Arrhythmia

- Arrhythmia is defined as loss of cardiac rhythm, especially irregularity of heart beat.

PATHOPHYSIOLOGY:

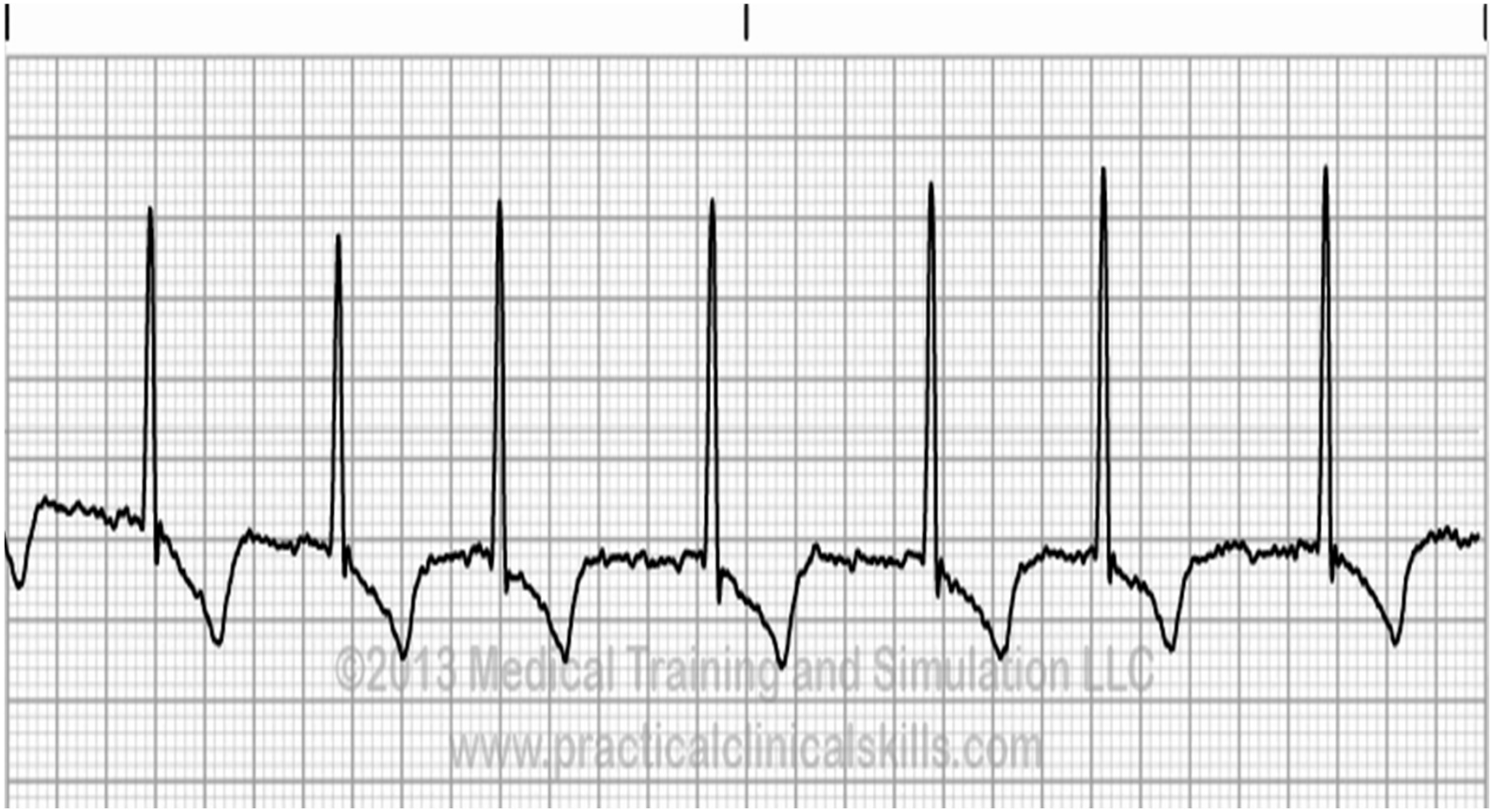
SUPRAVENTRICULAR ARRHYTHMIAS:

- Common supraventricular tachycardias requiring drug treatment are atrial fibrillation (AF) or atrial flutter, paroxysmal supraventricular tachycardia (PSVT), and automatic atrial tachycardias.

Atrial Fibrillation and Atrial Flutter:

- AF is characterized as an extremely rapid (400 to 600 atrial beats/min) and disorganized atrial activation.

- There is a loss of atrial contraction (atrial kick), and supraventricular impulses penetrate the atrioventricular (AV) conduction system in variable degrees, resulting in irregular ventricular activation and irregularly irregular pulse (120 to 180 beats/min).

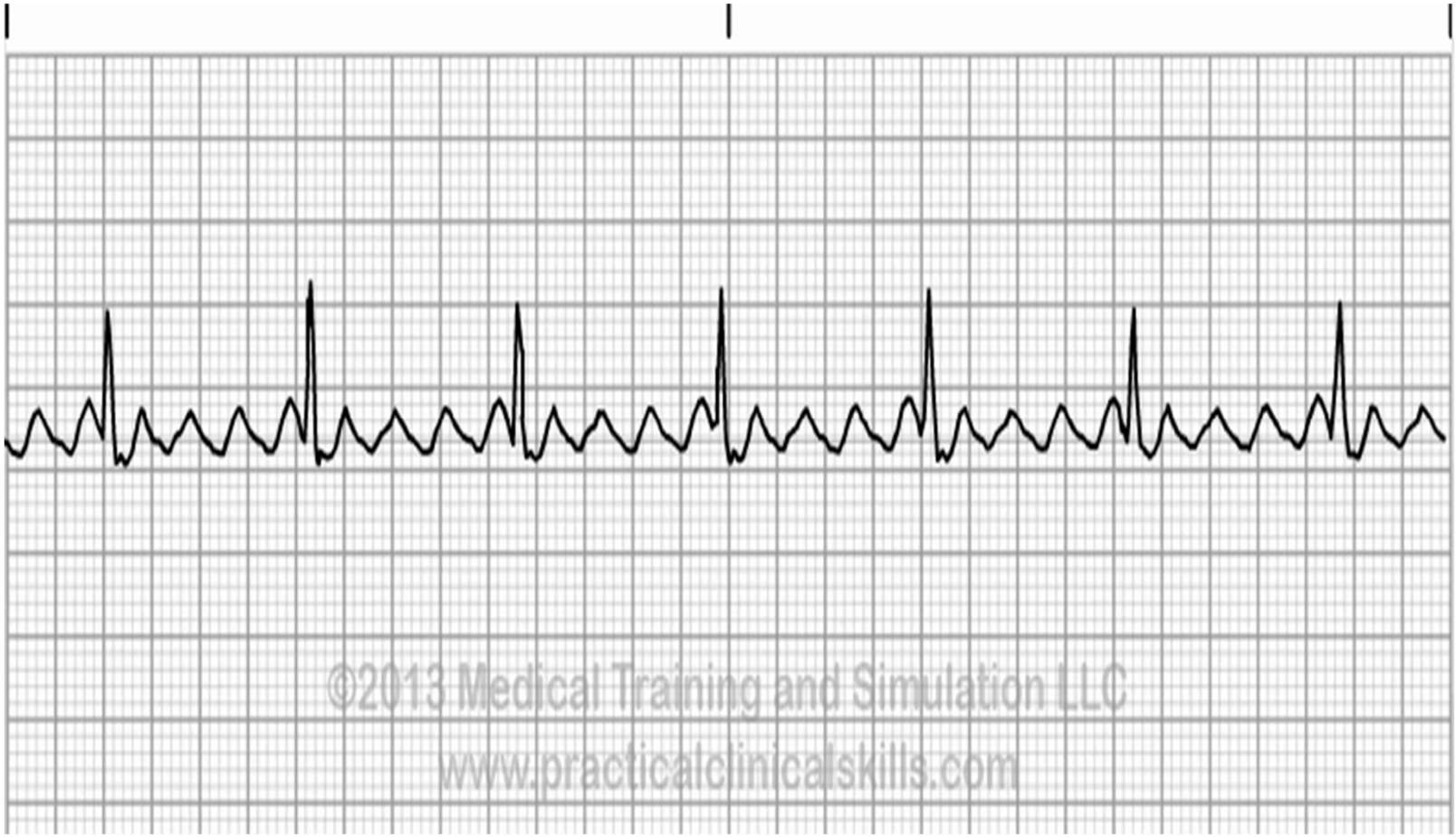


Atrial Fibrillation ECG Tracing

- Atrial flutter is characterized by rapid (270 to 330 atrial beats/min) but regular atrial activation.

- The ventricular response usually has a regular pattern and a pulse of 300 beats/min.

- This arrhythmia occurs less frequently than AF but has similar precipitating factors, consequences, and drug therapy.



Atrial Flutter Tracing

- The predominant mechanism of AF and atrial flutter is reentry, which is usually associated with organic heart disease that causes atrial distention (e.g., ischemia or infarction, hypertensive heart disease, valvular disorders).

- PSVT arising by reentrant mechanisms includes arrhythmias caused by AV nodal reentry, AV reentry incorporating an anomalous AV pathway, sinoatrial (SA) nodal reentry, and intra atrial reentry.

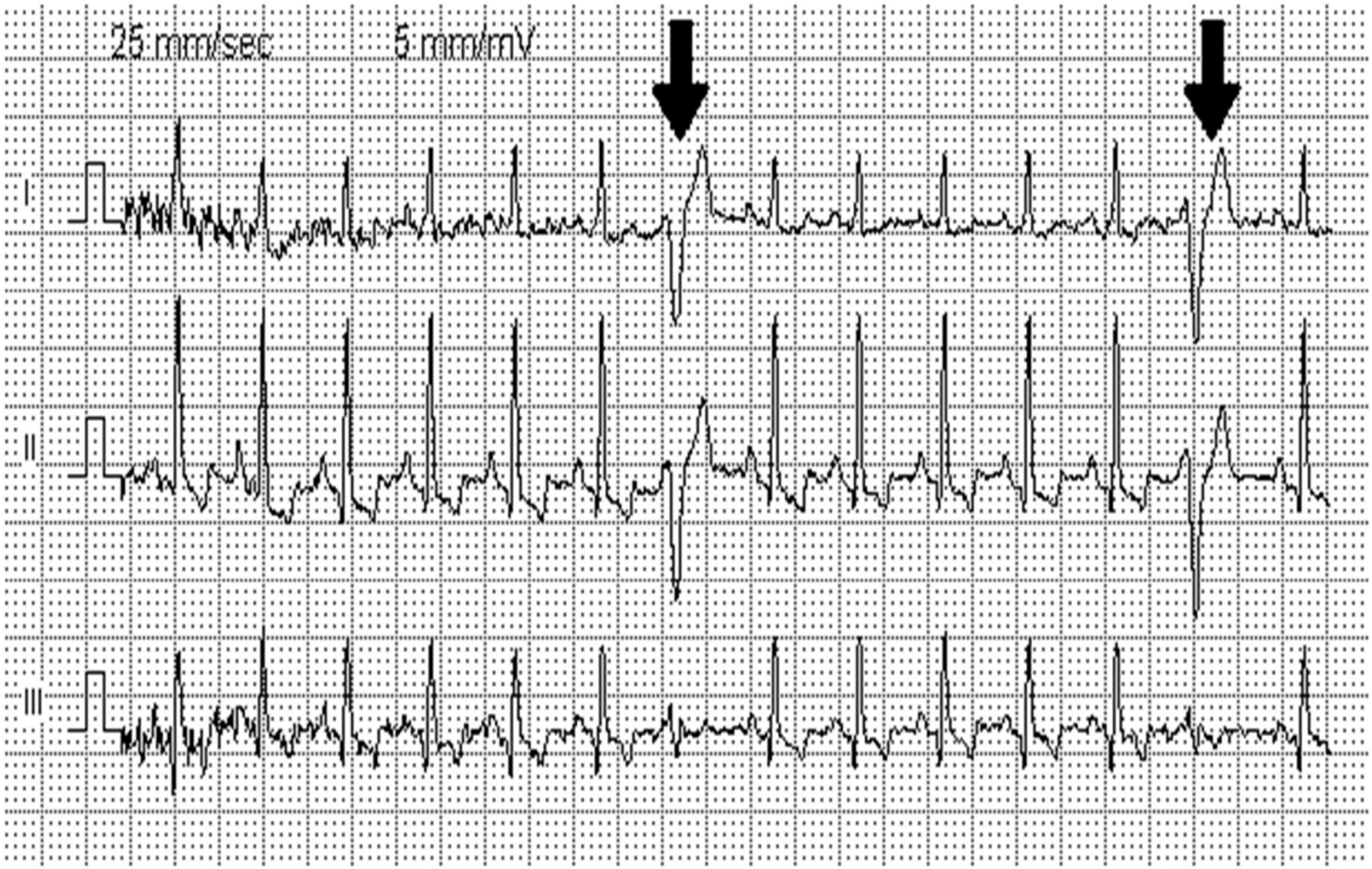
- Automatic atrial tachycardias such as multifocal atrial tachycardia appear to arise from supraventricular foci with enhanced automatic properties.

- Severe pulmonary disease is the underlying precipitating disorder in 60% to 80% of patients.

VENTRICULAR ARRHYTHMIAS:

Premature Ventricular Complexes:

- Premature ventricular complexes (PVCs) are common ventricular rhythm disturbances that occur in patients with or without heart disease and may be elicited experimentally by abnormal automaticity, triggered activity, or reentrant mechanisms.



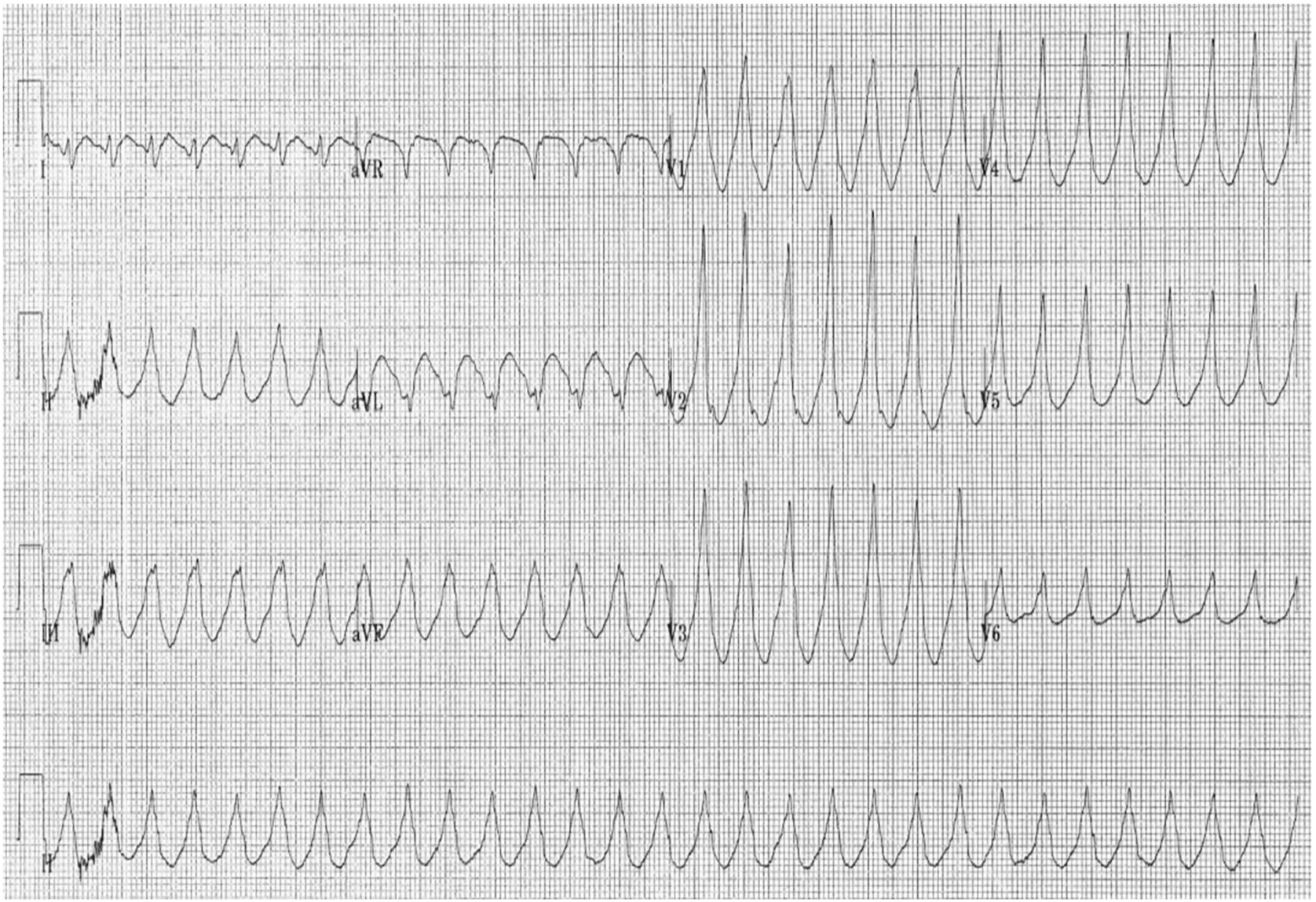
Two Ventricular Premature Complexes

Ventricular Tachycardia:

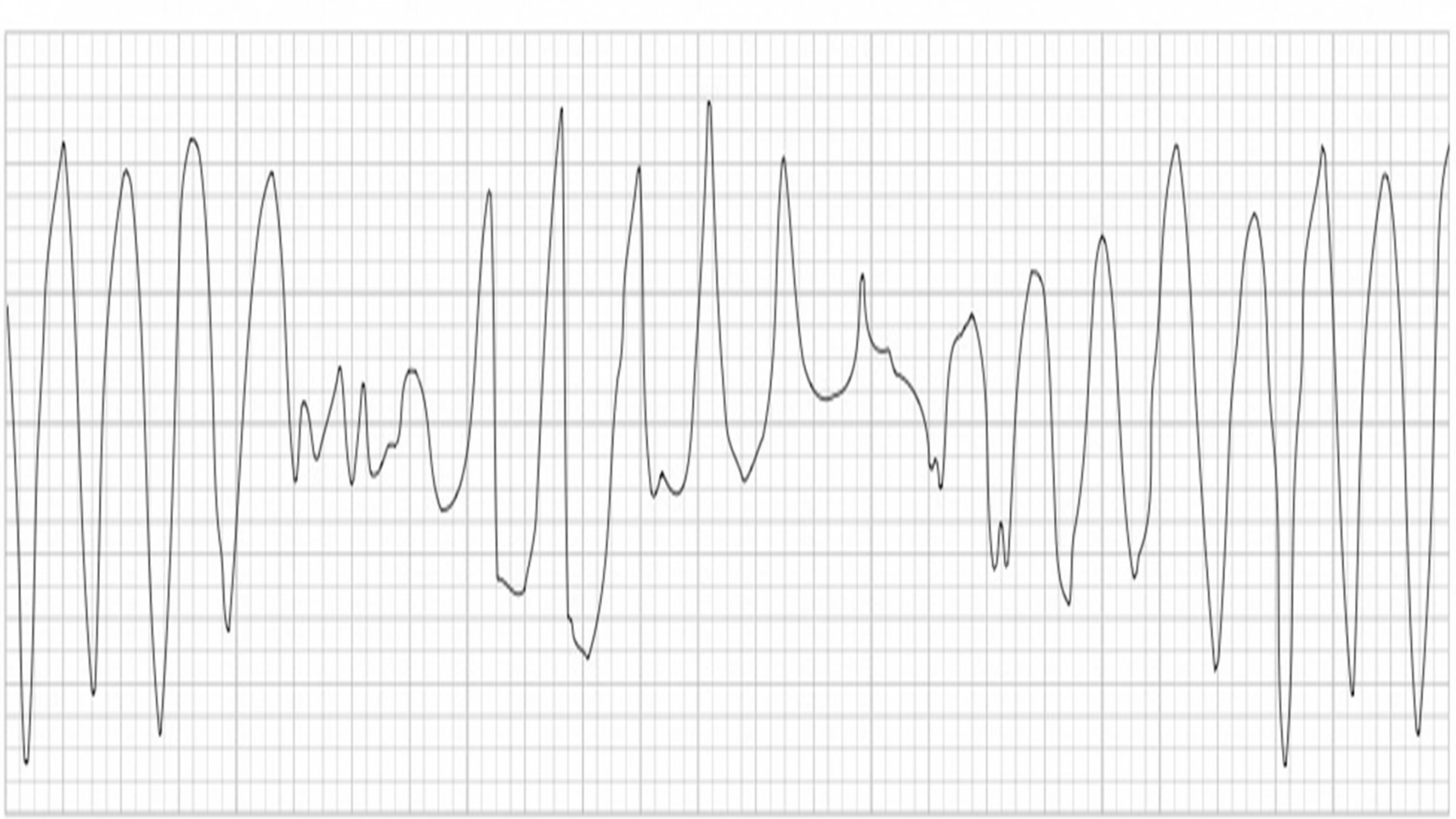
- Ventricular tachycardia (VT) is defined by three or more repetitive PVCs occurring at a rate greater than 100 beats/min.

- It occurs most commonly in acute myocardial infarction (MI); other causes are severe electrolyte abnormalities (e.g., hypokalemia), hypoxemia, and digitalis toxicity.

- The chronic recurrent form is almost always associated with underlying organic heart disease (e.g., idiopathic dilated cardiomyopathy or remote MI with left ventricular [LV] aneurysm).



Monomorphic ventricular tachycardia



Torsades de pointes

QRS complexes varying in amplitude, axis and duration.

- Incessant VT refers to VT occurring more frequently than sinus rhythm, so that VT becomes the dominant rhythm.

- Monomorphic VT has a consistent QRS configuration, whereas polymorphic VT has varying QRS complexes.

- Torsade de pointes (TdP) is a polymorphic VT in which the QRS complexes appear to undulate around a central axis.

BRADYARRHYTHMIAS:

- Asymptomatic sinus bradyarrhythmias (heart rate less than 60 beats/min) are common especially in young, athletically active individuals.

- However, some patients have sinus node dysfunction (sick sinus syndrome) because of underlying organic heart disease and the normal aging process, which attenuates SA nodal function.

- AV block or conduction delay may occur in any area of the AV conduction system. AV block may be found in patients without underlying heart disease (e.g., trained athletes) or during sleep when vagal tone is high.

CLINICAL PRESENTATION

- Supraventricular tachycardias may cause a variety of clinical manifestation ranging from no symptoms to minor palpitations and/or irregular pulse to severe and even life-threatening symptoms.

- Patients may experience dizziness or acute syncopal episodes; symptoms of HF; anginal chest pain; or, more often, a choking or pressure sensation during the tachycardia episode.

- Patients with bradyarrhythmias experience symptoms associated with hypotension such as dizziness, syncope, fatigue, and confusion.

- If LV dysfunction exists, symptoms of congestive HF may be exacerbated.

DESIRED OUTCOME

- The desired outcome depends on the underlying arrhythmia.

- For example, the ultimate treatment goals of treating AF or atrial flutter are restoring sinus rhythm, preventing thromboembolic complications, and preventing further recurrences.

- Drugs may have antiarrhythmic activity by directly altering conduction in several ways.

- Drugs may depress the automatic properties of abnormal pacemaker cells by decreasing the slope of phase 4 depolarization and/or by elevating threshold potential.

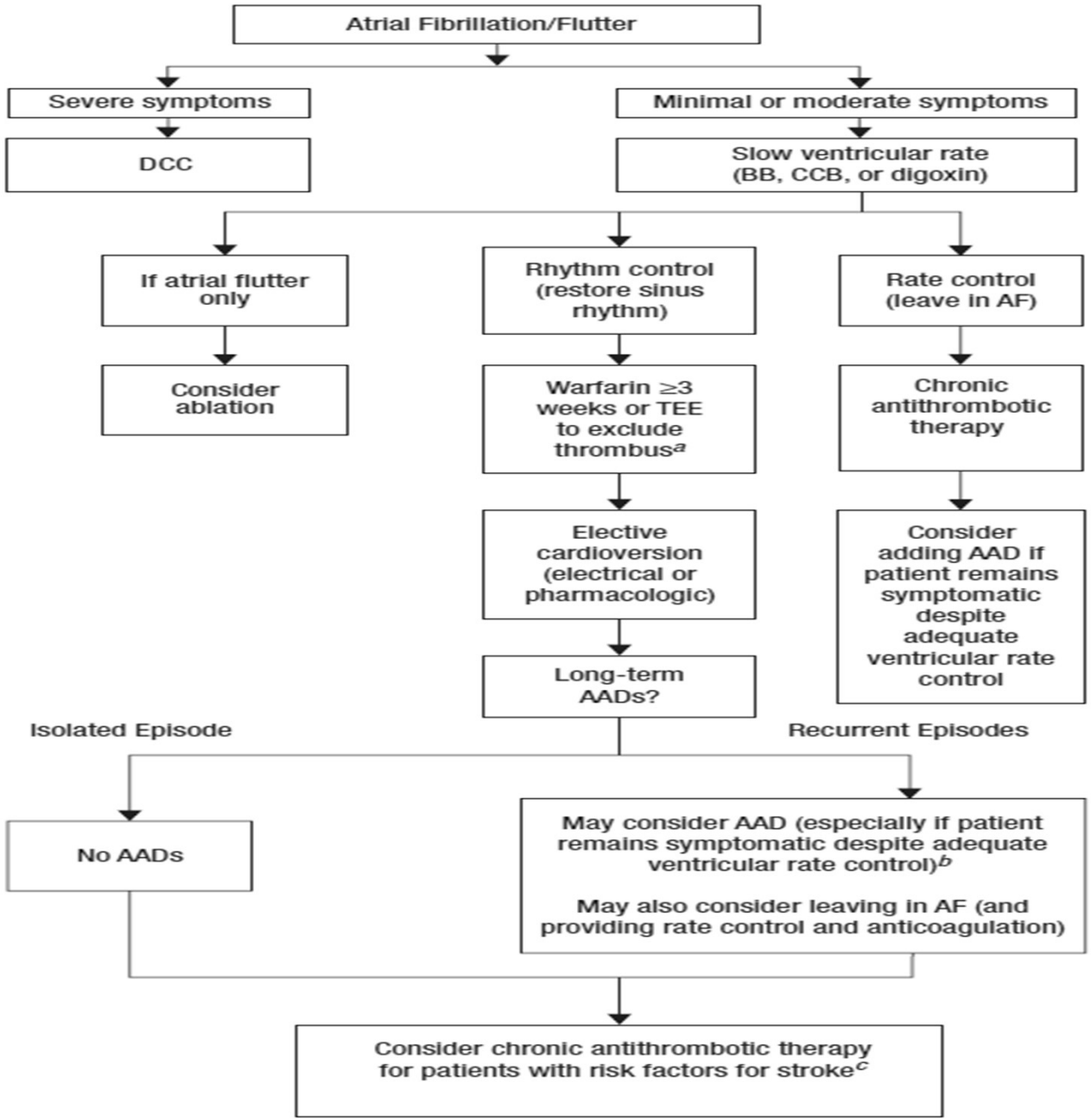
Type	Drug	Conduction Velocity[a]	Refractory Period	Automaticity	Ion Block
Ia	Quinidine Procainamide Disopyramide	↓	↑	↓	Sodium (intermediate) Potassium
Ib	Lidocaine Mexiletine	0/↓	↓	↓	Sodium (fast on/off)
Ic	Flecainide Propafenone[b] Moricizine[c]	↓↓	0	↓	Sodium (slow on/off) Potassium[d]
II[e]	β-Blockers	↓	↑	↓	Calcium (indirect)
III	Amiodarone[f] Dofetilide Sotalol[b] Ibutilide	0	↑↑	0	Potassium
IV[e]	Verapamil Diltiazem	↓	↑	↓	Calcium

Typical Maintenance Doses of Oral Antiarrhythmic Drugs

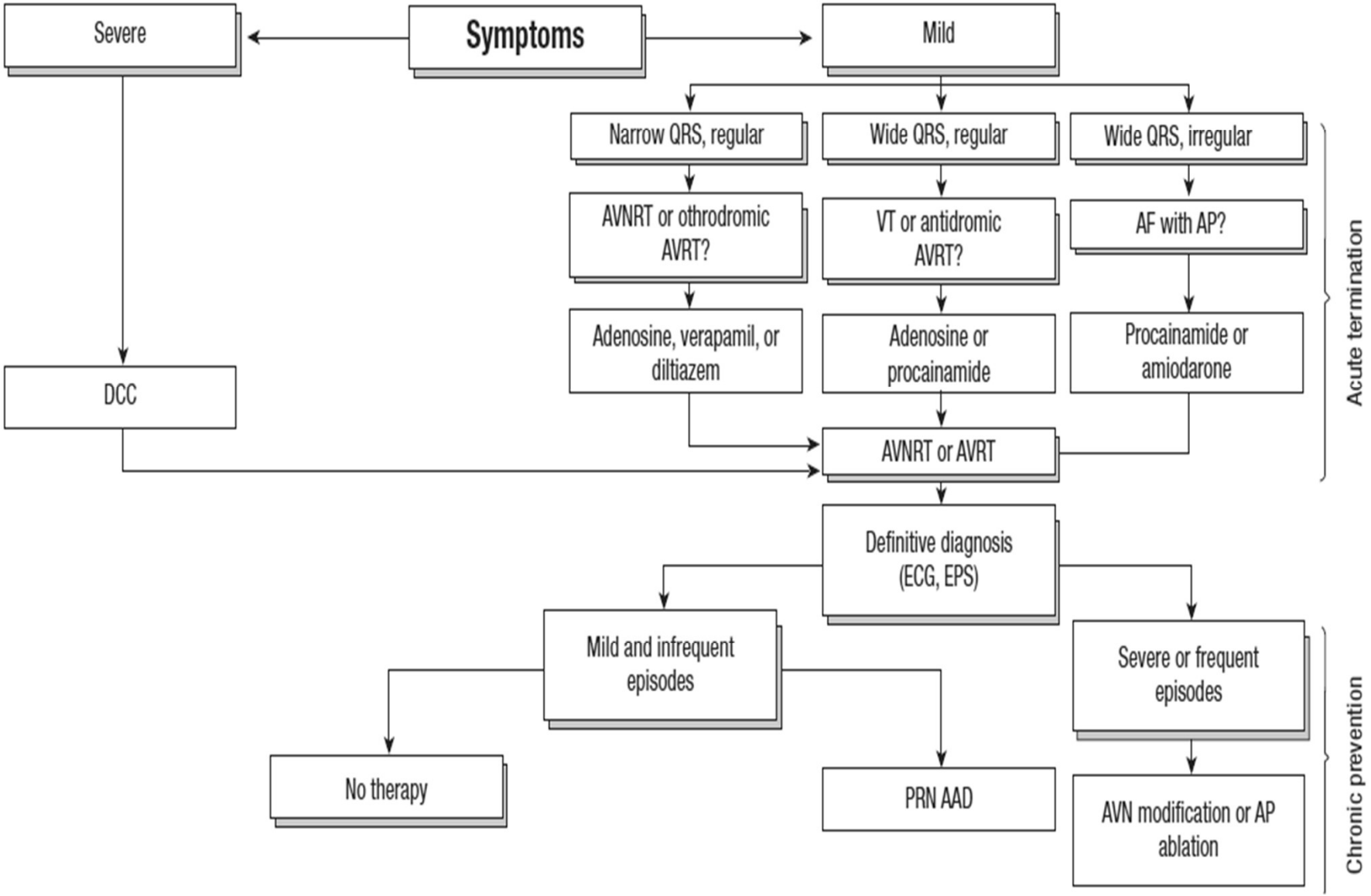
Drug	Dose	Dose Adjusted
Quinidine	200–300 mg sulfate salt q 6 h 324–648 mg gluconate salt q 8–12 h	HEP, age >60 years
Procainamide	500–1,000 mg q 6 h (Pronestyl SR) 1,000–2,000 mg q 12 h (Procanbid)	HEP, REN[a]
Disopyramide	100–150 mg q 6 h 200–300 mg q 12 h (SR form)	HEP, REN
Mexiletine	200–300 mg q 8 h	HEP
Flecainide	50–150 mg q 8 h	HEP, REN
Propafenone	150–300 mg q 8 h	HEP
Moricizine	200 mg q 8 h	HEP, REN
Sotalol	80–160 mg q 12 h	REN[b]
Dofetilide	500 mcg q 12 h	REN[c]
Amiodarone	400 mg two to three times daily until 10 g total, then 200–400 mg daily[d]	

Intravenous Antiarrhythmic Dosing

Drug	Clinical Situation	Dose
Amiodarone	Pulseless VT/VF	300 mg IV/IO push (can give additional 150 mg IV/IO push if persistent VT/VF), followed by infusion of 1 mg/min for 6 hours, then 0.5 mg/min
	Stable VT (with a pulse)	150 mg IV over 10 minutes, followed by infusion of 1 mg/min for 6 hours, then 0.5 mg/min
	AF (termination)	5 mg/kg IV over 30 minutes, followed by infusion of 1 mg/min for 6 hours, then 0.5 mg/min
Diltiazem	PSVT; AF (rate control)	0.25 mg/kg IV over 2 minutes (may repeat with 0.35 mg/kg IV over 2 minutes), followed by infusion of 5–15 mg/hour
Ibutilide	AF (termination)	1 mg IV over 10 minutes (may repeat if needed)
Lidocaine	Pulseless VT/VF	1–1.5 mg/kg IV/IO push (can give additional 0.5–0.75 mg/kg IV/IO push every 5–10 minutes if persistent VT/VF [maximum cumulative dose = 3 mg/kg]), followed by infusion of 1–4 mg/min (1–2 mg/min if liver disease or HF)
	Stable VT (with a pulse)	1–1.5 mg/kg IV push (can give additional 0.5–0.75 mg/kg IV push every 5–10 minutes if persistent VT [maximum cumulative dose = 3 mg/kg]), followed by infusion of 1–4 mg/min (1–2 mg/min if liver disease or HF)
Procainamide	AF (termination); stable VT (with a pulse)	15–18 mg/kg IV over 60 minutes, followed by infusion of 1–4 mg/min
Verapamil	PSVT; AF (rate control)	2.5–5 mg IV over 2 minutes (may repeat up to maximum cumulative dose of 20 mg); can follow with infusion of 2.5–15 mg/hour


Atrial Fibrillation/Flutter
Severe symptoms
DCC
Minimal or moderate symptoms
Slow ventricular rate (BB, CCB, or digoxin)
If atrial flutter only
Consider ablation
Rhythm control (restore sinus rhythm)
Warfarin ≥3 weeks or TEE to exclude thrombus[a]
Elective cardioversion (electrical or pharmacologic)
Long-term AADs?
Rate control (leave in AF)
Chronic antithrombotic therapy
Consider adding AAD if patient remains symptomatic despite adequate ventricular rate control
Isolated Episode
Recurrent Episodes
No AADs
May consider AAD (especially if patient remains symptomatic despite adequate ventricular rate control)[b]
May also consider leaving in AF (and providing rate control and anticoagulation)
Consider chronic antithrombotic therapy for patients with risk factors for stroke[c]

treatment of acute *(top portion)* paroxysmal supraventricular tachycardia and chronic prevention of recurrences



Acute Ventricular Tachycardia

- If severe symptoms are present, synchronized DCC should be institute immediately to restore sinus rhythm.

- Patients with mild or no symptoms can be treated initially with antiarrhythmic drugs. IV amiodarone is now recommended as first-line therapy in this situation.

- Patients with chronic recurrent sustained VT are at extremely high risk for death; trial-and-error attempts to find effective therapy are unwarranted.

- The automatic ICD (implantable cardioverter-defibrillator) is a highly effective method for preventing sudden death due to recurrent VT or VF.

- For an acute episode of TdP, most patients require and respond to DCC.

- However, TdP tends to be paroxysmal and often recurs rapidly after DCC.

- IV magnesium sulfate is considered the drug of choice for preventing recurrences of TdP.

- Agents that prolong the QT interval should be discontinued, and exacerbating factors (e.g., hypokalemia, hypomagnesemia) corrected. Drugs that further prolong repolarization (e.g., IV procainamide) are contraindicated. Lidocaine is usually ineffective.

- Treatment of sinus node dysfunction involves elimination of symptomatic bradycardia and possibly managing alternating tachycardias such as AF.

- In general, long-term therapy of choice for patients with significant symptoms is a permanent ventricular pacemaker.

- Patients who remain symptomatic may benefit from adding an α-adrenergic stimulant such as midodrine.

- Other drugs that have been used successfully (with or without β-blockers) include fludrocortisone, anticholinergics (scopolamine patches, disopyramide), α-adrenergic agonists (midodrine), adenosine analogs (theophylline, dipyridamole), and selective serotonin reuptake inhibitors (sertraline, fluoxetine).

Adenosine:

- Drug therapy involves blocking the AV node because most PSVT rhythms involve a re-entry circuit within this area.

- An initial 6-mg IV bolus is given; if this is unsuccessful within 2 minutes, it can be followed by one or two additional 12-mg IV boluses, up to a maximum of 30 mg.

- Because of its short half-life (9 seconds), adenosine should be administered as a rapid bolus (over 1–3 seconds), followed immediately by a saline flush.

- Nondihydropyridine calcium channel blockers, verapamil and diltiazem, can be used in patients with PSVT.

- Verapamil (2.5–5 mg IV given over 2 minutes) achieves peak therapeutic effects in 3 to 5 minutes after dosing and can be repeated at 10- to 15-minute intervals to a maximum dose of 20 mg if needed.

- In high-risk patients with MI who are not candidates for β-blockade, alternative antiarrhythmic therapy with amiodarone can be considered.

- Amiodarone is a class III antiarrhythmic agent but also has antiadrenergic, class I, and class IV activity.

- Treatment with amiodarone (800 mg/day for 7 days followed by 400 mg/day for 6 days of the week for 1 year) was associated with a significant reduction in cardiac mortality and significant ventricular arrhythmias.