG testing (Class IIa)

Infrequent Symptoms (>30 days)

ICM (Class IIa)

Abnormal

Normal

Ambulatory ECG monitoring‖ (Class I)

Significant arrythmias

No significant arrhythmias

SND

AV Block

Conduction disorder with 1:1 AV conduction

Observation

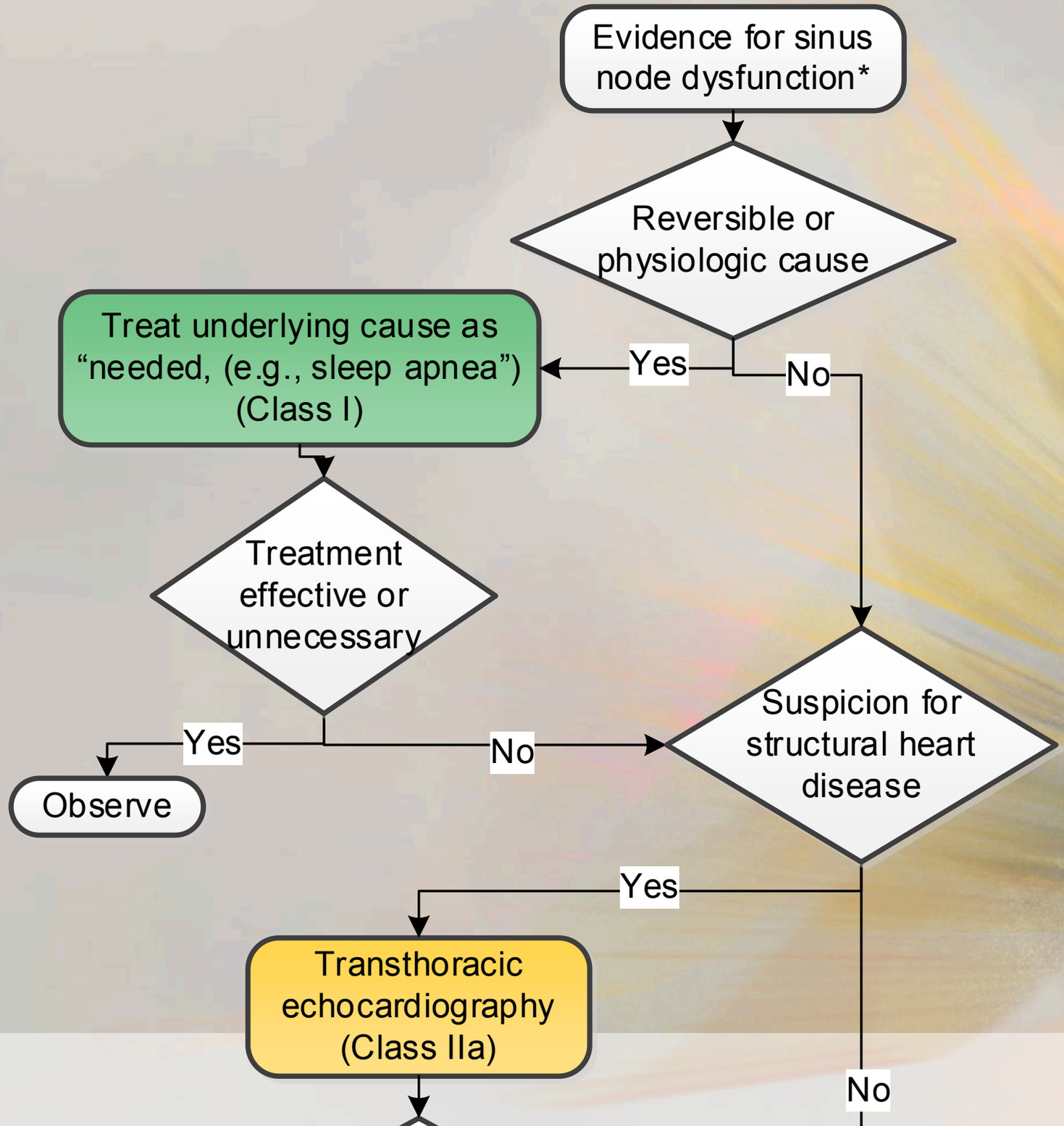
SND Diagnostic algorithm†

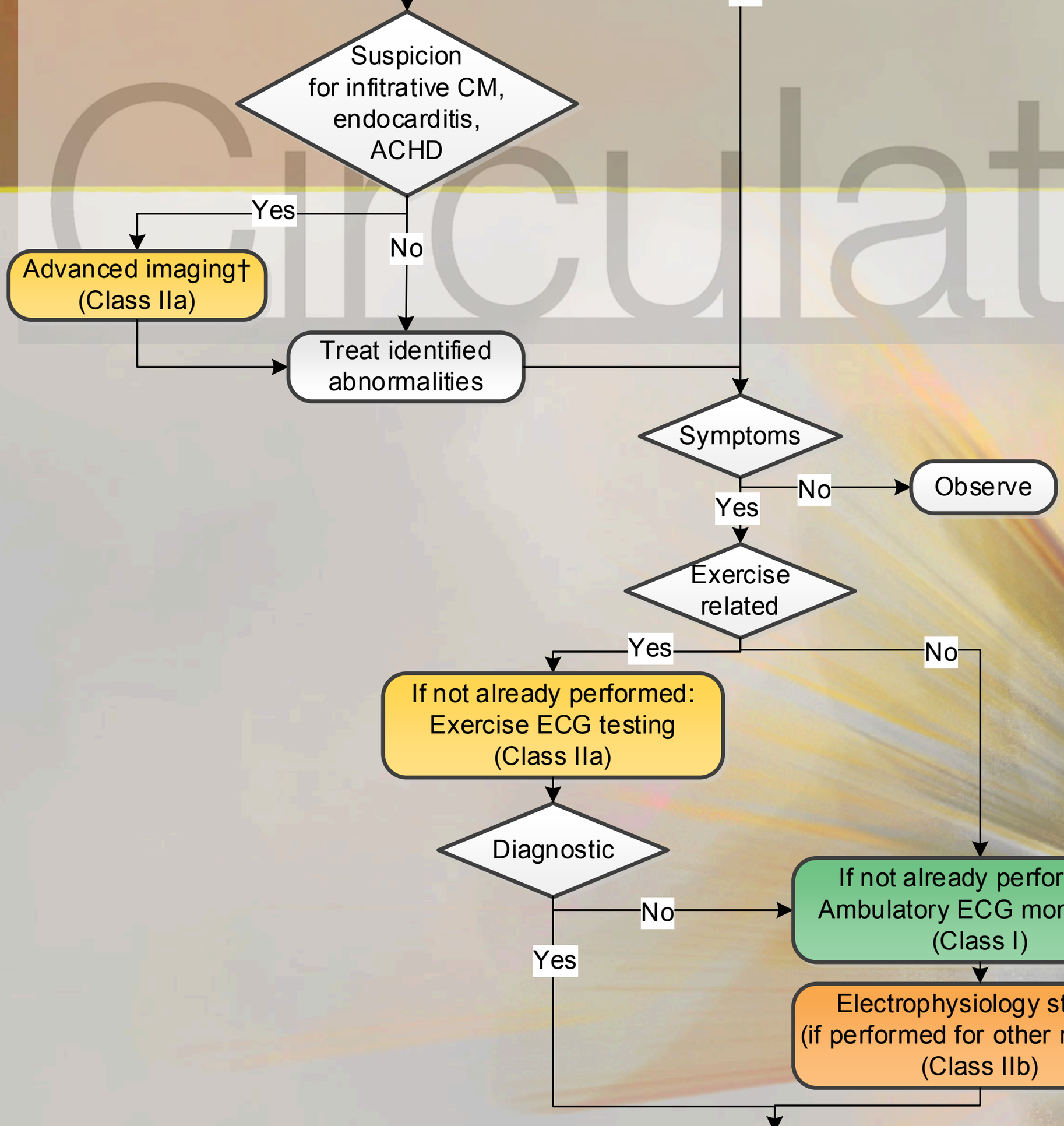
AV Block
Diagnostic algorithm‡

Conduction disorder
Diagnostic algorithm§

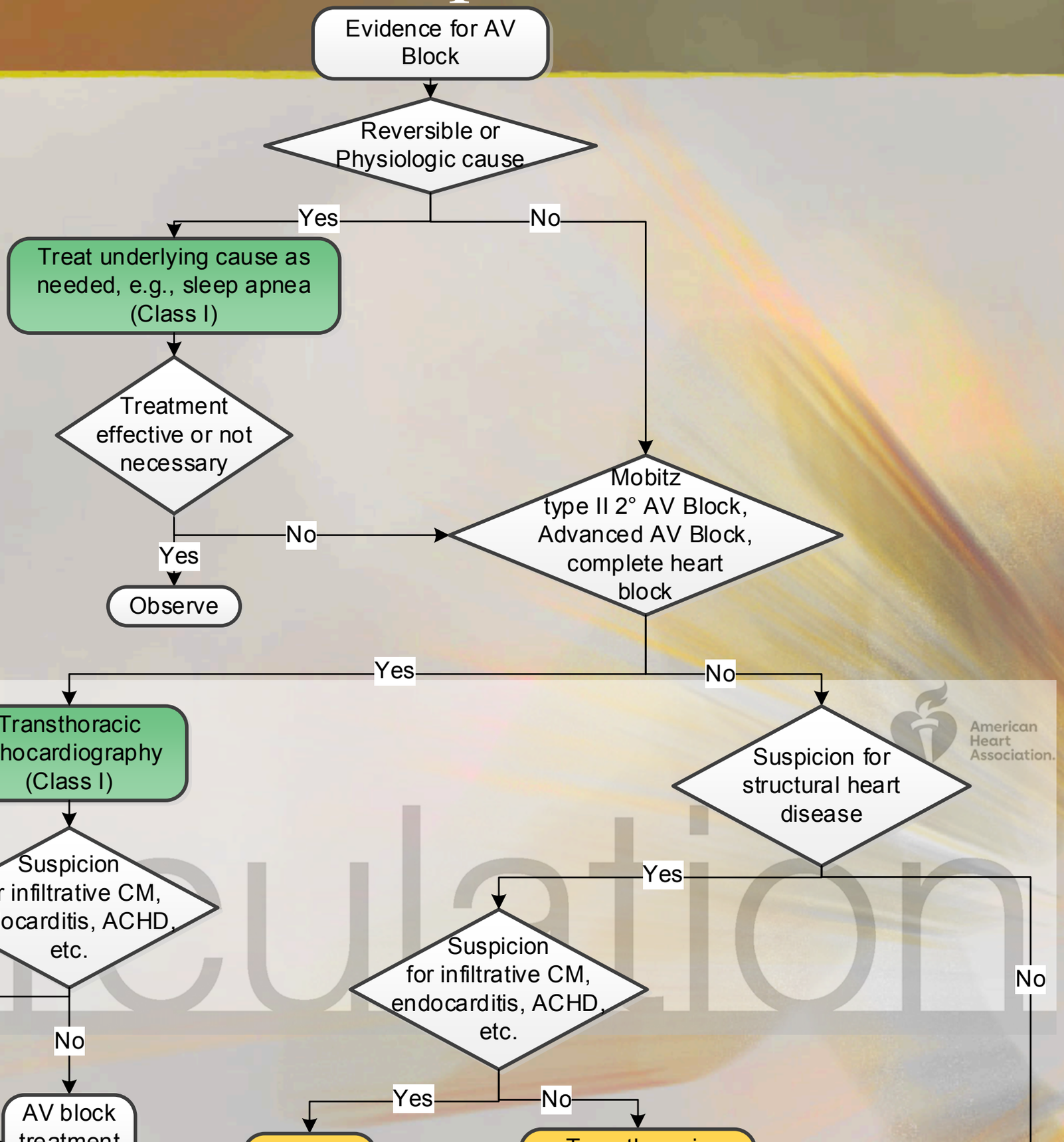
Continued concern for bradycardia?

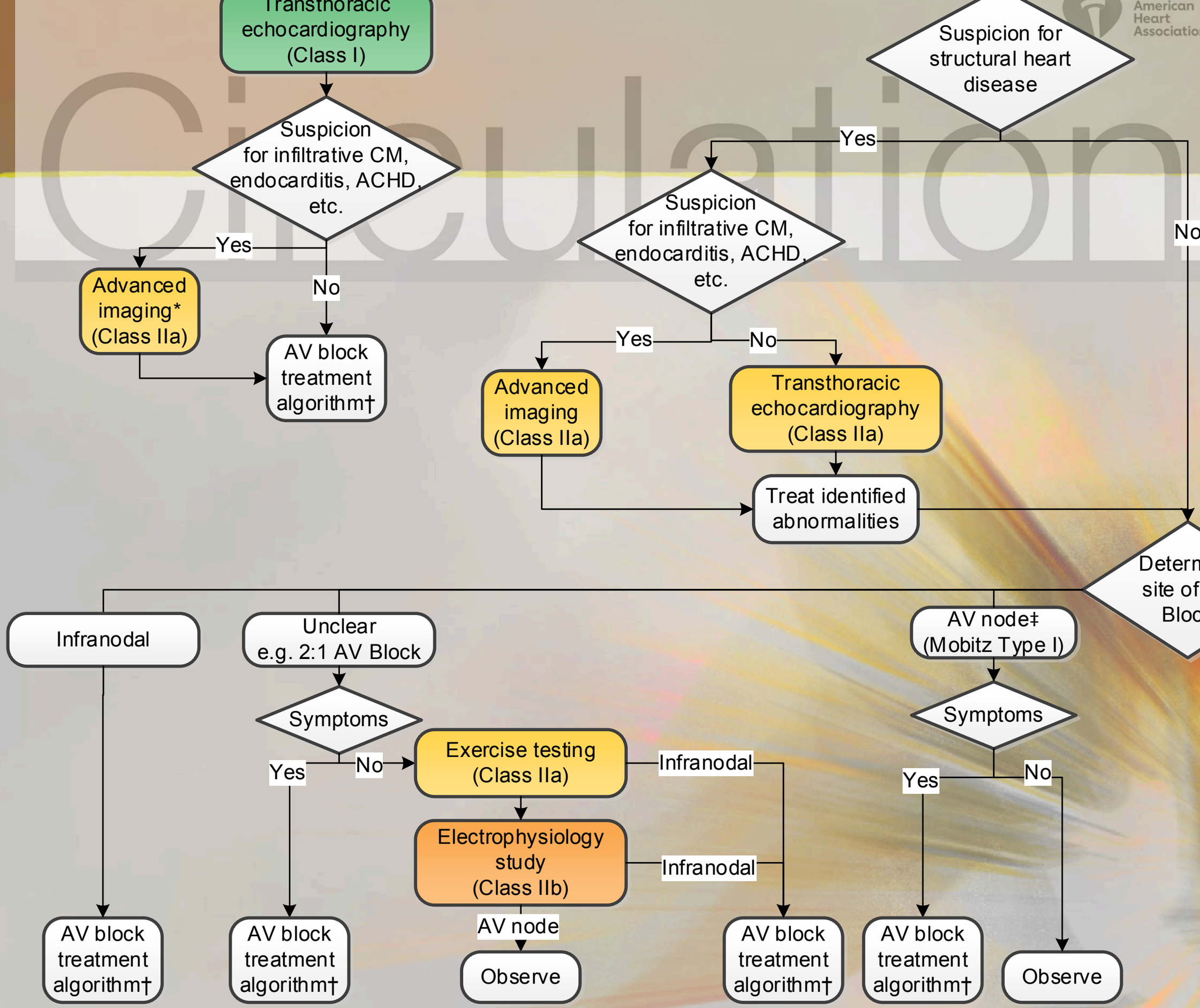
Initial Evaluation of Suspected or Documented SND




Suspicion for infitrative CM, endocarditis, ACHD
Yes
No
Advanced imaging† (Class IIa)
Treat identified abnormalities
Symptoms
No
Observe
Yes
Exercise related
Yes
No
If not already performed: Exercise ECG testing (Class IIa)
Diagnostic
No
Yes
If not already performed: Ambulatory ECG monitoring (Class I)
Electrophysiology study† (if performed for other reasons) (Class IIb)

Initial Evaluation of Suspected AV Block





Conclusion

- History is important especially drug history
- 12lead ECG to look for clue
- Correlate ECG (+/- prolonged monitoring) with symptoms
- Investigate for underlying cause (blood test, echo)