Arrhythmia 341

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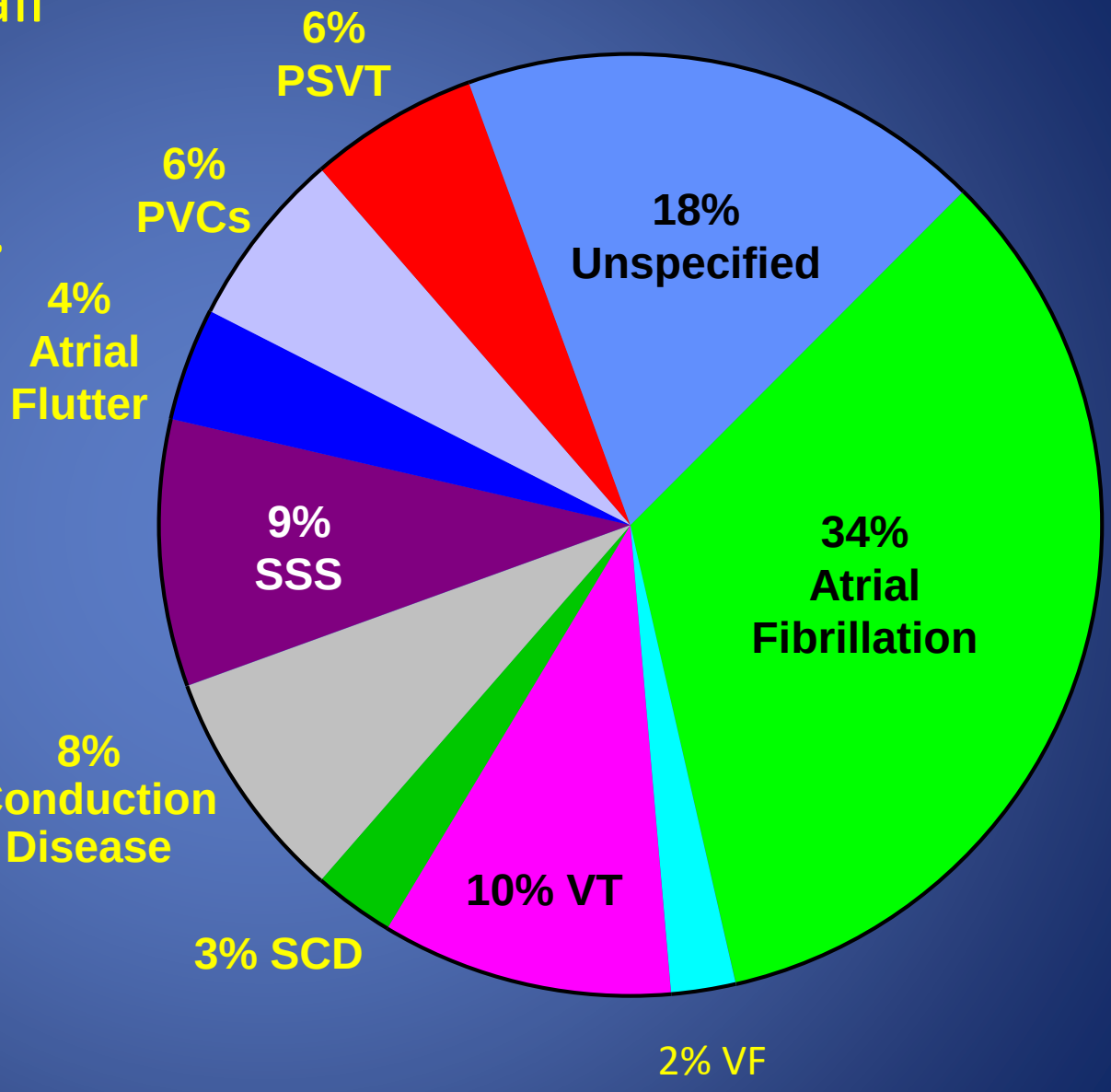
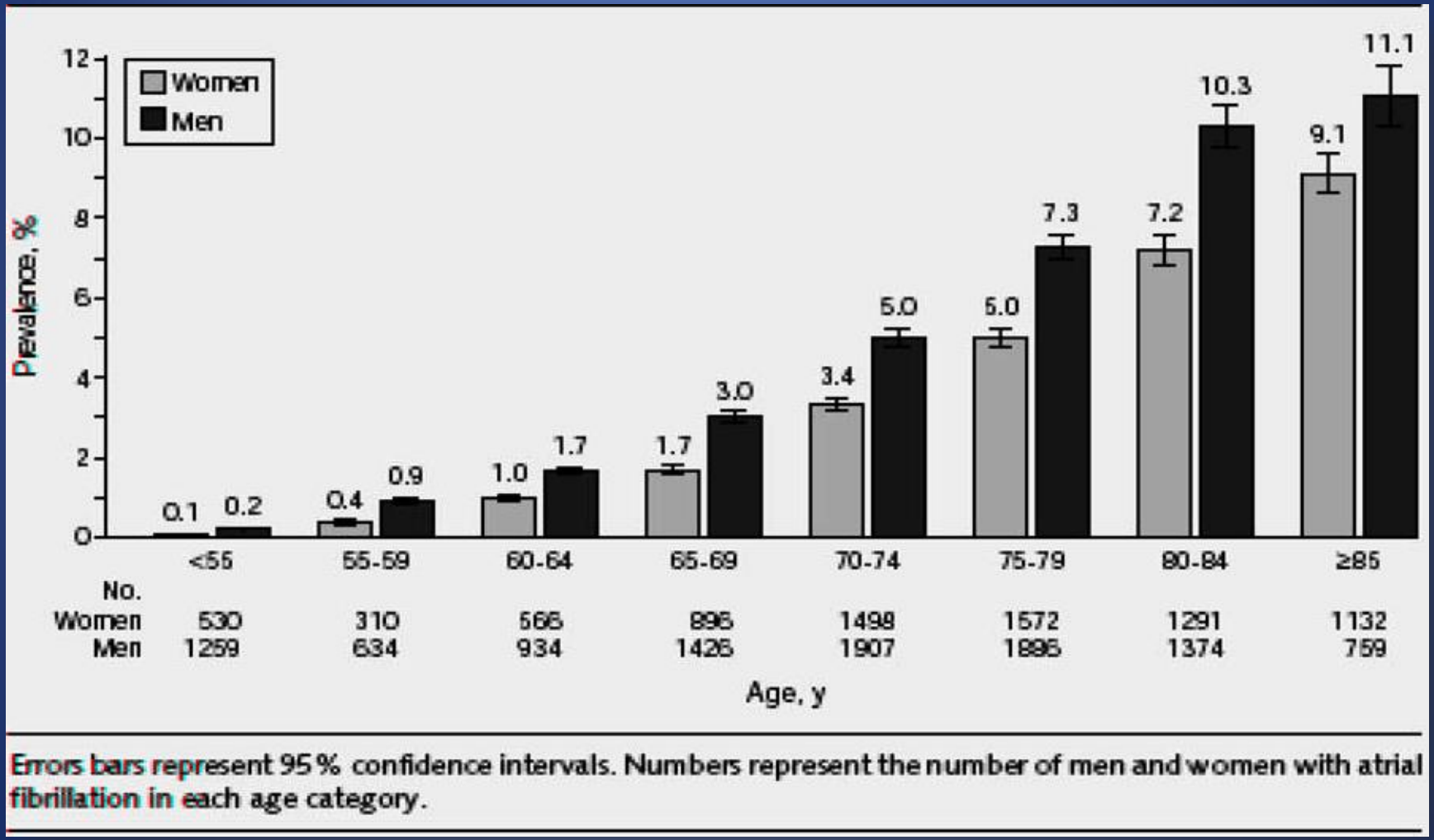
Objectives

- Epidemiology and Mechanisms of AF
- Evaluation of AF patients
- Classification of AF
- Treatment and Risk stratification of AF
- Identify other forms of Arrhythmia

Atrial fibrillation accounts for 1/3 of all patient discharges with arrhythmia as principal diagnosis.



AF Prevalence in US Population

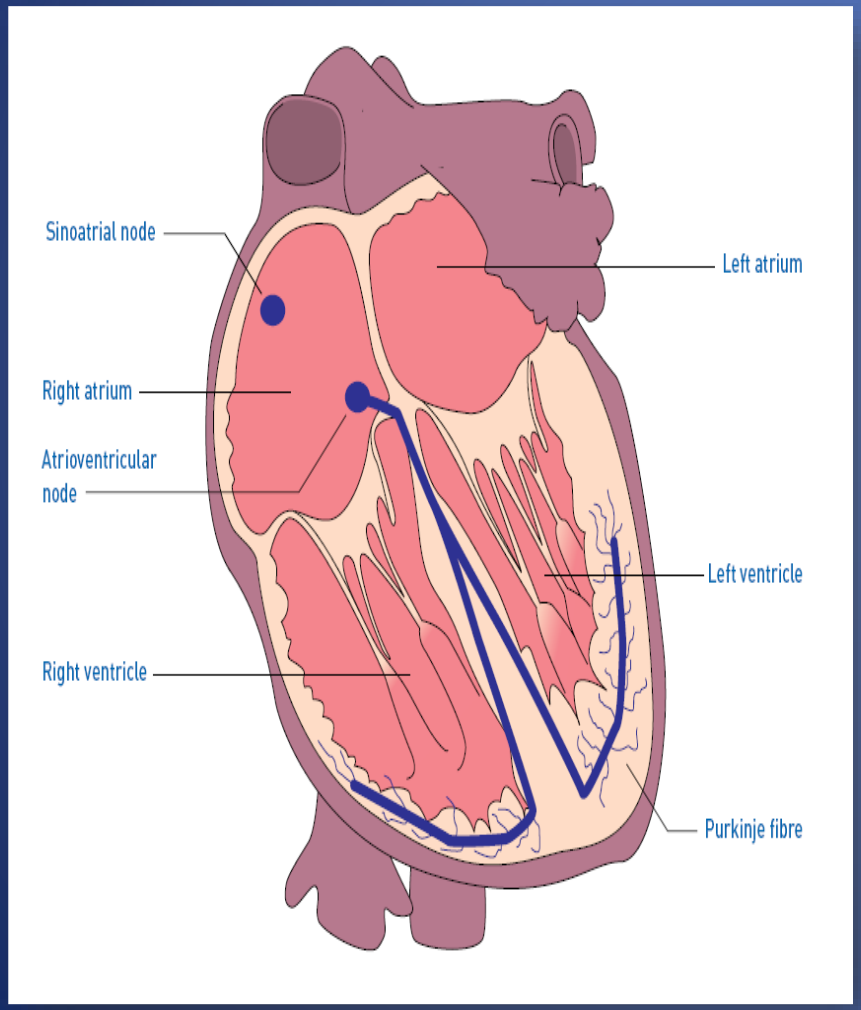


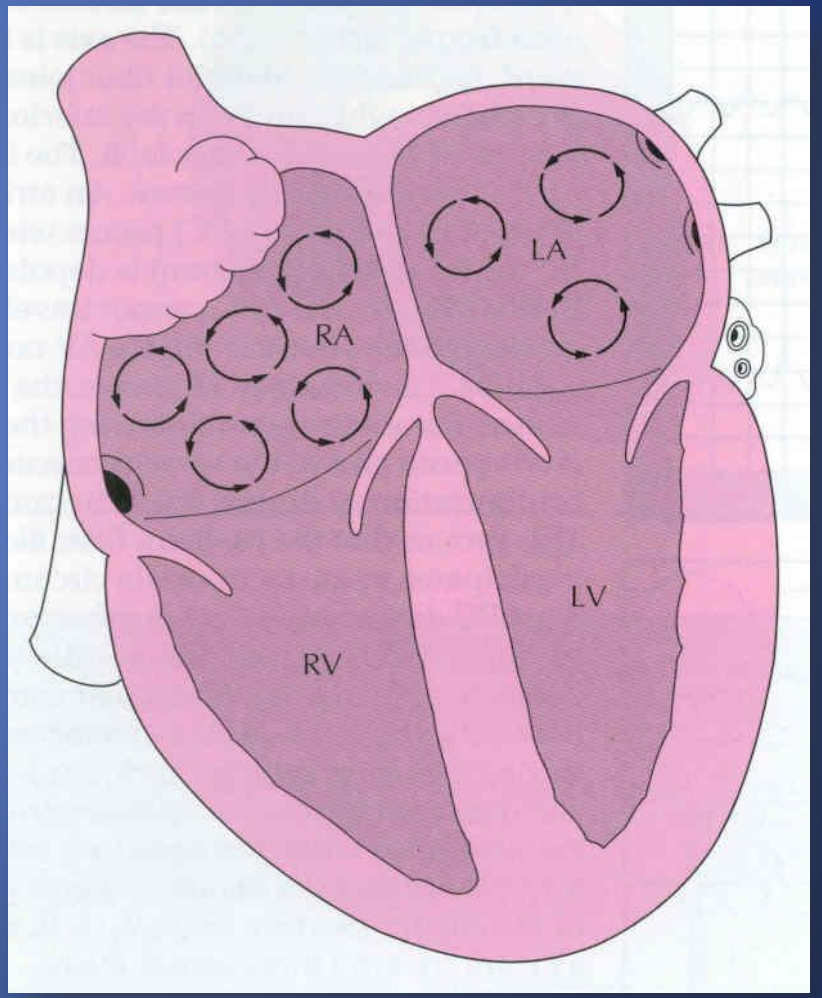
Errors bars represent 95% confidence intervals. Numbers represent the number of men and women with atrial fibrillation in each age category.

Pathophysiology of Atrial Fibrillation and associated Stroke

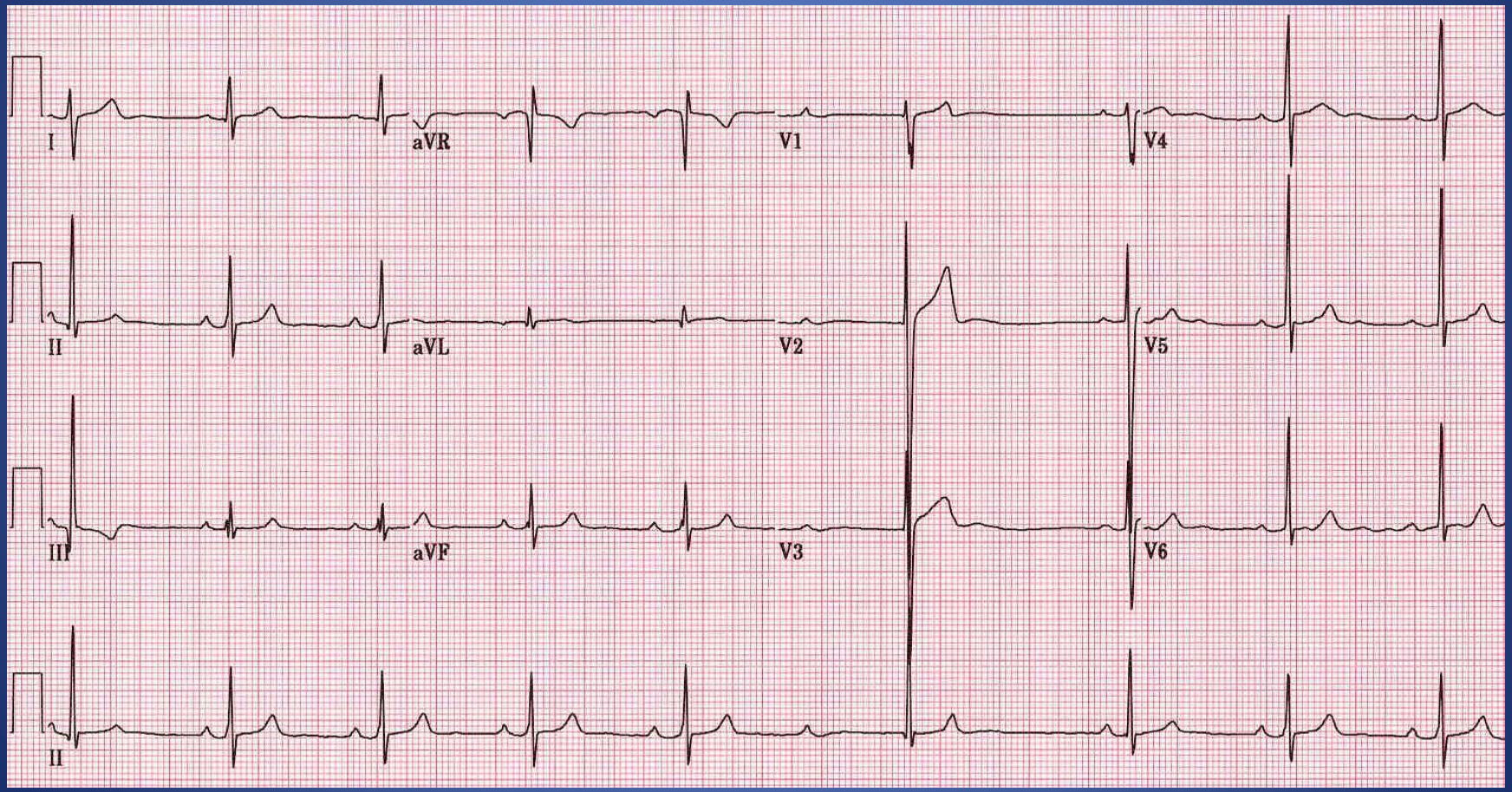
Normal regulation of heart rate and rhythm

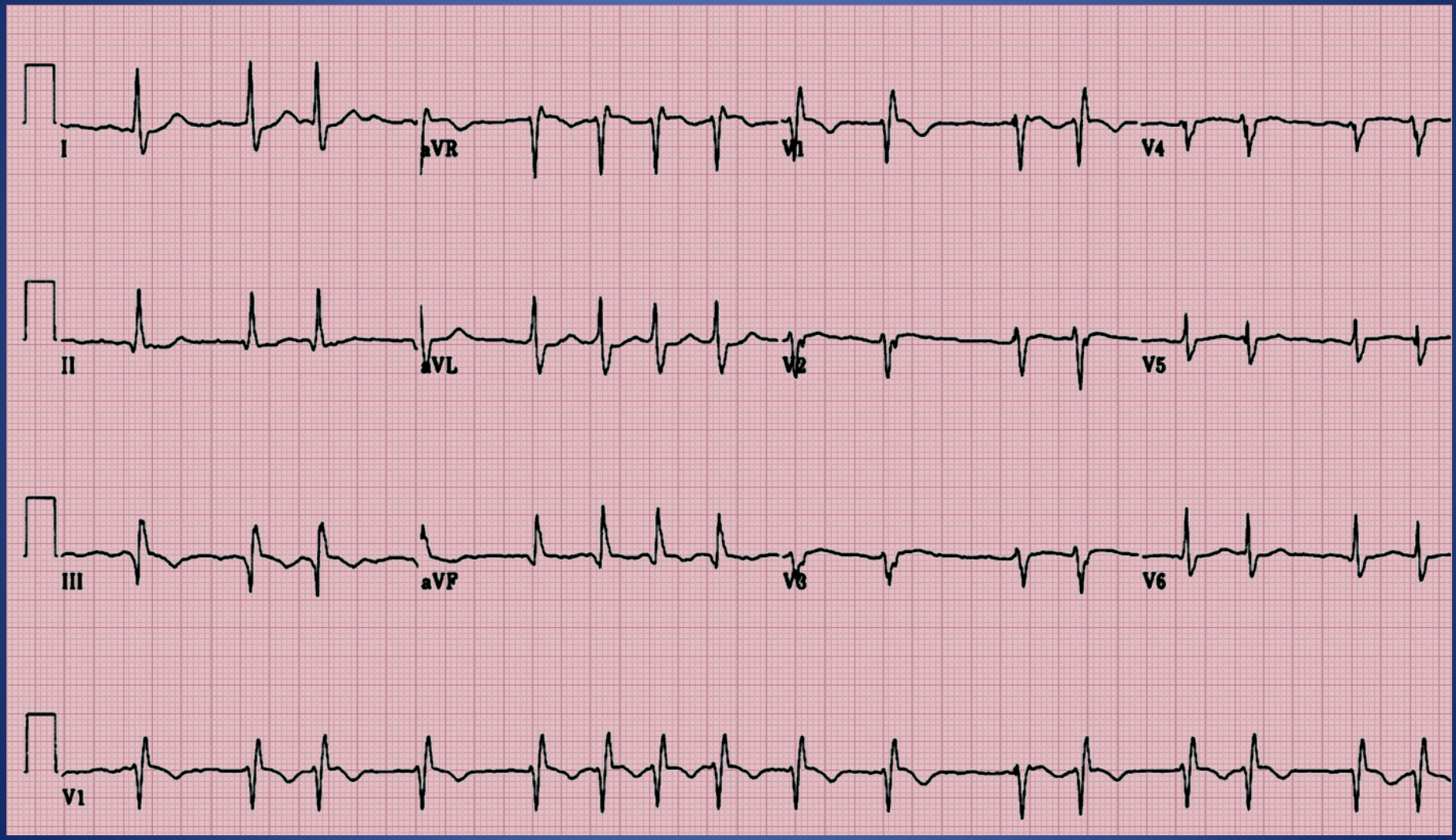
- Contraction is controlled by the sinoatrial (SA) node





Normal EKG




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

Normal heart rhythm is disrupted in AF

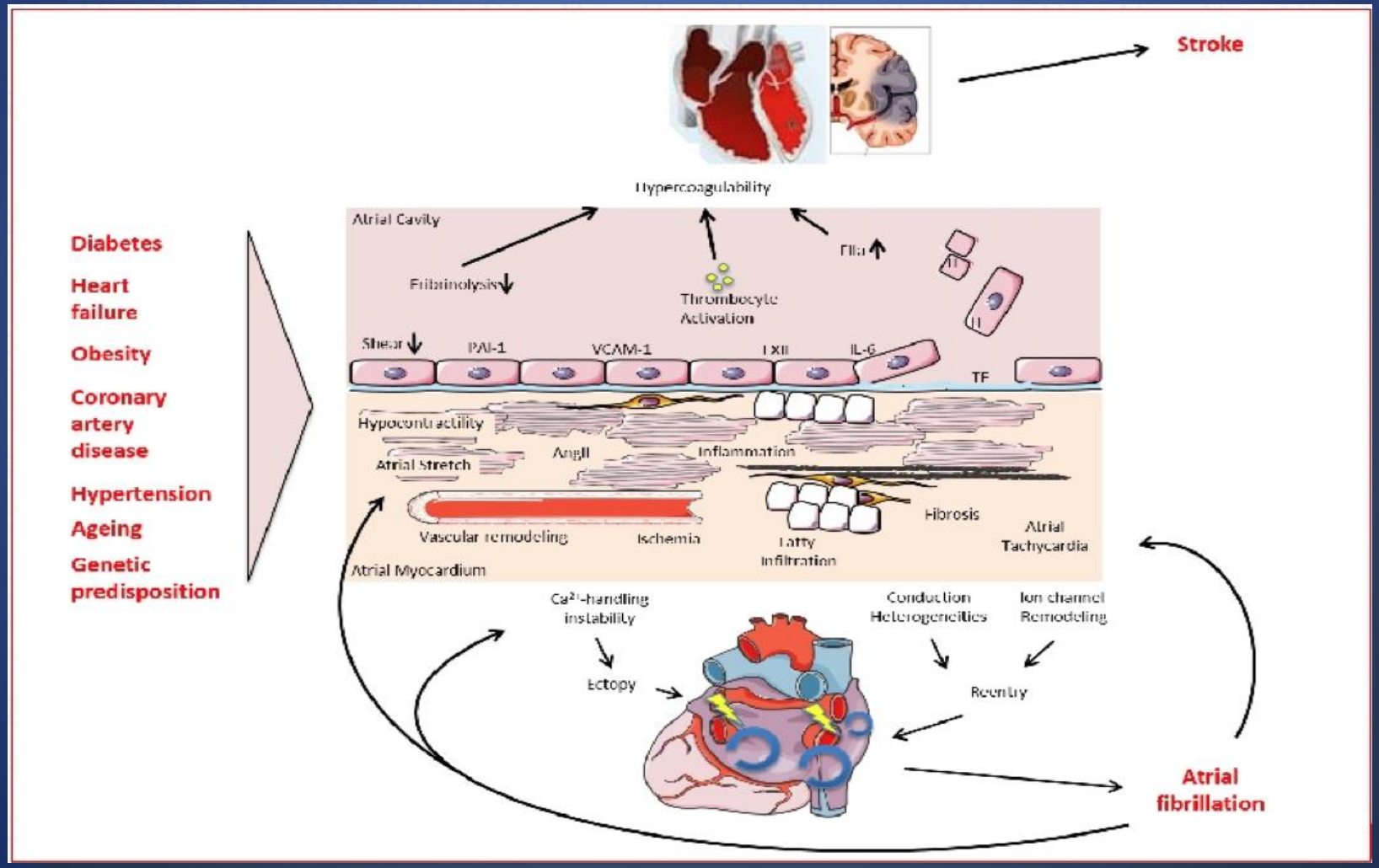
- AF is characterized by:
  - Rapid (350–600 beats/min) and irregular atrial rhythm
  - Reduced filling of the left and right ventricles
- Conduction of most impulses from the atria to ventricles is blocked at the AV node
- Contraction of the ventricles can be:
  - Irregular and rapid (110–180 beats/min; tachycardia)
  - Irregular and slow (<50 beats/min; bradycardia)
  - Normal
- Cardiac output can be reduced

AF begets AF

- AF causes remodelling:
  - **Electrical**: shortening of refractory period
  - **Structural**: enlargement of atrial cavities
- Many episodes of AF resolve spontaneously
- Over time AF tends to become persistent or permanent.

Wijffels MC et al. Circulation 195;92:1954–68

AF begets AF


Stroke
Hypercoagulability
Atrial Cavity
Fibrinolysis
Thrombocyte Activation
IIa
Shear
PAI-1
VCAM-1
LXII
IL-6
TF
Hypocontractility
AngII
Inflammation
Atrial Stretch
Vascular remodeling
Ischemia
Fibrosis
Fatty Infiltration
Atrial Tachycardia
Atrial Myocardium
Diabetes
Heart failure
Obesity
Coronary artery disease
Hypertension
Ageing
Genetic predisposition
Ca2+-handling instability
Conduction Heterogeneities
Ion channel Remodeling
Ectopy
Reentry
Atrial fibrillation

Consequences of AF

Event	Association with AF
Death	Increased mortality, especially cardiovascular mortality due to sudden death, heart failure or stroke.
Stroke	20–30% of all strokes are due to AF. A growing number of patients with stroke are diagnosed with 'silent', paroxysmal AF.
Hospitalizations	10–40% of AF patients are hospitalized every year.
Quality of life	Quality of life is impaired in AF patients independent of other cardiovascular conditions.
Left ventricular dysfunction and heart failure	Left ventricular dysfunction is found in 20–30% of all AF patients. AF causes or aggravates LV dysfunction in many AF patients, while others have completely preserved LV function despite long-standing AF.
Cognitive decline and vascular dementia	Cognitive decline and vascular dementia can develop even in anticoagulated AF patients. Brain white matter lesions are more common in AF patients than in patients without AF.

Diagnosis of Atrial Fibrillation

Atrial Fibrillation: Cardiac Causes

- Hypertensive heart disease
- Ischemic heart disease
- Valvular heart disease
  - Rheumatic: mitral stenosis
  - Non-rheumatic: aortic stenosis, mitral regurgitation
- Pericarditis
- Cardiac tumors: atrial myxoma
- Sick sinus syndrome
- Cardiomyopathy
  - Hypertrophic
  - Idiopathic dilated (? cause vs. effect)
- Post-coronary bypass surgery

Atrial Fibrillation: Non-Cardiac Causes

- Pulmonary
  - COPD
  - Pneumonia
  - Pulmonary embolism
- Metabolic
  - Thyroid disease: hyperthyroidism
  - Electrolyte disorder
- Toxic: alcohol (‘holiday heart’ syndrome)

Heterogeneous clinical presentation of AF

- With or without detectable heart disease
- Episodic
  - Symptoms may be absent or intermittent
  - Up to 90% of episodes may not cause symptoms
- Symptoms vary according to
  - Irregularity and rate of ventricular response
  - Functional status
  - AF duration
  - Patient factors
  - Co-morbidities

Fuster V et al. Circulation 2006;114:e257–e354;
Page RL et al. Circulation 1994;89:224–7

Signs and symptoms

Cause	Sign/symptom
• Irregular heart beat	• Irregularly irregular pulse • Palpitations
• Decreased cardiac output	• Fatigue • Diminished exercise capacity • Breathlessness (dyspnoea) • Weakness (asthenia)
• Hypotension	• Dizziness and fainting (syncope)
• Cardiac ischaemia	• Chest pain (angina)
• Increased risk of clot formation	• Thromboembolic TIA, stroke

Fuster V et al. Circulation 2006;114:e257–354

Clinical evaluation of patients with AF

- All patients
  - History
  - Physical examination
  - Electrocardiogram (ECG)
  - Transthoracic echocardiogram (TTE)
  - Blood tests
  - Holter monitor
  - Chest x-ray
- Selected patients
  - Transesophageal echocardiogram (TEE)

Adapted from Fuster V et al. Circulation 2006;114:e257–354

History and physical examination

- Clinical conditions associated with AF
  - Underlying heart conditions (e.g. valvular heart disease, heart failure, coronary artery disease, hypertension)
  - Other reversible conditions
- Family history
  - Familial AF (lone AF in a family)
  - AF secondary to other genetic conditions (familial cardiomyopathies)
- Type of AF
  - First episode, paroxysmal, persistent, permanent
  - Triggers – e.g. emotional stress, alcohol, physical exercise, gastroesophageal disease
  - Specific symptoms
  - Response to any treatments administered

Fuster V et al. Circulation 2006;114:e257–354;
de Vos CB et al. Eur Heart J 2008;29:632–9

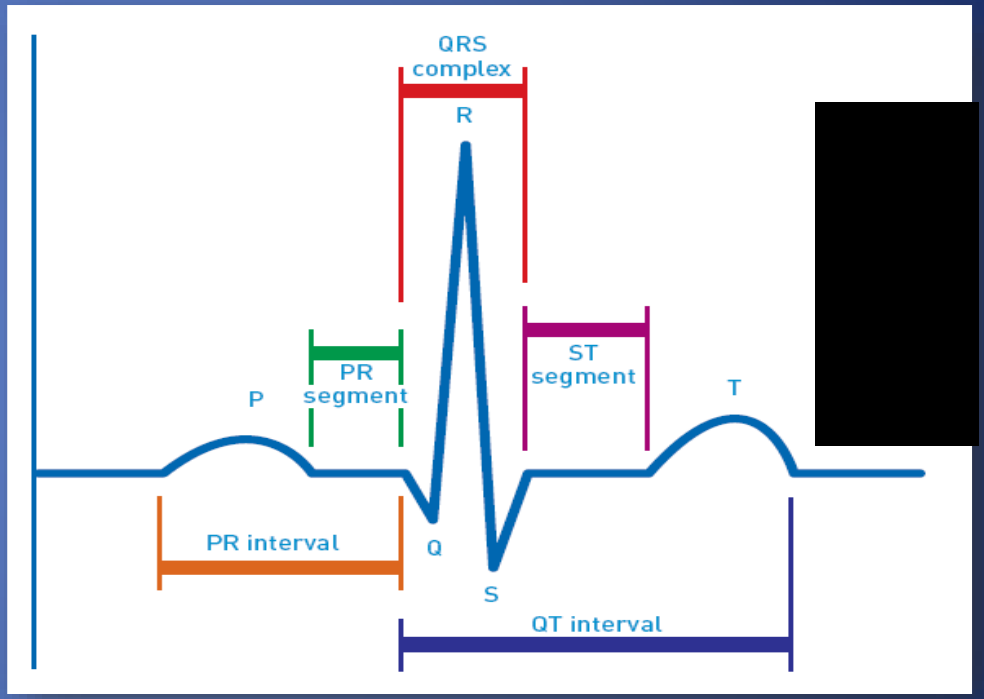
Electrocardiogram

- Assesses the electrical activity of the heart
- Essential for all patients with suspected AF, to identify
  - Abnormal heart rhythm (verify AF)
  - Left ventricular hypertrophy
  - Pre-excitation
  - Bundle-branch block
  - Prior MI
  - Differential diagnosis of other atrial arrhythmias

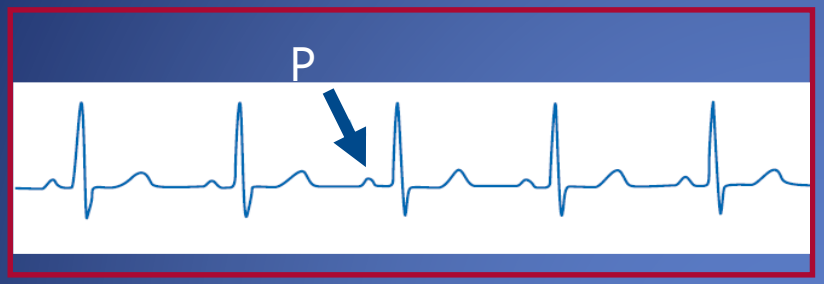
Fuster V et al. Circulation 2006;114:e257–354

Eletrocardiogram: normal sinus rhythm

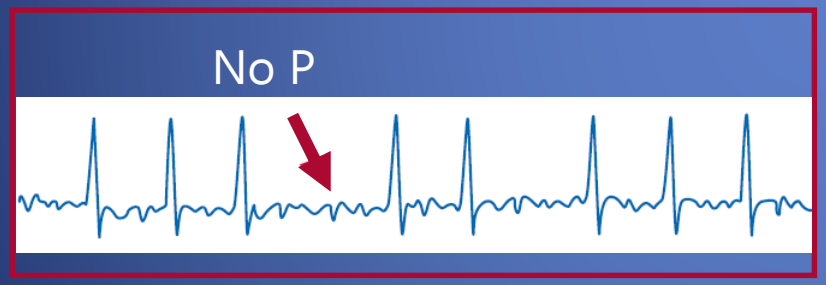
- Impulse from sinoatrial (SA) node stimulates myocardium to contract
- P-wave: atrial depolarization
- QRS complex: ventricular depolarization
- T-wave: ventricular repolarization



Electrocardiogram: loss of P wave in AF



- Normal sinus rhythm
  - Normal heart rate
  - Regular rhythm
  - P Waves
  - Steady baseline

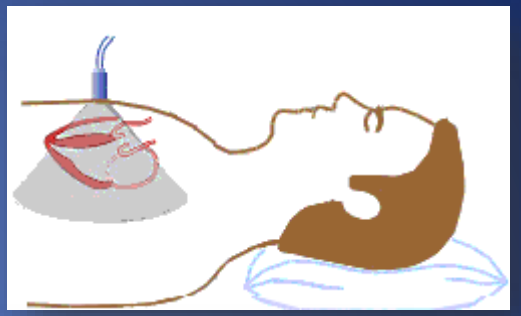


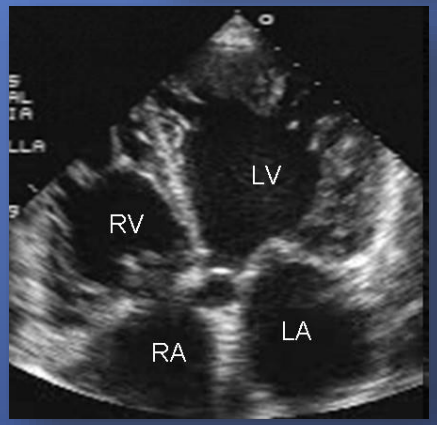
- AF
  - Heart rate increased (tachyarrhythmia)*
  - Irregular rhythm
  - No P wave
  - Irregular baseline

*Reduced heart rate (bradyarrythmia) may also be observed

Transthoracic echocardiography (TTE)

- Non-invasive
- Used to identify
  - Size and functioning of atria and ventricles
  - Ventricle hypertrophy
  - Pericardial disease
  - Valvular heart disease



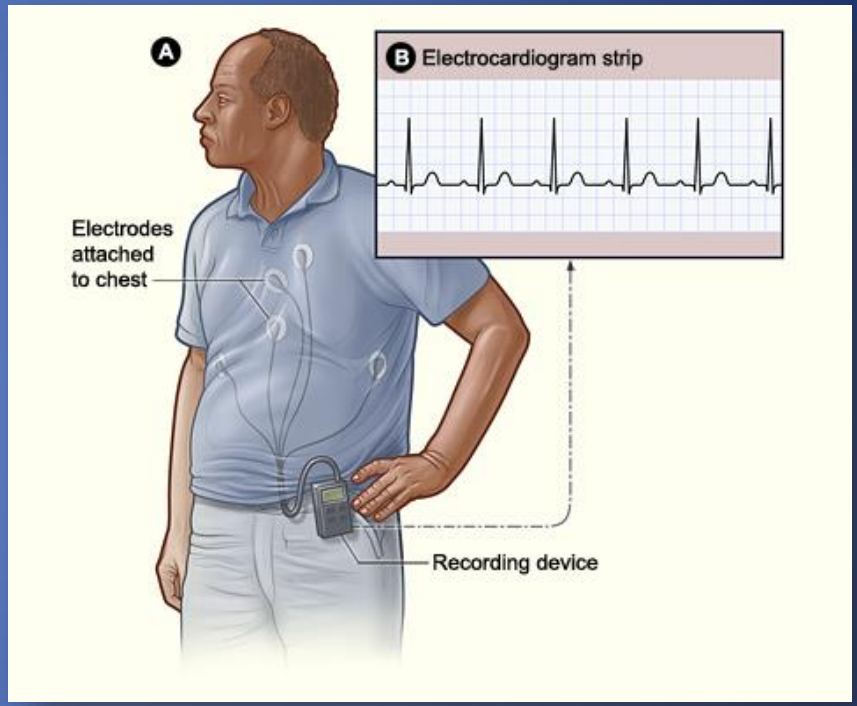


Laboratory tests

- Routine blood tests should be carried out at least once
  in patients with AF
- Important parameters to assess include:
  - Thyroid function
  - Renal function
  - Hepatic function
  - Serum electrolytes
  - Complete blood count

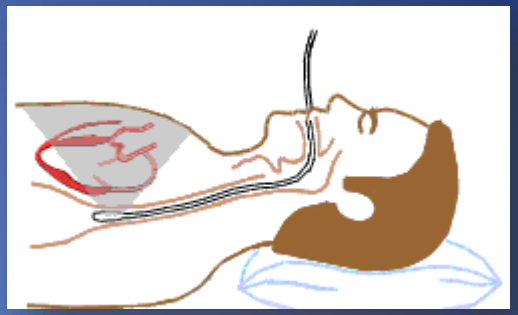
Holter monitor

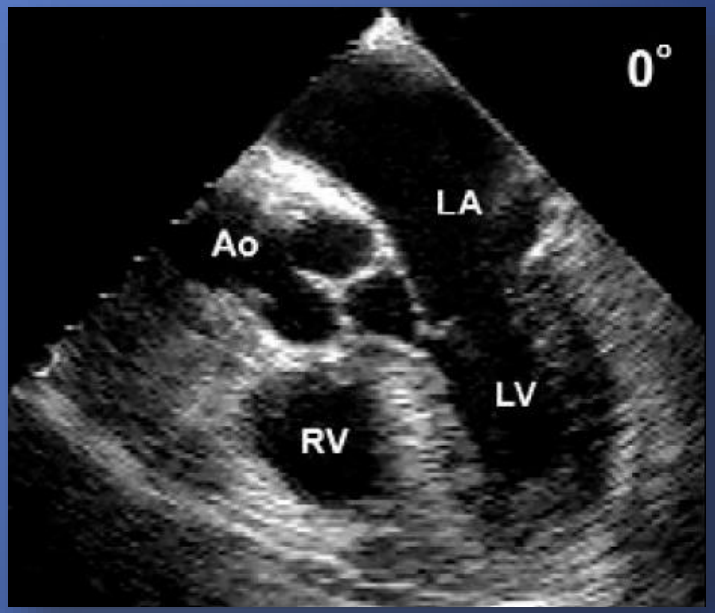
- Portable ECG device
- Continuous monitoring for a short period of time (typically 24 hours)
- Useful for
  - Detecting asymptomatic AF
  - Evaluating patients with paroxysmal AF
  - Associating symptoms with heart rhythm disturbance
  - Assessing response to treatment



Transoesophageal echocardiogram (TEE)

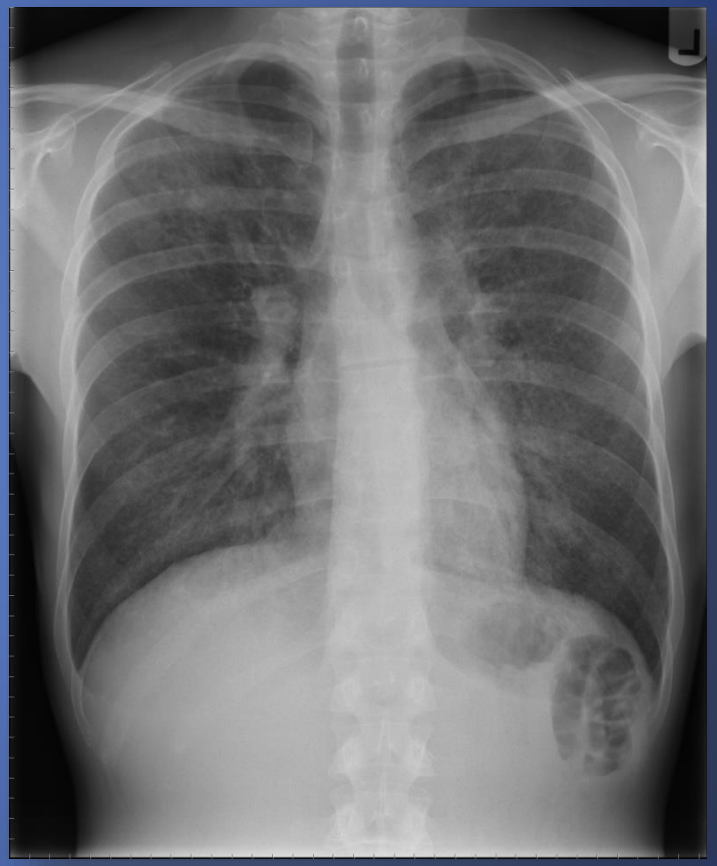
- Ultrasound transducer positioned close to the heart using an endoscope-like device
- High quality images of cardiac structure and function
  - Particularly the left atrial appendage, the most common site of thrombi in patients with AF
- Not routinely used but useful for:
  - Accurate assessment of risk of stroke
  - Detection of low flow velocity ('smoke' effect)
  - Sensitive detection of atrial thrombi





Chest Radiography

- When clinical findings suggest an abnormality chest radiography may be used to
  - Evaluate pulmonary pathology and vasculature
  - Detect congestive heart failure
  - Assess enlargement of the cardiac chambers



Summary slide for evaluation of AF patient

APPENDIX 3. INITIAL CLINICAL EVALUATION IN PATIENTS WITH AF

Minimum Evaluation	
1. History and physical examination, to define	• Presence and nature of symptoms associated with AF • Clinical type of AF (paroxysmal, persistent, or permanent) • Onset of first symptomatic attack or date of discovery of AF • Frequency, duration, precipitating factors, and modes of initiation or termination of AF • Response to any pharmacological agents that have been administered • Presence of any underlying heart disease or reversible conditions (e.g., hyperthyroidism or alcohol consumption)
2. ECG, to identify	• Rhythm (verify AF) • LVH • P-wave duration and morphology or fibrillatory waves • Pre-excitation • Bundle-branch block • Prior MI • Other atrial arrhythmias • To measure and follow R-R, QRS, and QT intervals in conjunction with antiarrhythmic drug therapy
3. TTE, to identify	• VHD • LA and RA size • LV and RV size and function • Peak RV pressure (pulmonary hypertension) • LV hypertrophy • LA thrombus (low sensitivity) • Pericardial disease
4. Blood tests of thyroid, renal, and hepatic function	• For a first episode of AF • When ventricular rate is difficult to control
Additional Testing (1 or several tests may be necessary)	
1. 6-min walk test	• If adequacy of rate control is in question • If adequacy of rate control is in question
2. Exercise testing	• To reproduce exercise-induced AF • To exclude ischemia before treatment of selected patients with a type IC * antiarrhythmic drug
3. Holter or event monitoring	• If diagnosis of type of arrhythmia is in question • As a means of evaluating rate control
4. TEE	• To identify LA thrombus (in LAA) • To guide cardioversion
5. Electrophysiological study	• To clarify the mechanism of wide-QRS-complex tachycardia • To identify a predisposing arrhythmia such as atrial flutter or paroxysmal supraventricular tachycardia • To seek sites for curative AF ablation or AV conduction block/modification
6. Chest radiograph, to evaluate	• Lung parenchyma, when clinical findings suggest an abnormality • Pulmonary vasculature, when clinical findings suggest an abnormality

Classification of Atrial Fibrillation

Classification of AF

TABLE 3 **Definitions of AF: A Simplified Scheme**

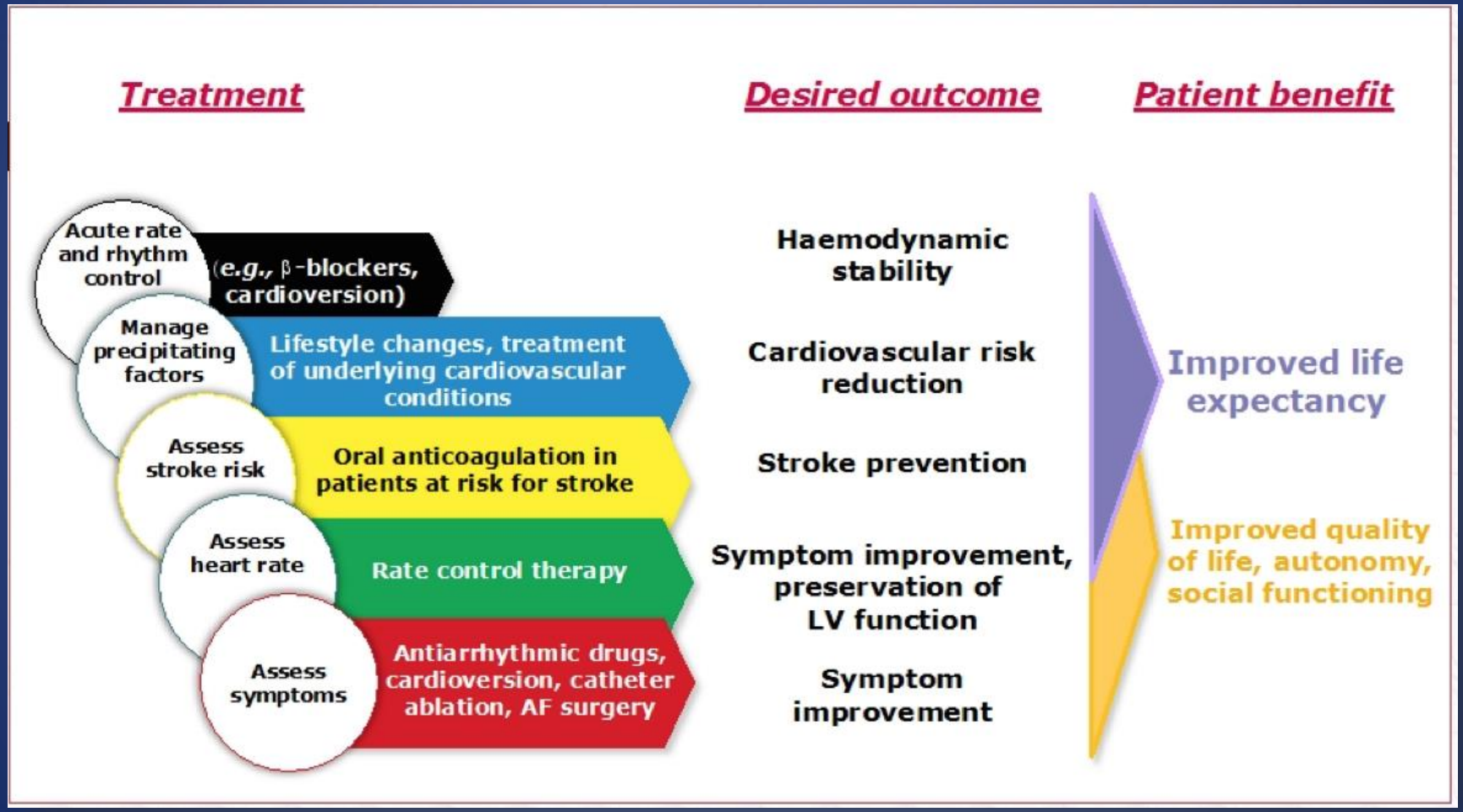
Term	Definition
Paroxysmal AF	• AF that terminates spontaneously or with intervention within 7 d of onset. • Episodes may recur with variable frequency.
Persistent AF	• Continuous AF that is sustained >7 d.
Long-standing persistent AF	• Continuous AF >12 mo in duration.
Permanent AF	• The term "permanent AF" is used when the patient and clinician make a joint decision to stop further attempts to restore and/or maintain sinus rhythm. • Acceptance of AF represents a therapeutic attitude on the part of the patient and clinician rather than an inherent pathophysiological attribute of AF. • Acceptance of AF may change as symptoms, efficacy of therapeutic interventions, and patient and clinician preferences evolve.
Nonvalvular AF	• AF in the absence of rheumatic mitral stenosis, a mechanical or bioprosthetic heart valve, or mitral valve repair.

Classification of AF

Classification	Definition
Lone or primary	AF without clinical/ECG evidence of cardiopulmonary disease
Secondary	AF associated with cardiopulmonary disease (e.g. myocardial infarction or pneumonia)
Non-valvular	AF that is not associated with damage to the heart valves (e.g. rheumatic mitral valve disease, prosthetic heart valve or mitral valve repair)

Treatment Atrial Fibrillation

The Five Domains of Integrated AF Management



3 Strategies

- Prevention of thromboembolism
- Rate control
- Restoration and maintenance of sinus rhythm

Treatment options for AF

STROKE PREVENTION	CONTROL OF HEART RATE	MAINTENANCE OF SINUS RHYTHM
PHARMACOLOGIC	PHARMACOLOGIC	PHARMACOLOGIC
• Warfarin • Aspirin • Dabigatran • Apixaban • Rivaroxaban • Rivaroxaban	• Ca^{2+}-channel blockers • β-blockers • Digoxin	• Antiarrhythmic drugs – Class IA – Class IC – Class III: e.g. amiodarone, dronedarone
NON-PHARMACOLOGIC	NON-PHARMACOLOGIC	NON-PHARMACOLOGIC
• Removal/isolation of left atrial appendage, e.g. WATCHMAN® device or surgery	• Ablate/pace	• Ablation • Surgery (MAZE)

ACE = angiotensin-converting enzyme

Prevention of Thromboembolism

The $CHADS_2$ Index

Stroke Risk Score for Atrial Fibrillation

	Score (points)	Prevalence (%)*
Congestive Heart failure	1	32
Hypertension	1	65
Age >75 years	1	28
Diabetes mellitus	1	18
Stroke or TIA	2	10
Moderate-High risk	≥2	50-60
Low risk	0-1	40-50

VanWalraven C, et al. *Arch Intern Med* 2003; 163:936.

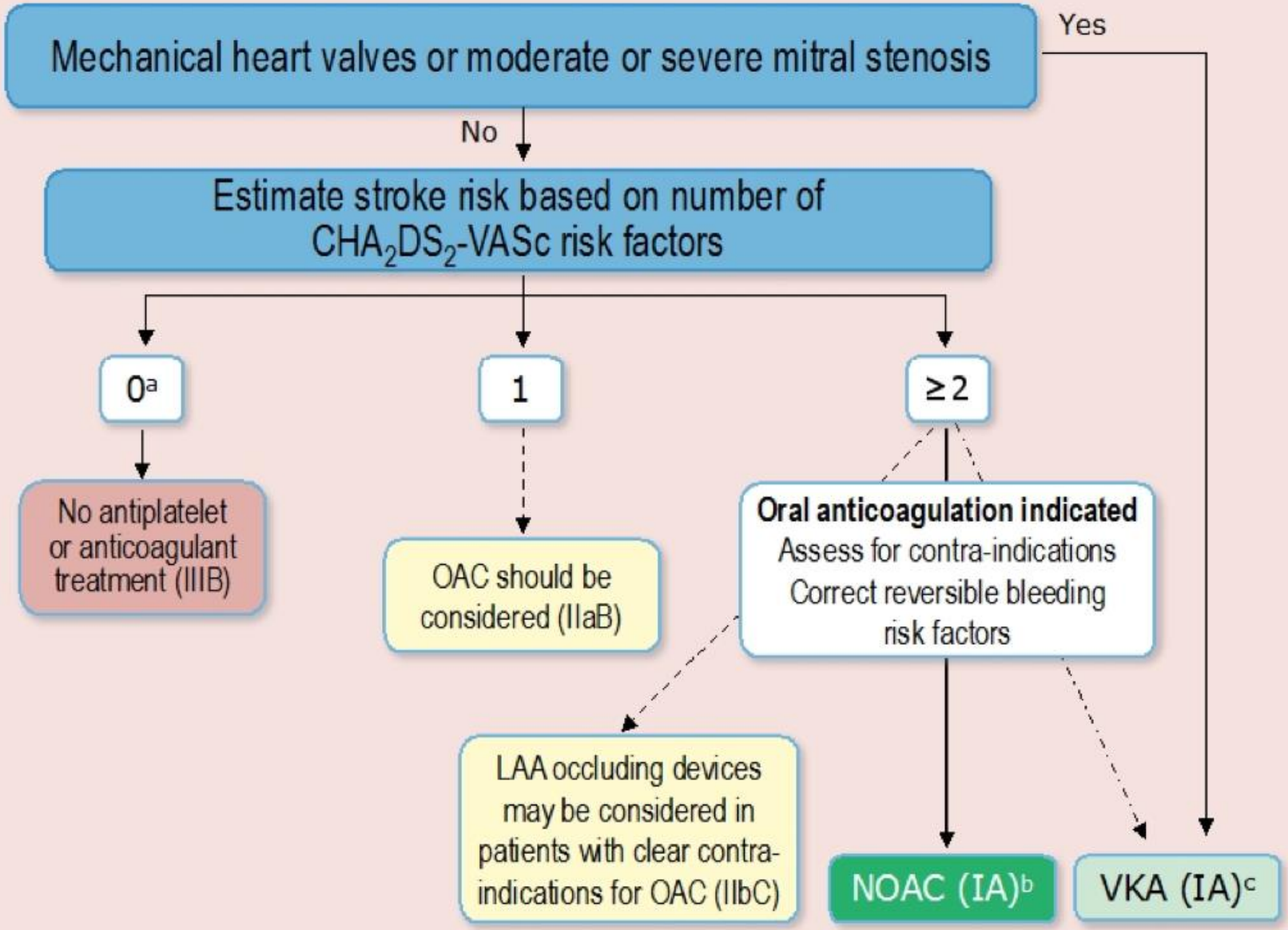
* Nieuwlaat R, et al. (EuroHeart survey) *Eur Heart J* 2006 (E-published).

The CHA_2DS_2VASc Index

Stroke Risk Score for Atrial Fibrillation

	Weight (points)
Congestive heart failure or LVEF ≤ 35%	1
Hypertension	1
Age >75 years	2
Diabetes mellitus	1
Stroke/TIA/systemic embolism	2
Vascular Disease (MI/PAD/Aortic plaque)	1
Age 65-74 years	1
Sex category (female)	1
Moderate-High risk	≥ 2
Low risk	0-1

Lip GYH, Halperin JL. *Am J Med* 2010; 123: 484.



[a] Includes women without other stroke risk factors
[b] IIaB for women with only one additional stroke risk factor
[c] IB for patients with mechanical heart valves or mitral stenosis

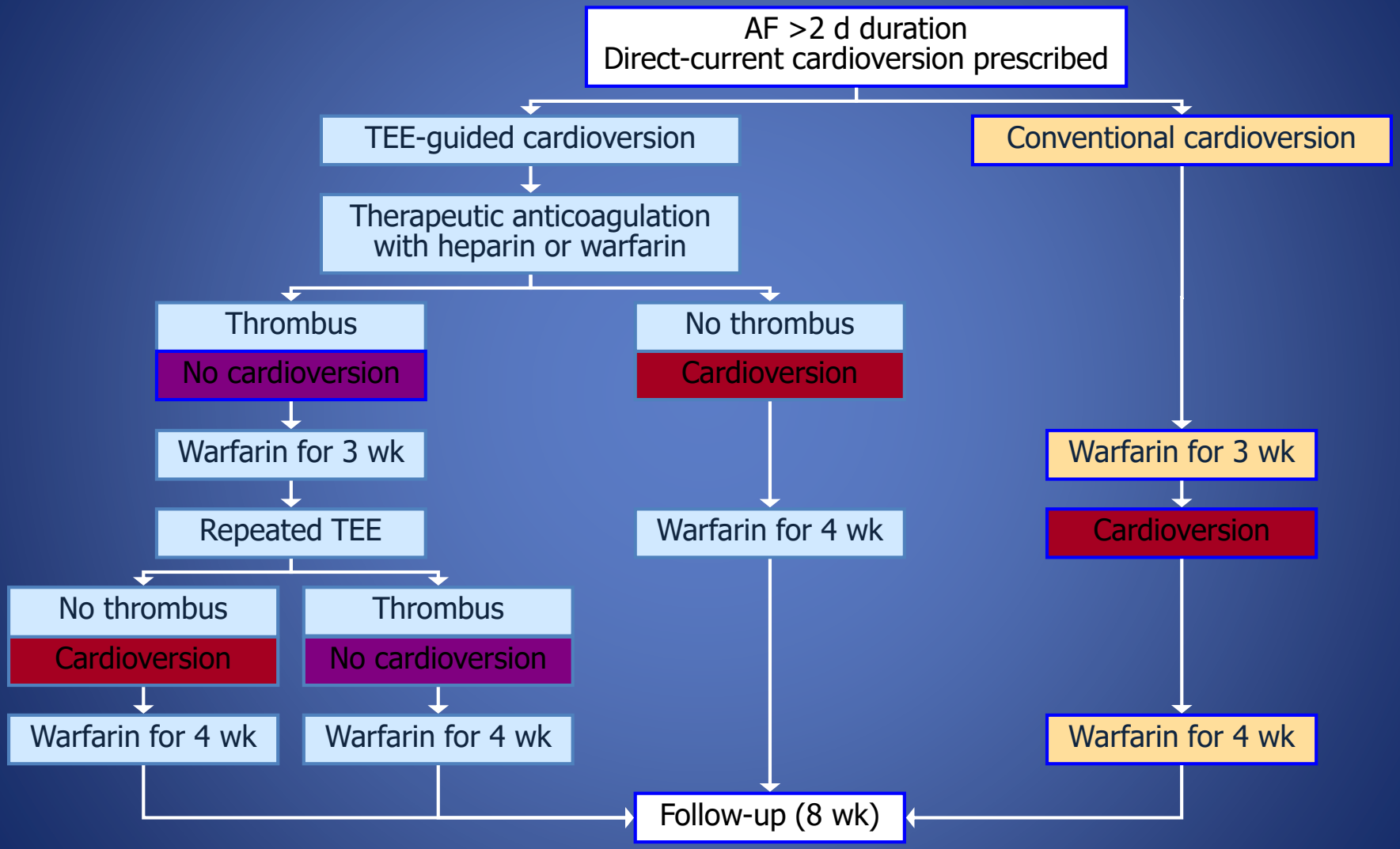
Restoration of Sinus Rhythm

Rhythm-control therapies

- The objective of rhythm-control therapy is to restore (cardioversion) and maintain normal sinus rhythm
- Cardioversion can be achieved by:
  - Pharmacotherapy with antiarrhythmic agents
  - Electrical shocks (direct-current cardioversion)
- Direct-current cardioversion is generally more effective than pharmacotherapy
- Likelihood of successful cardioversion decreases with the duration of AF
  - Pharmacological cardioversion is most effective when initiated within 7 days of AF onset
- Cardioversion can dislodge thrombi in the atria, increasing the risk of stroke
  - Thromboprophylaxis is recommended for ≥3 wk before and for at least 4 wks after cardioversion in patients with AF that has persisted for ≥48 h

Fuster V et al. Circulation 2006; 114:e257–354

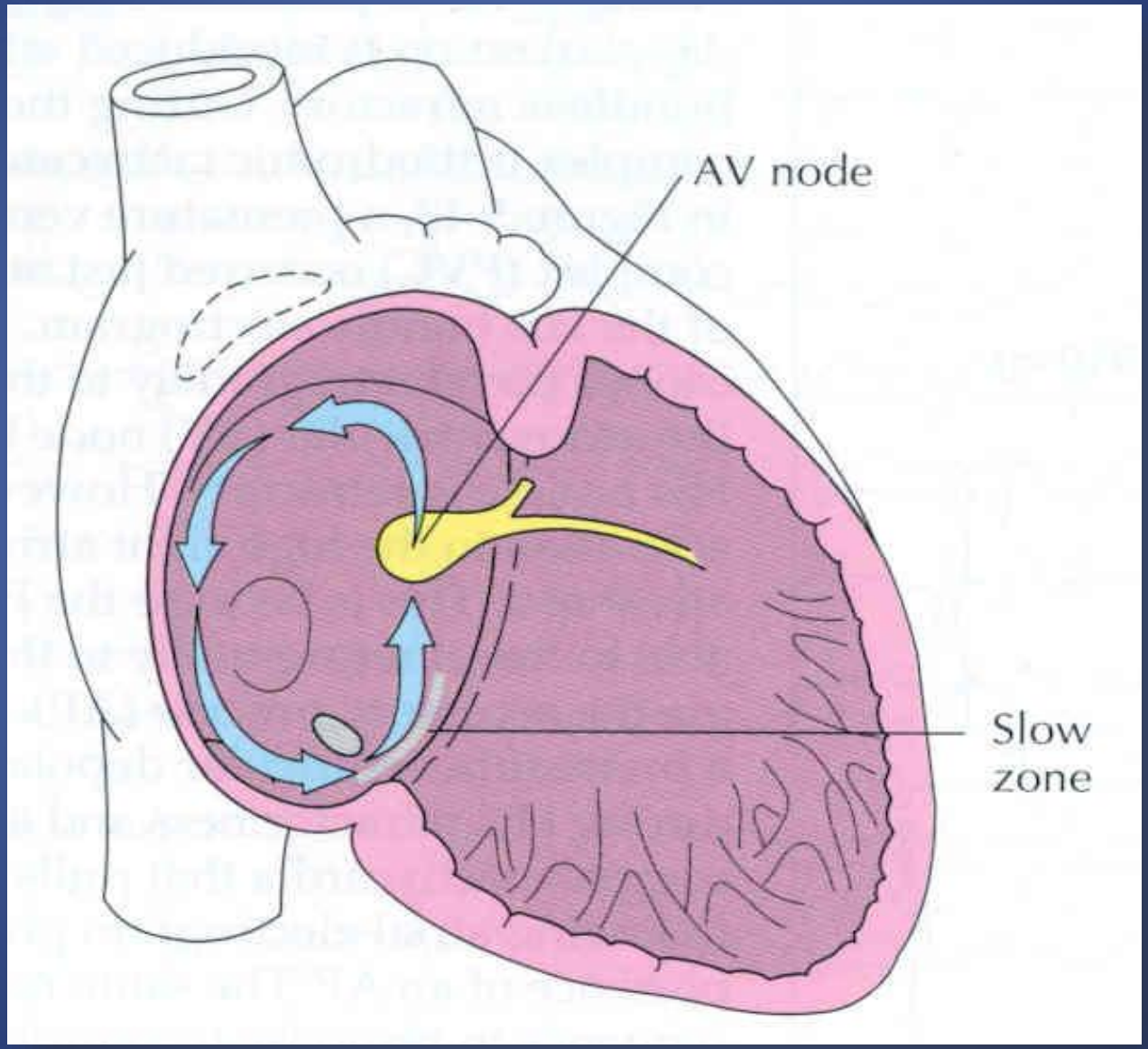
TEE-guided cardioversion: ACUTE study design

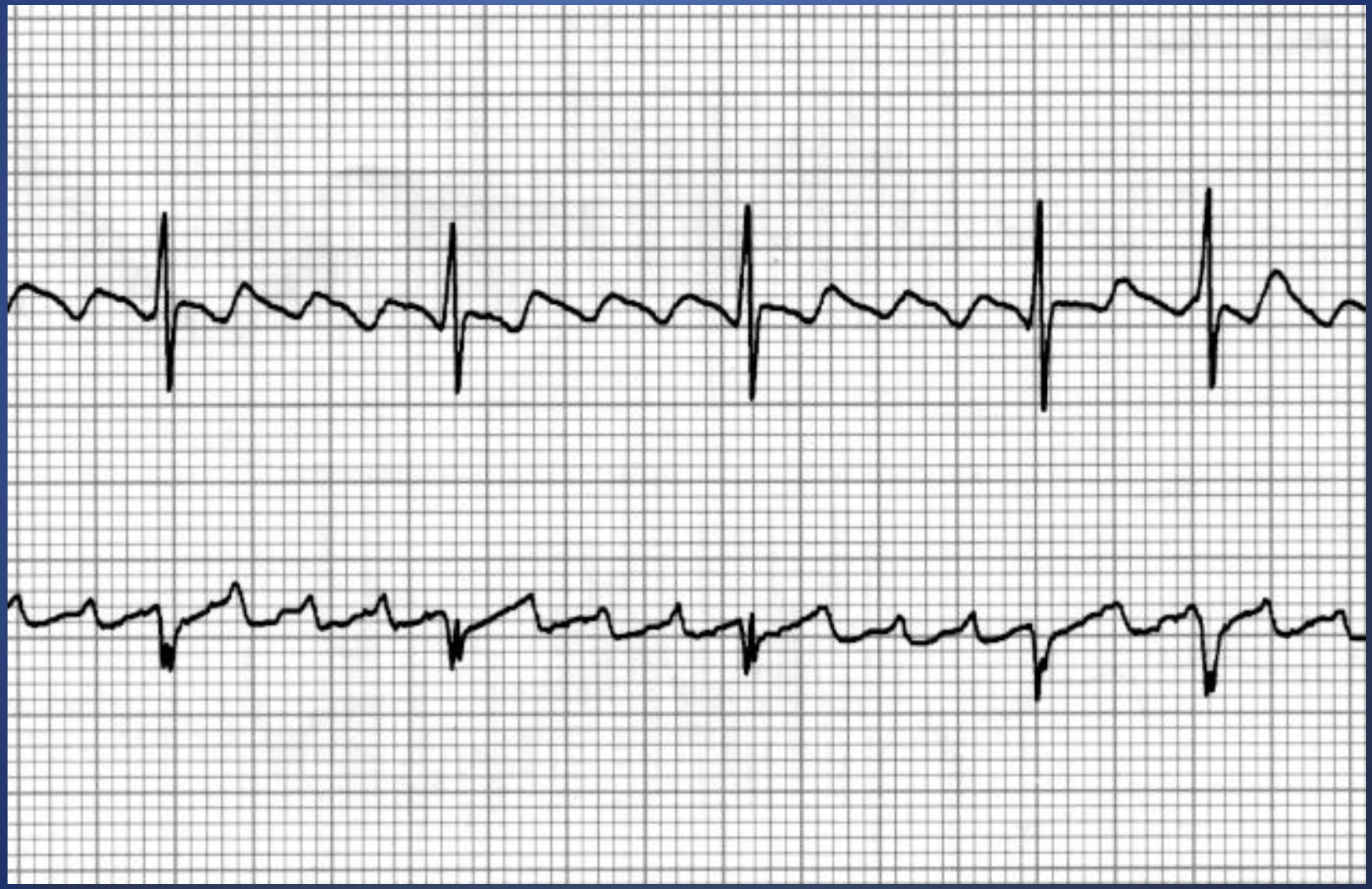


DC = direct-current; TEE = transoesophageal echocardiography

Klein AL et al. N Engl J Med 2001;344:1411–20

Atrial Flutter


AV node
Slow
zone



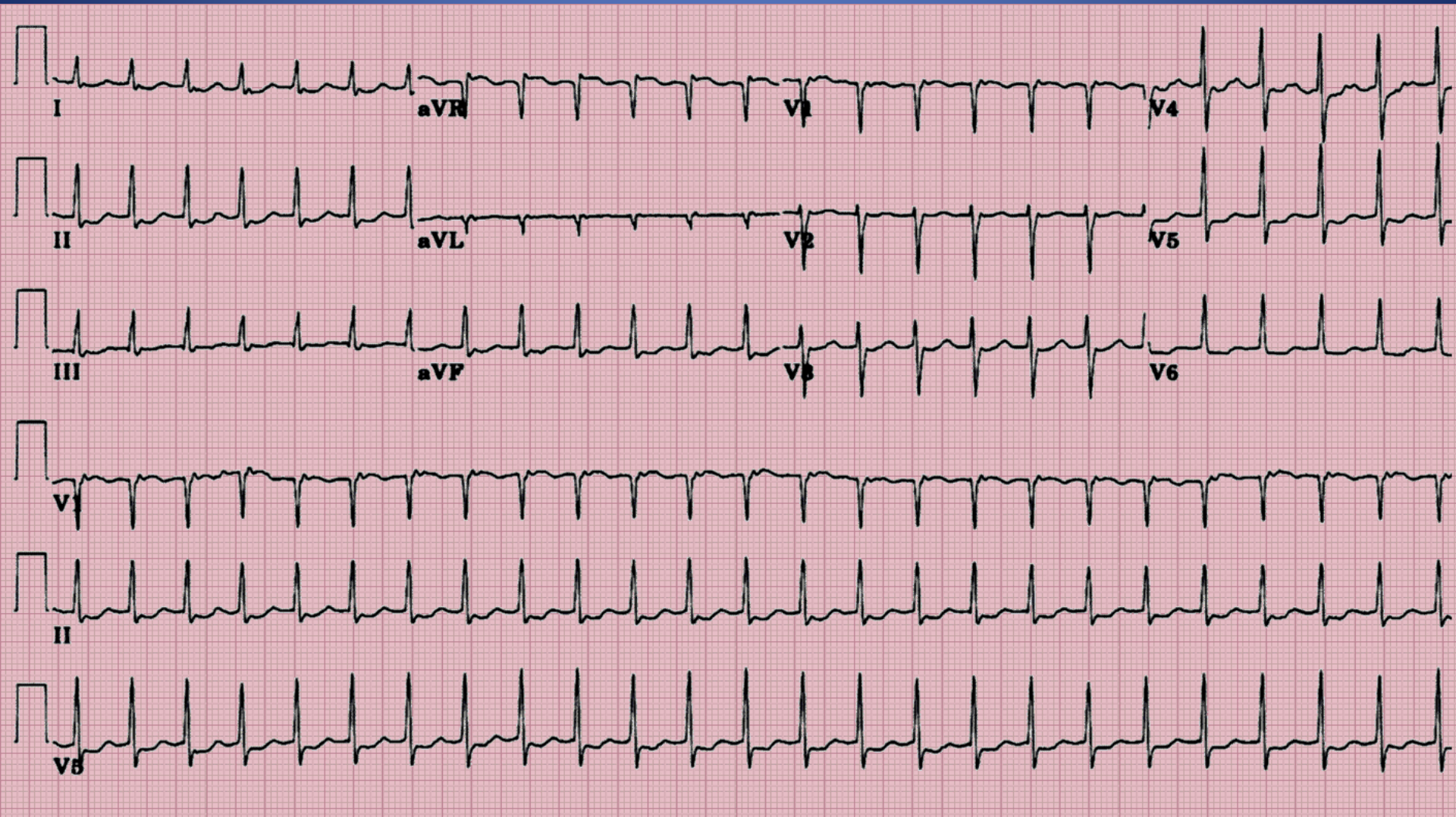
Rx – Atrial Flutter

- ***Unstable*** pt (i.e. low BP / CP / AMS):
  - Synchronized cardioversion as per ACLS
  - 50J → 100J → 200J → 300J → 360J

- ***Stable*** pt:
  - Rate control - just like atrial fibrillation (AFib)
  - Elective cardioversion - just like AFib
  - Anti-coagulation – just like AFib
  - Refer for Ablation

SVT

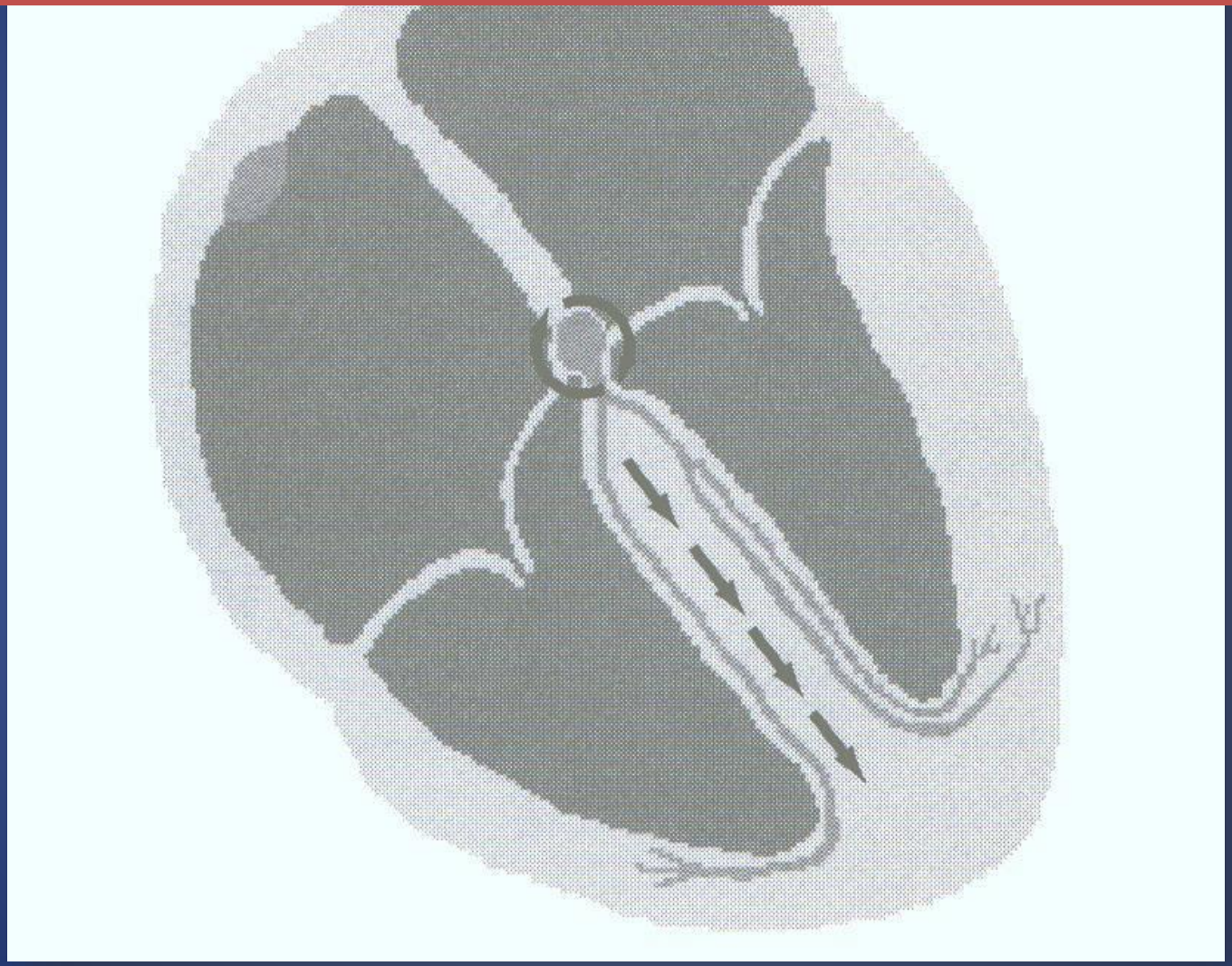
AVRT-Narrow complex



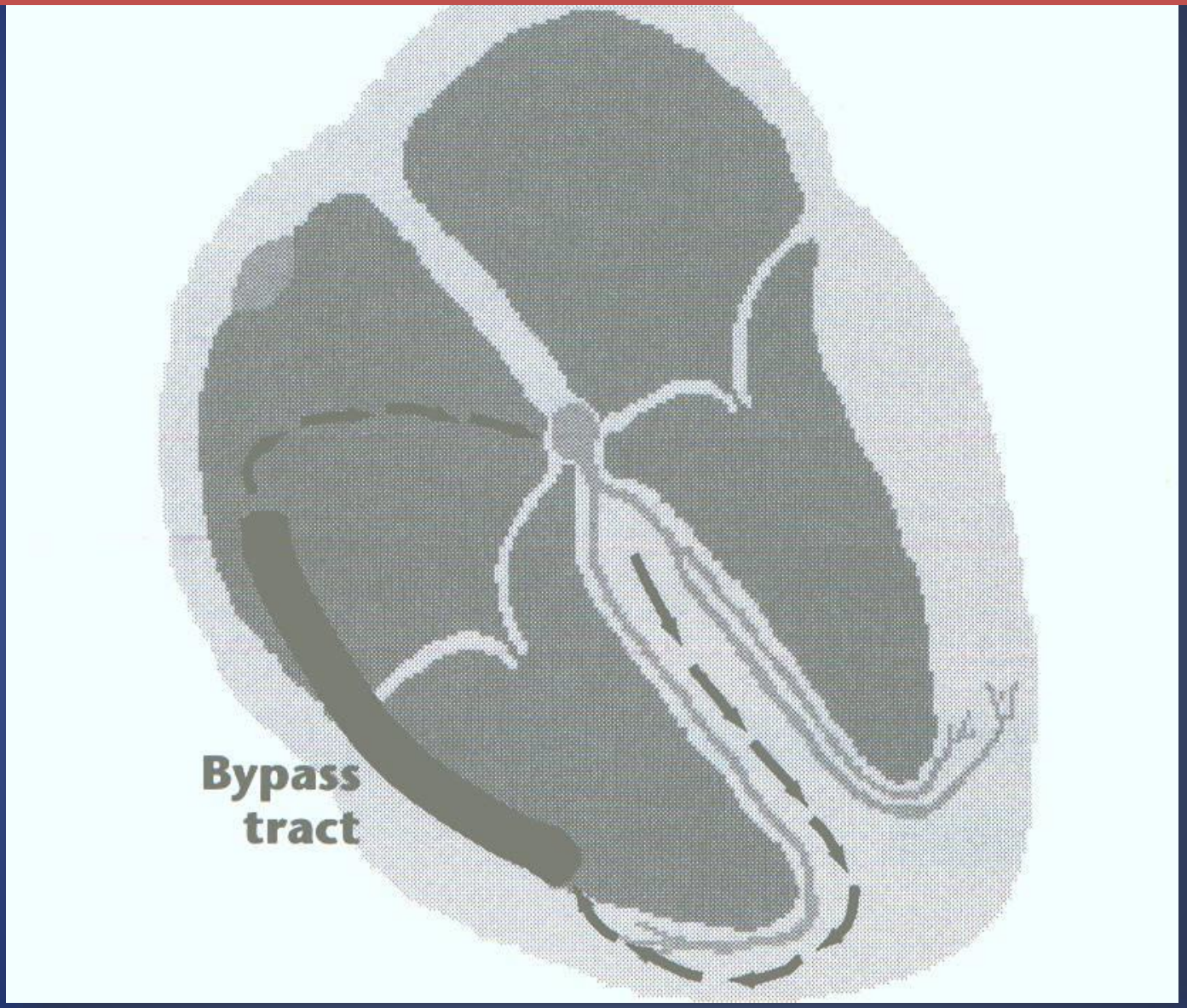
So What Is Actually Meant By Supraventricular Tachycardia?

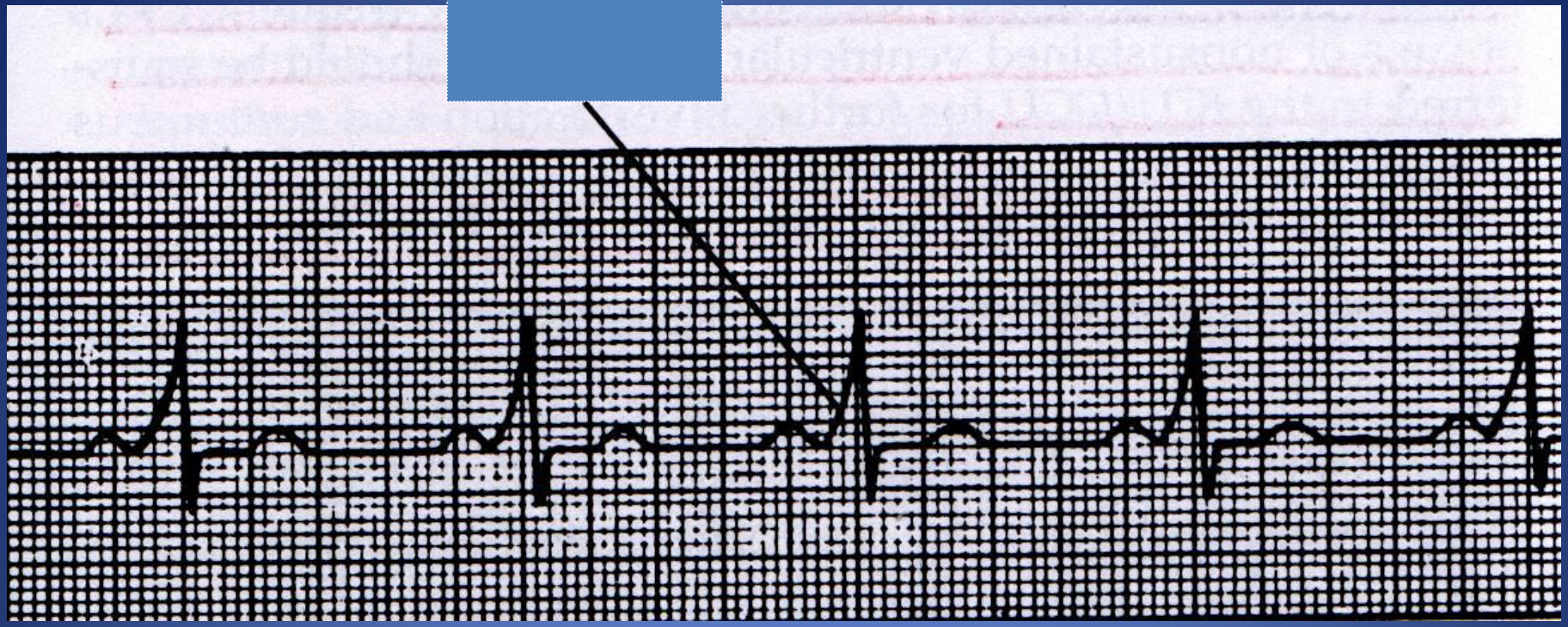
- Arrhythmias of supraventricular origin using a re-entrant mechanism with abrupt onset & termination
- AVNRT (60%)
- AVRT (30%)
- Atrial tachycardia (10%)

Atrioventricular Nodal Re-entrant Tachycardia (AVNRT)



Atrioventricular Re-entrant Tachycardia (AVRT)





Wolf-Parkinson-White (WPW) Syndrome

Treatment options

- Medical therapy
- Radio Frequency Ablation

Other Arrhythmias

- Ventricular Tachycardia
- Ventricular Fibrillation

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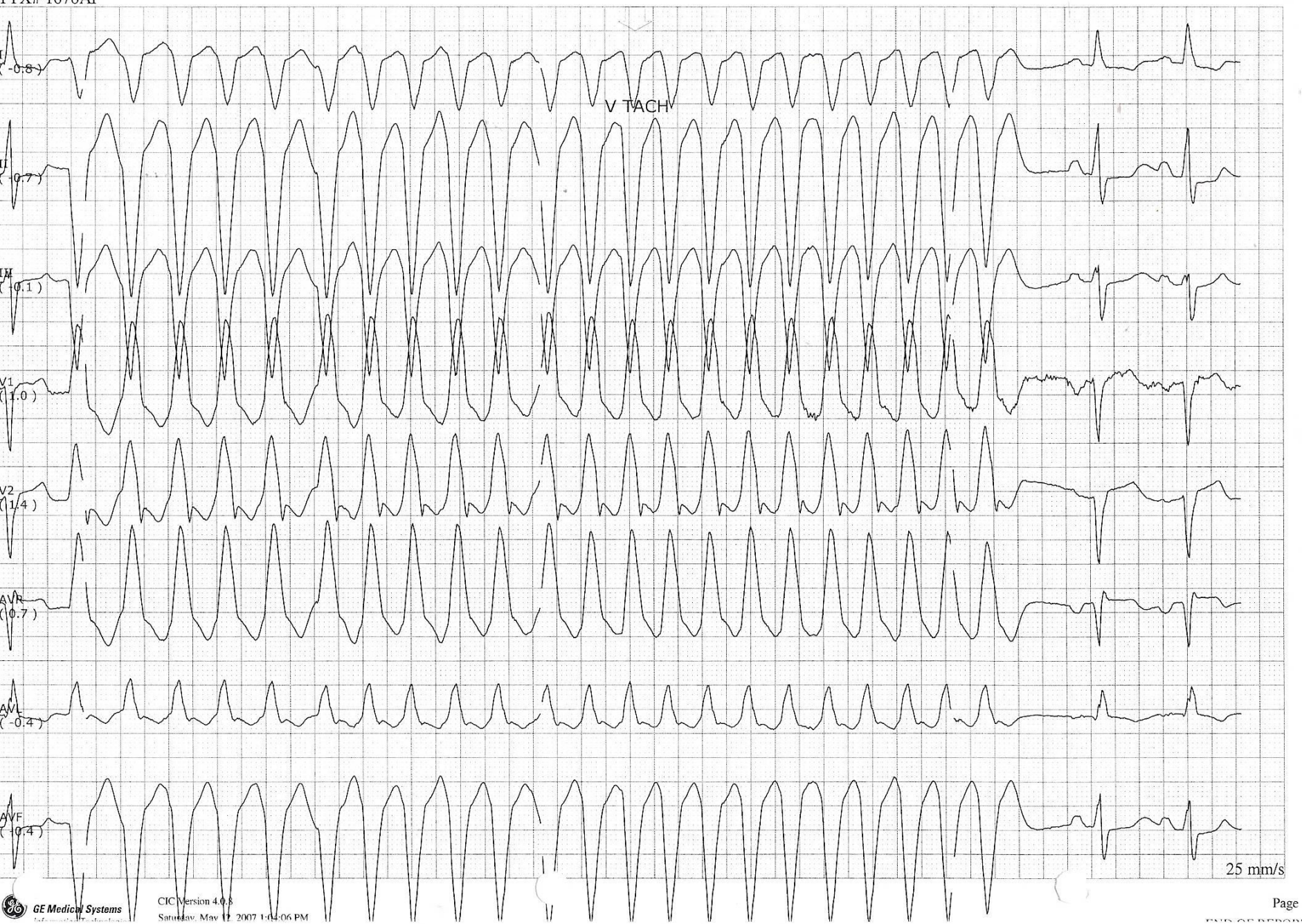
V TACH HR 130 PVC 7 ST V1 1.0 mm

TTX# 1070AP



GE Medical Systems

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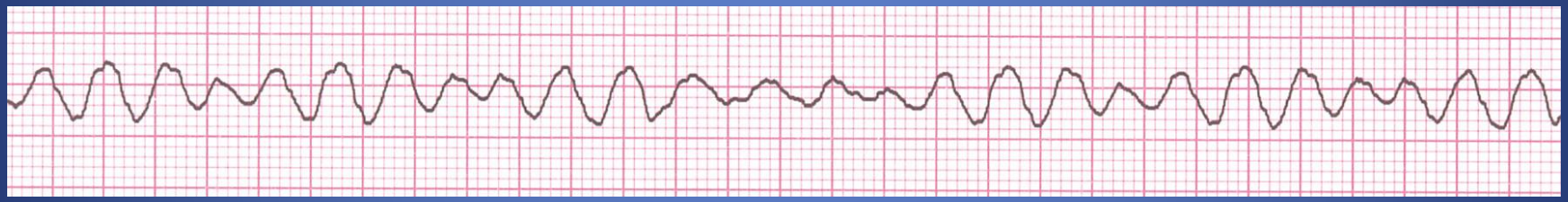
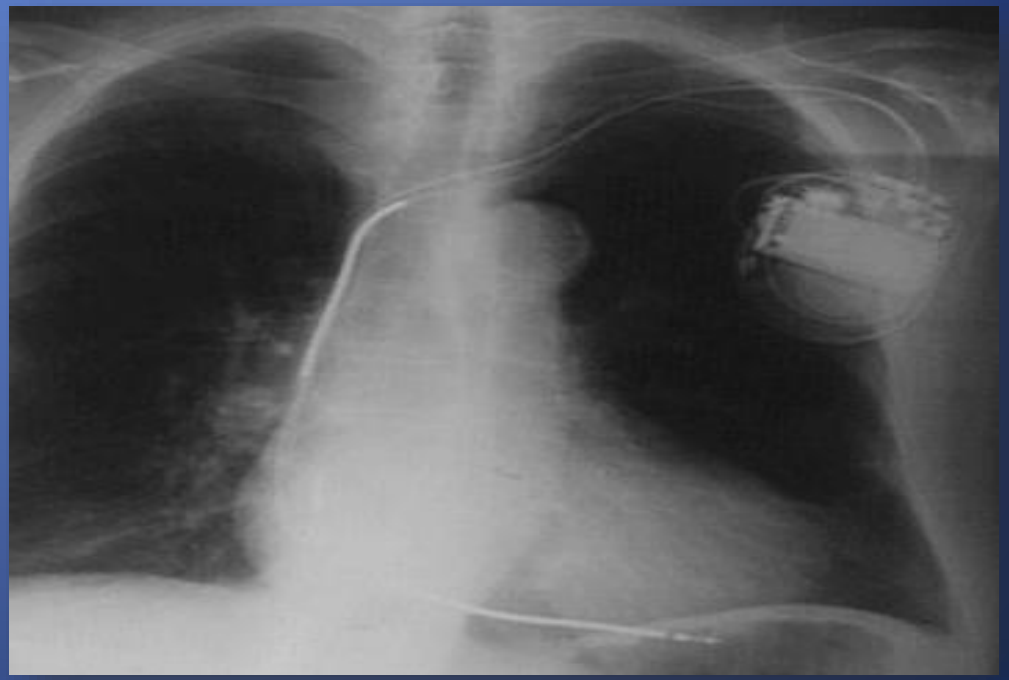


Treatment options

- Treat the underlying cause
- Automatic Implantable defibrillators



Thank You