



Heart function alterations *Arrhythmia, abnormal ECG*



Cardiovascular Physiology

Dr. Mohammad Ashraf

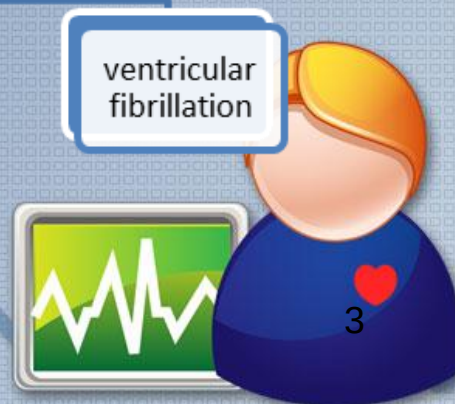
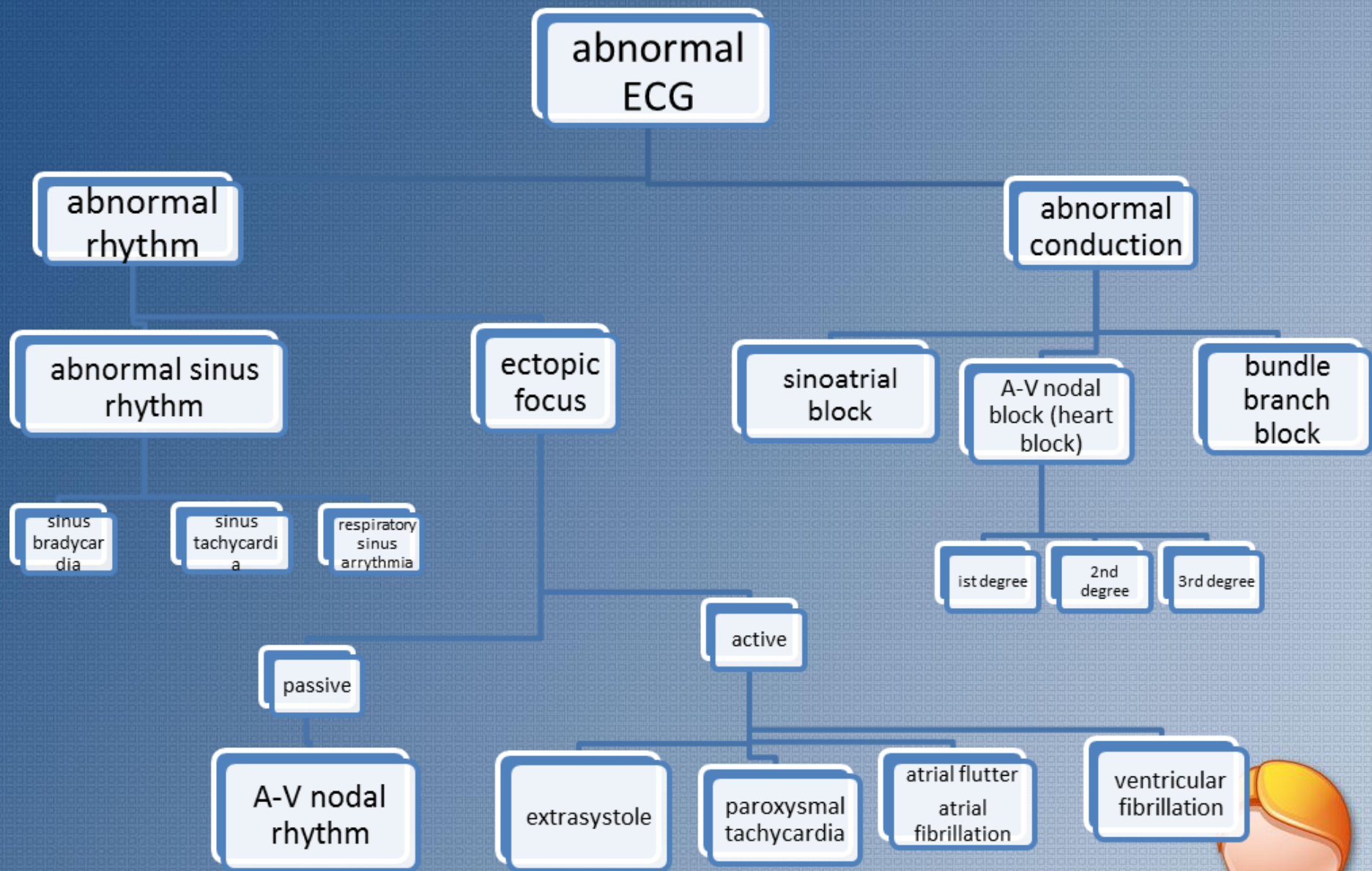


M.Ashraf - abnormal ECG

Arrhythmias

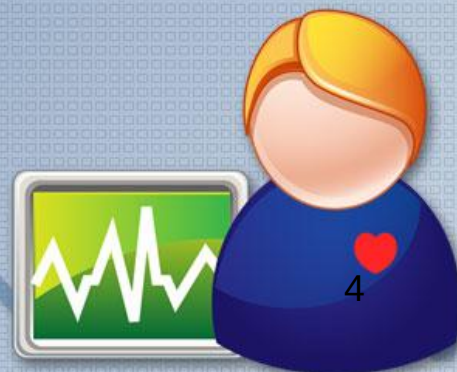
- Arrhythmias are abnormalities of electrical rhythm that result from abnormal impulse **formation**, impulse **conduction**, or **both**.
- Clinically, it is important to:
 - Identify common arrhythmias and their clinical presentation.
 - Understand underlying pathophysiology.
 - Determine if/what treatment is necessary.





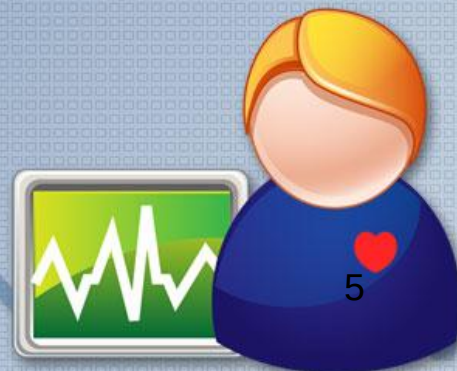
I. Abnormal sinus rhythm

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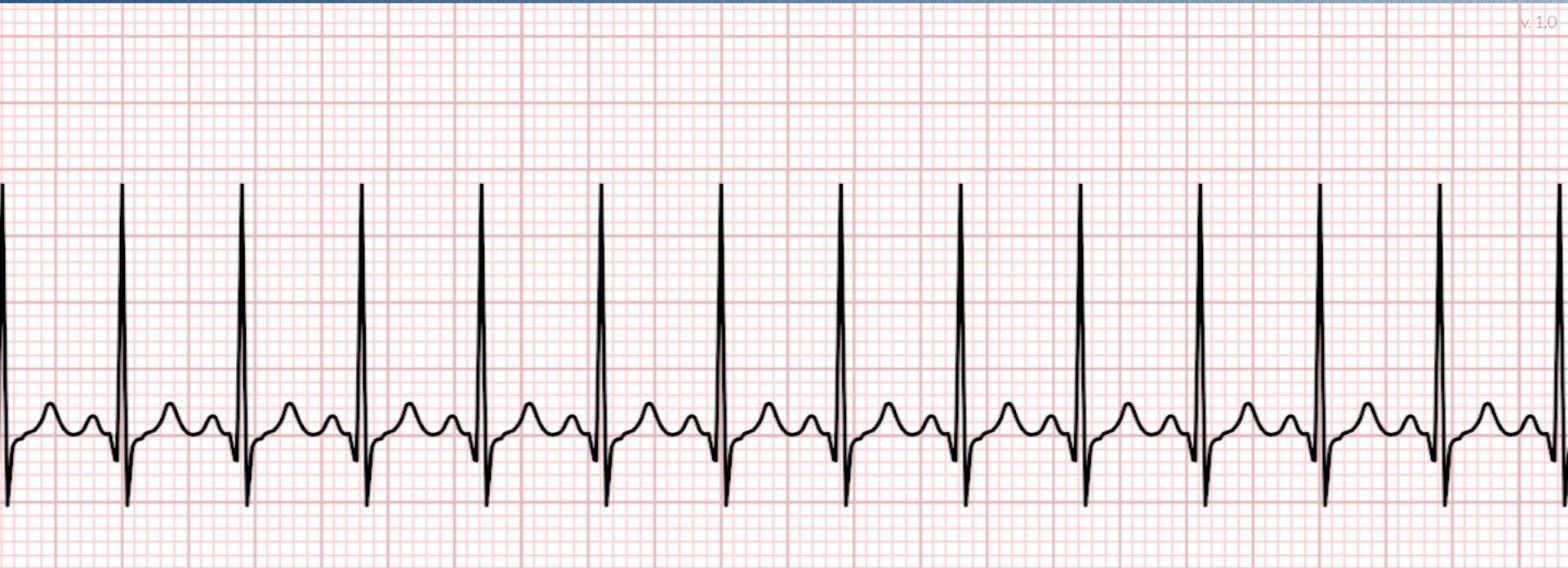


Sinus tachycardia

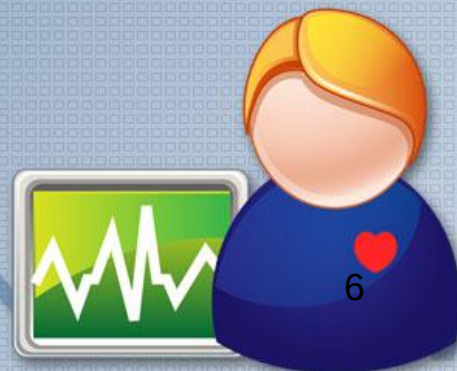
- The impulses arise from SAN but at a rate faster than 100 per min.
- causes:
 - Physiological: as in exercise, emotions.
 - Pathological: as fever, thyrotoxicosis & anemia.
- Patients may report heart palpitations.



- ECG: normal rapid waves.

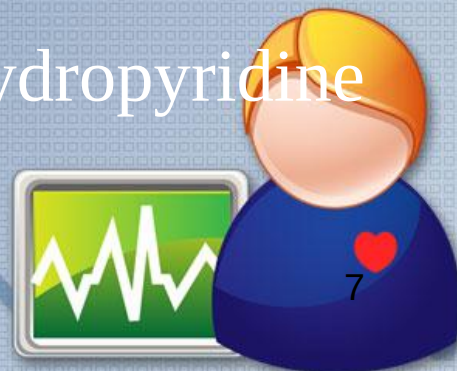


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Sinus bradycardia

- The impulses arise from SAN but at a rate slower than 60 per min.
- causes:
 - **Physiological:** as in athletics, during sleep.
 - **Pathological:** as hypothermia, myxoedema & ↑ intracranial tension & sick sinus syndrome (often develop in elderly).
 - **Drugs:** use of β -blockers and nondihydropyridine calcium channel blockers.



- ECG: normal slow waves

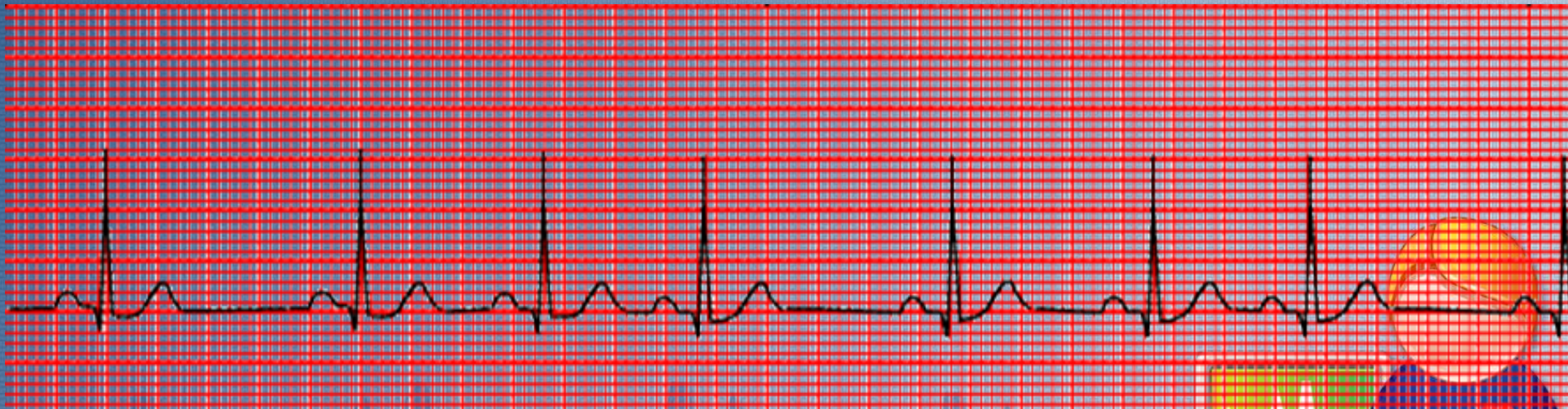


- Usually asymptomatic.
- **Treatment:**
 - If asymptomatic, no treatment is required.
 - If bradycardia causes symptoms of low COP (eg, syncope, altered mental status), treat with anticholinergics (eg, atropine). Pacemaker insertion if condition is chronic.



Respiratory sinus arrhythmia

- Normally, HR increases during inspiration and decreases during expiration.
- ECG: normal with increased HR during inspiration.

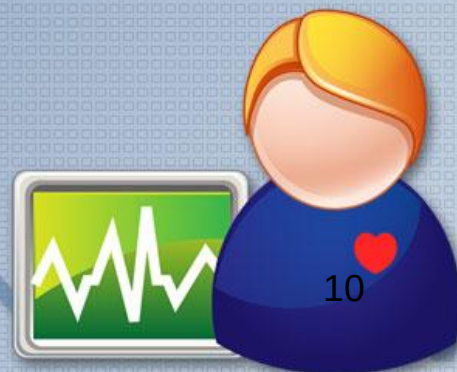


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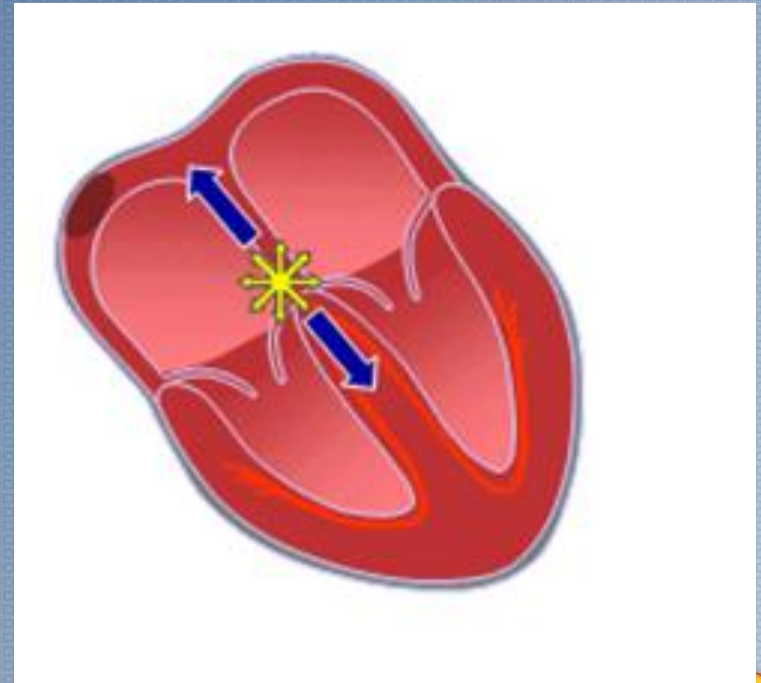
II. Ectopic rhythm

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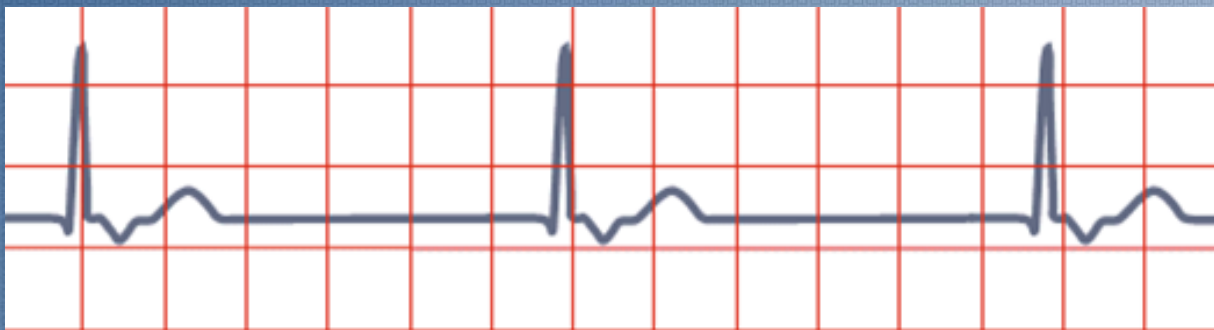
Passive ectopic A-V nodal rhythm

- When the SAN stops, the impulses will arise from the AVN.
- The rhythm is regular but slower.

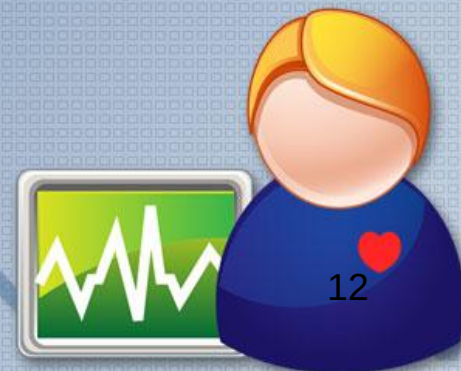


- ECG:

- ✓ Inverted P wave (may be before or after QRS and may be absent).
- ✓ Shortened P-R interval.
- ✓ Normal QRS & T waves.



P-wave is often inverted, may be under or after QRS complex
Heart rate is slow



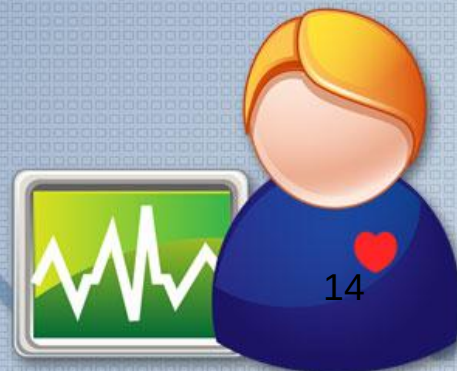
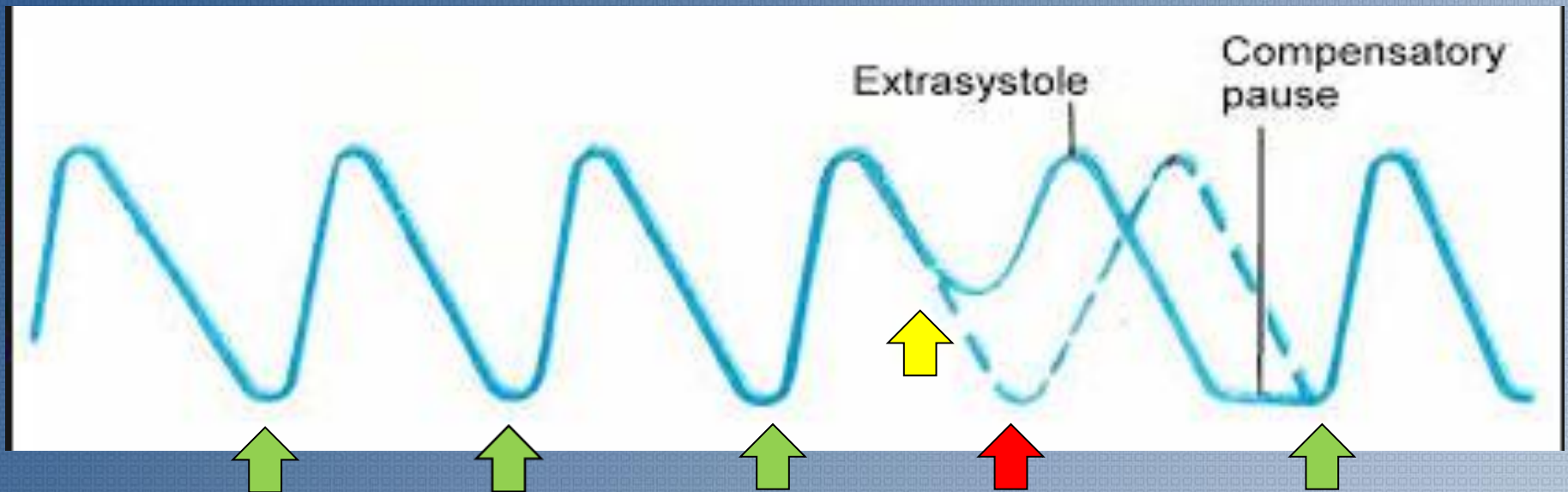
Active ectopic

Extrasystole (premature beat)

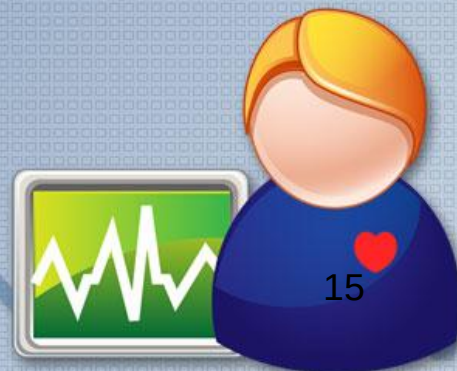
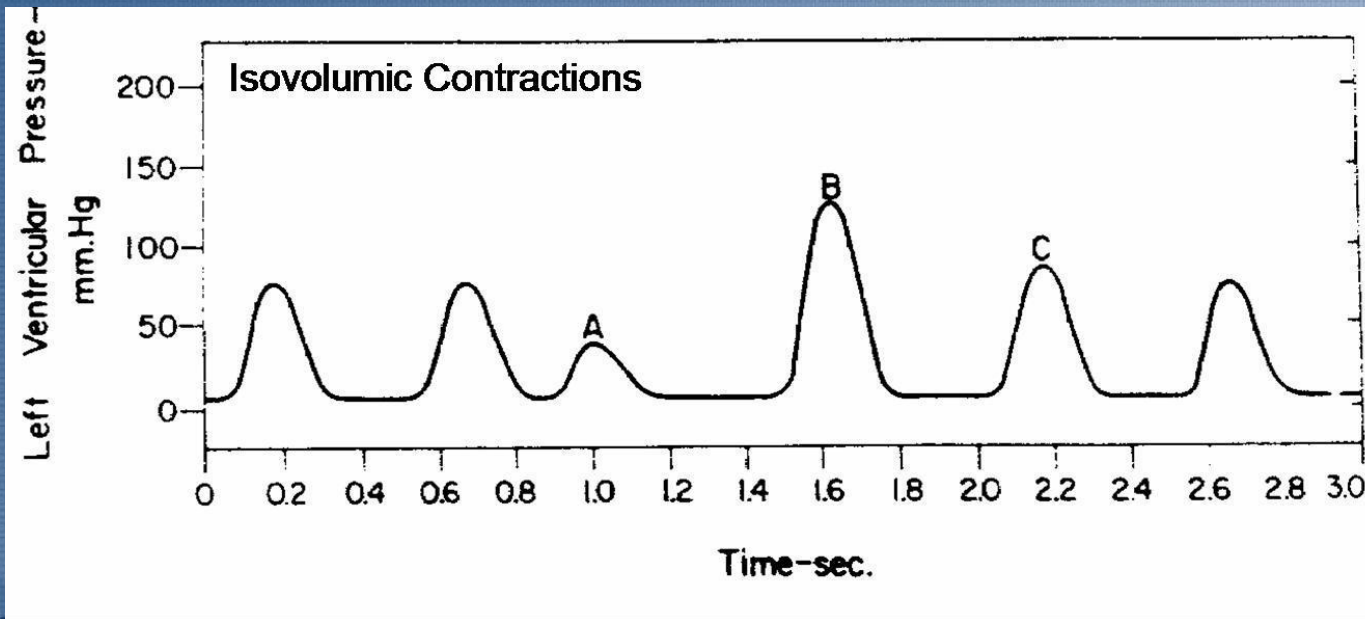
- This is a premature cardiac contraction produced by discharge from ectopic focus during diastole i.e. occurring before the next expected normal beat.
- As the next SA nodal impulse will fall during the absolute refractory period of the extrasystole, extrasystole is usually followed by a compensatory pause.



- Usually asymptomatic but some patients report palpitations or feel a “skipped beat.”



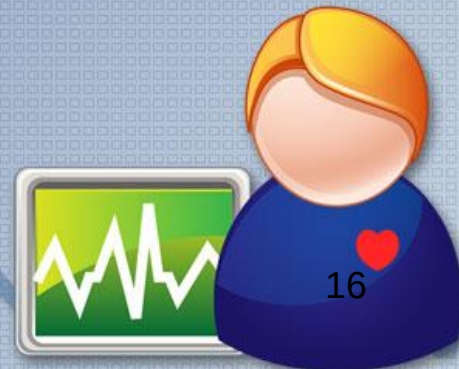
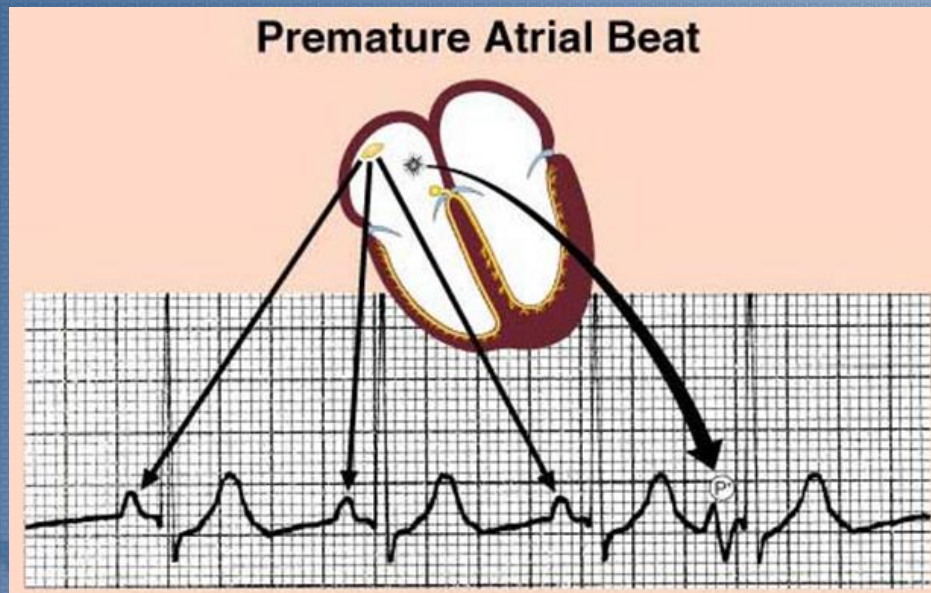
- The contraction produced by the extrasystole is weaker than normal contractions because the time available for ventricular filling is decreased.
- The contraction produced by the SAN after the compensatory pause is stronger than other contractions because the time available for ventricular filling is increased.



Types of extrasystole

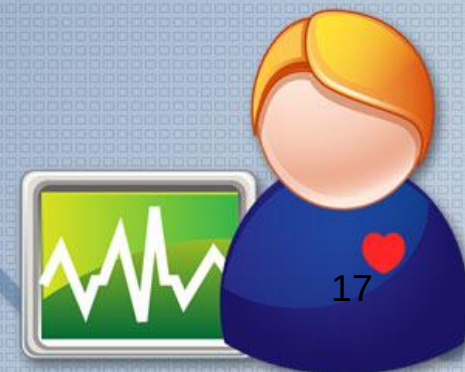
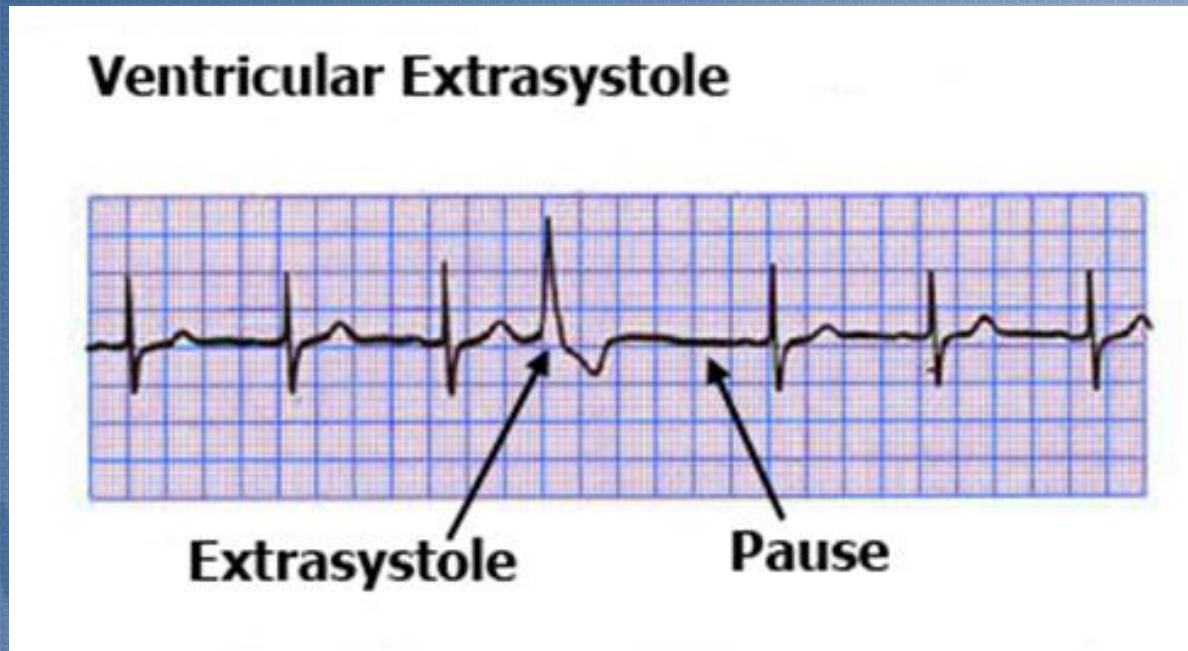
1. Atrial extrasystole: (the ectopic focus is in the atrium)

- ✓ The whole impulse is premature (short T-P line)
- ✓ P wave is abnormal (inverted or notched).
- ✓ QRS complex is normal.
- ✓ Followed by *incomplete* compensatory pause.



2. **Ventricular extrasystole:** (the ectopic focus is in the ventricle)

- ✓ The whole impulse is premature (short T-P line)
- ✓ P wave is absent.
- ✓ QRS complex is abnormal shaped (bizarre shaped), prolonged duration.
- ✓ Inverted T wave.
- ✓ Followed by compensatory pause.

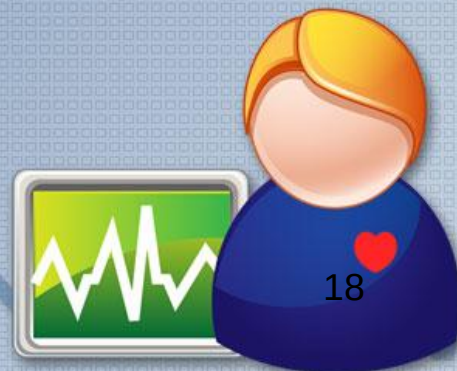




Multifocal PVC's: more than one shape



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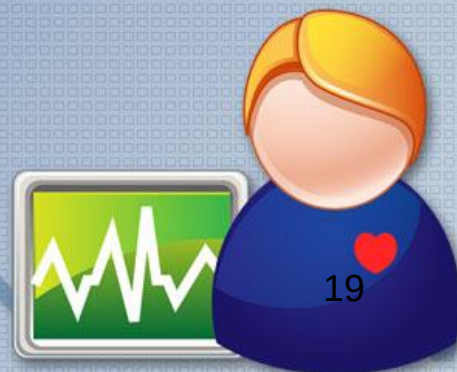


- **Treatment**

⇒ **Reassurance:** PVCs alone are not life threatening and do not increase the risk of fatal arrhythmias in individuals without underlying heart disease.

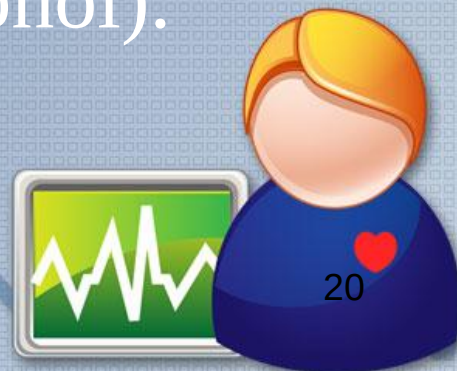
⇒ **Avoidance** of triggers of ectopic foci (eg, caffeine, nicotine, Anxiety and lack of sleep)

⇒ Electrolyte repletion may be helpful.



Paroxysmal tachycardia

- ⇒ This condition is characterized by **sudden** attacks of increased HR (> 200 beats / min.) that last for seconds, minutes, hours or even a day then the attack end **suddenly** i.e. in *paroxysms*.
- ⇒ Patients may report palpitations with/without precipitants (eg, stress, caffeine, alcohol).



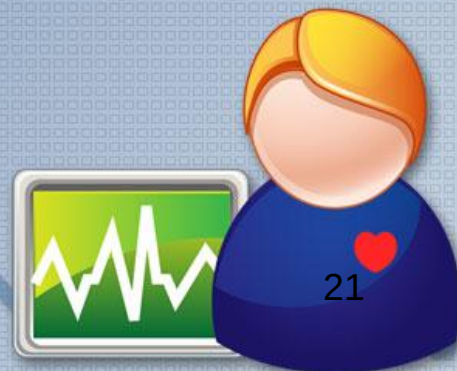
⇒ **Paroxysmal tachycardia may be:**

✓ **Supraventricular tachycardia.**

- Atrial.

- A-V nodal re-entrant tachycardia (AVNRT) (the most common)

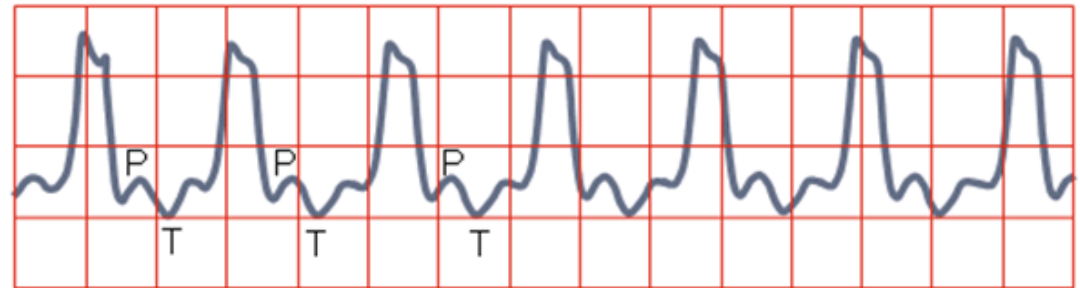
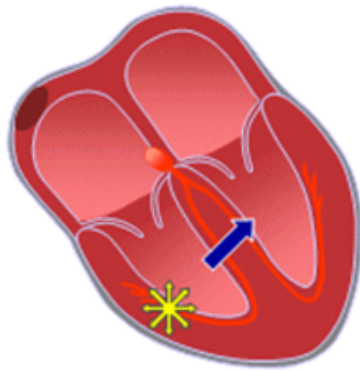
✓ **Ventricular tachycardia:** serious condition as it indicates a considerable damage in the ventricles and may lead to fatal ventricular fibrillation.



⇒ **ECG**: as extrasystole but the waves are repeated all over the paroxysm. retrograde P waves (via a reentry circuit) may be inverted or hidden

VENTRICULAR TACHYCARDIA

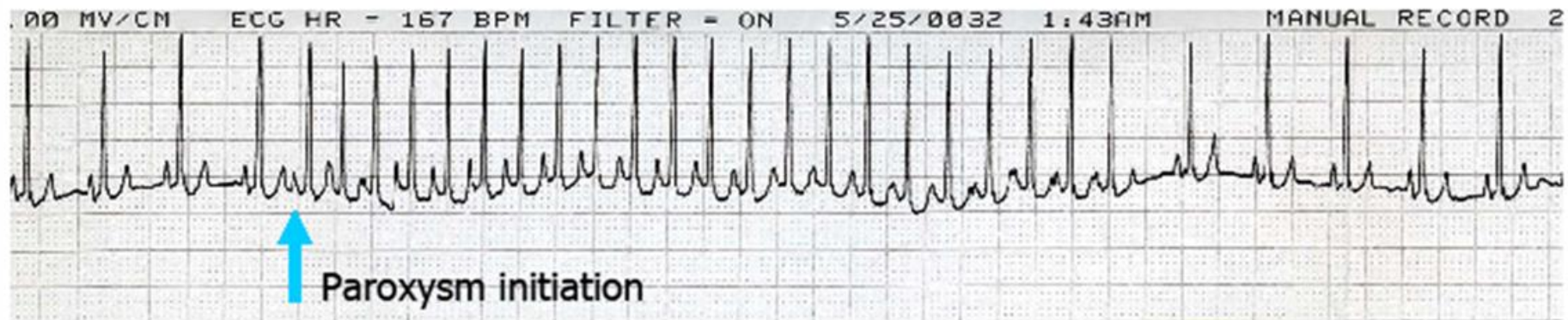
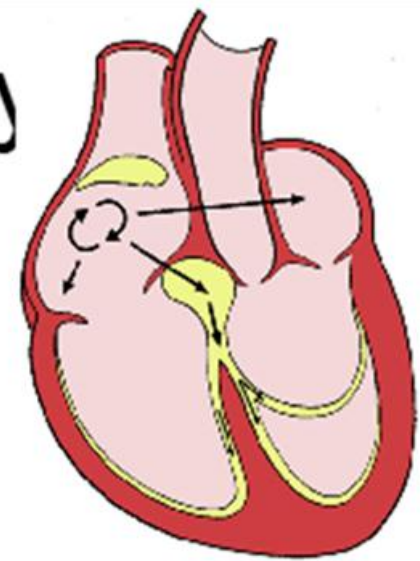
Impulses originate at ventricular pacemaker



Wide ventricular complexes. Rate > 120/min



Supraventricular tachy

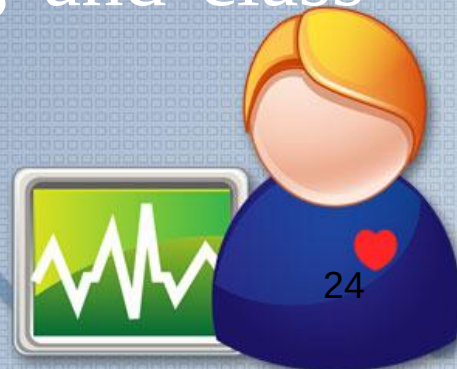


*AKA **Paroxysmal** atrial tachycardia

*Paroxysm = abrupt change

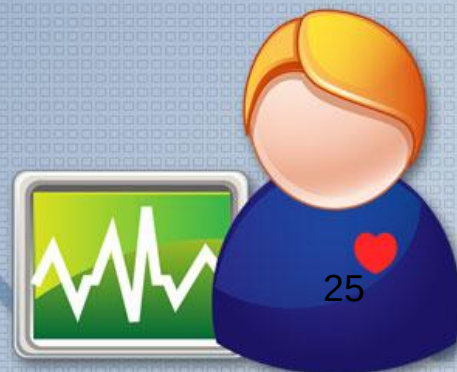
Treatment

- Paroxysmal Supraventricular tachycardia can be terminated by:
 - **pressure on the eyeball** (*oculo-cardiac reflex*) or *on the carotid sinus*.
 - If that is not successful, **IV adenosine** (also slows AV node conduction) is a rapid therapy.
- For more long-term control: β -blockers, nondihydropyridine CCBs, ablation, and class IA or IC antiarrhythmics.



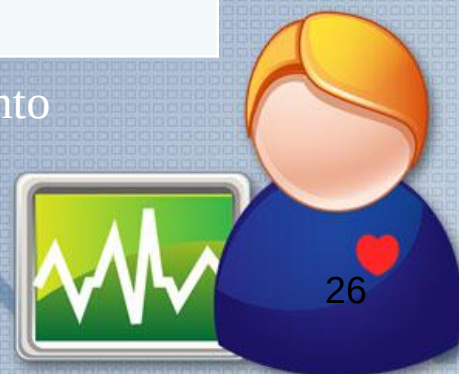
Atrial flutter & atrial fibrillation

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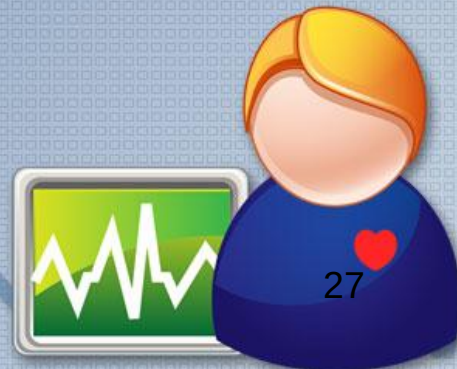
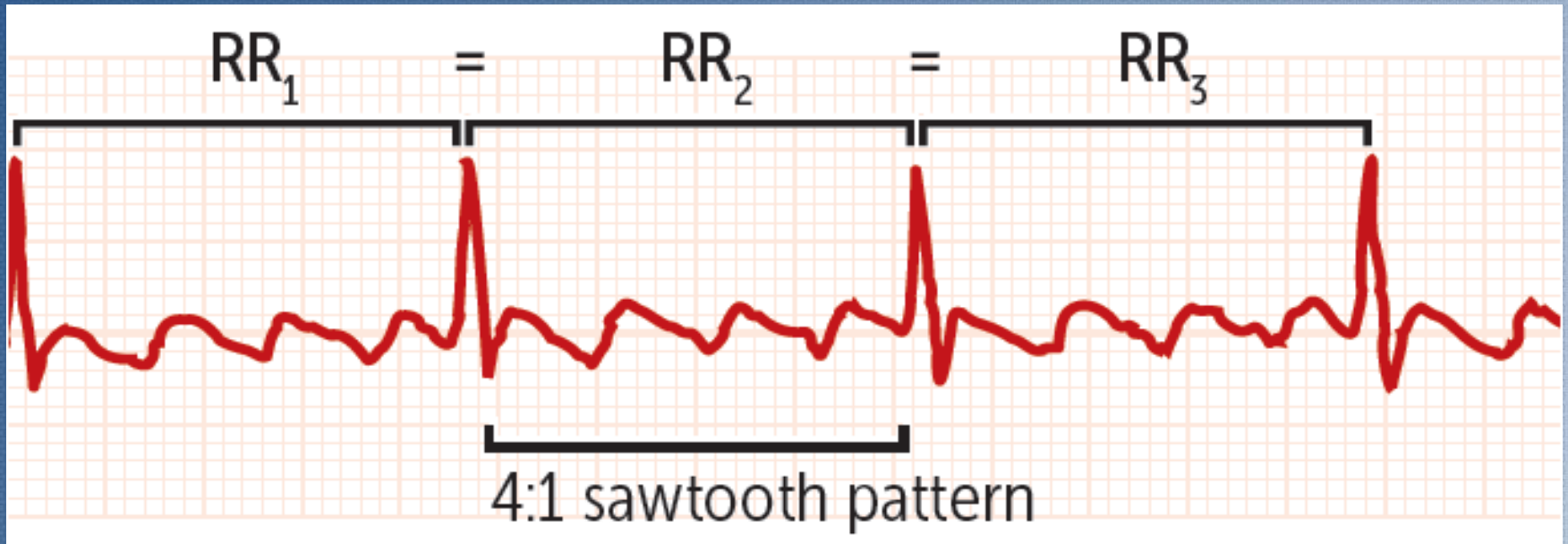


	Atrial flutter	atrial fibrillation
Atrial rhythm	200 – 400 Regular Atrium contracts as one unit	400 – 600 Irregular No effective atrial contractions
Ventricular rhythm	Regular	Irregular irregularity
ECG	Multiple P waves (saw tooth appearance) Normal & regular QRS & T waves	Absent P waves or replaced by f waves. Normal but irregular QRS & T waves.
Pulse deficit	Absent	present

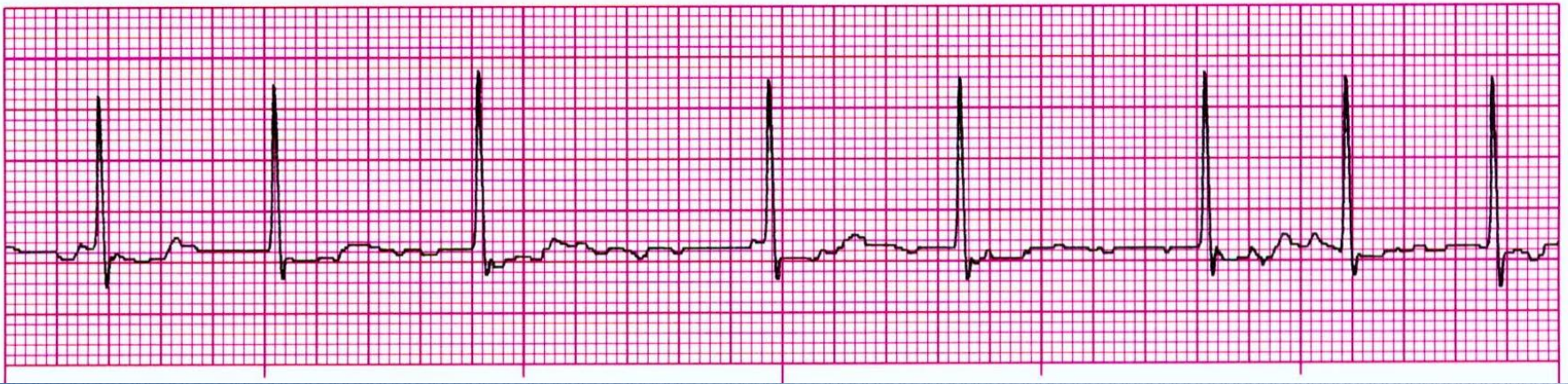
Flutter is a transient disease either return to sinus rhythm or converted into fibrillation.



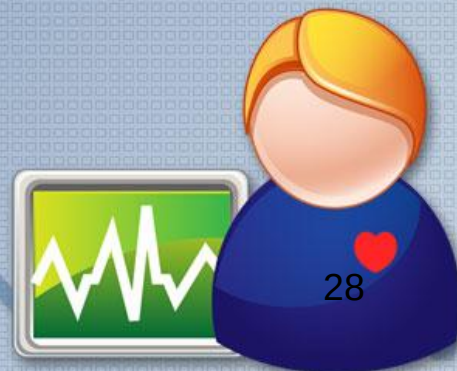
Atrial flutter



Atrial fibrillation



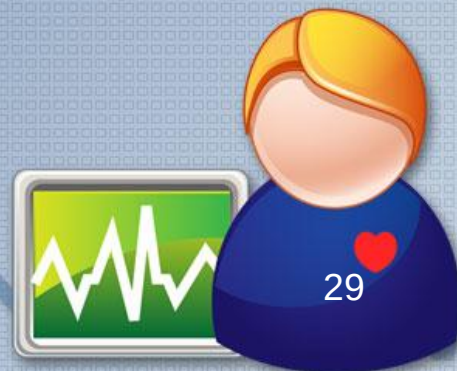
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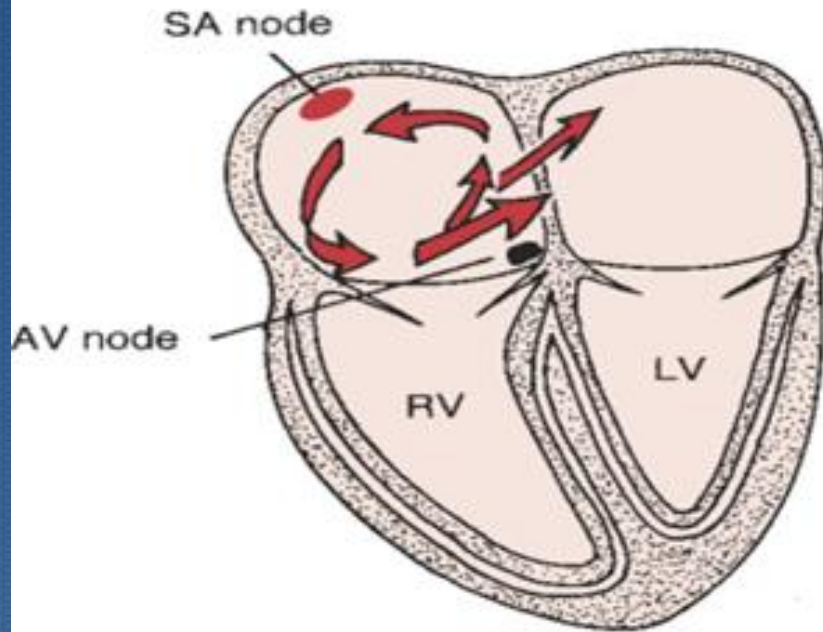
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Most common risk factors of atrial fibrillation are:

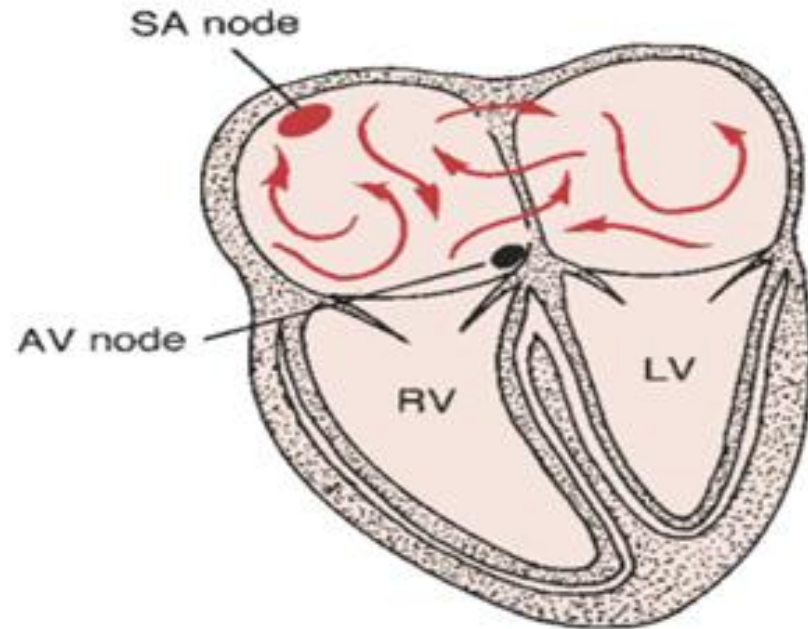
- ⇒ Often associated with right or left atrial enlargement eg, from mitral stenosis.
- ⇒ Hypertension The most important risk factor in the United States.
- ⇒ Coronary artery disease.
- ⇒ Congestive heart failure.
- ⇒ Excessive alcohol intake.
- ⇒ Thyrotoxicosis.



ATRIAL FLUTTER



ATRIAL FIBRILLATION



These make the formation of multiple re-entry circuits more likely to occur due to:

- i. Elongation of the pathway by atrial dilatation.*
- ii. Delay in conduction by ischemia.*
- iii. Shortening of absolute refractory period by drugs.*



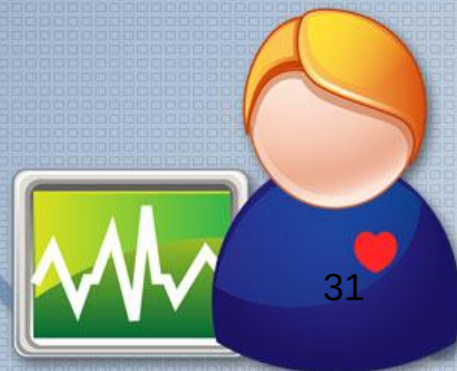
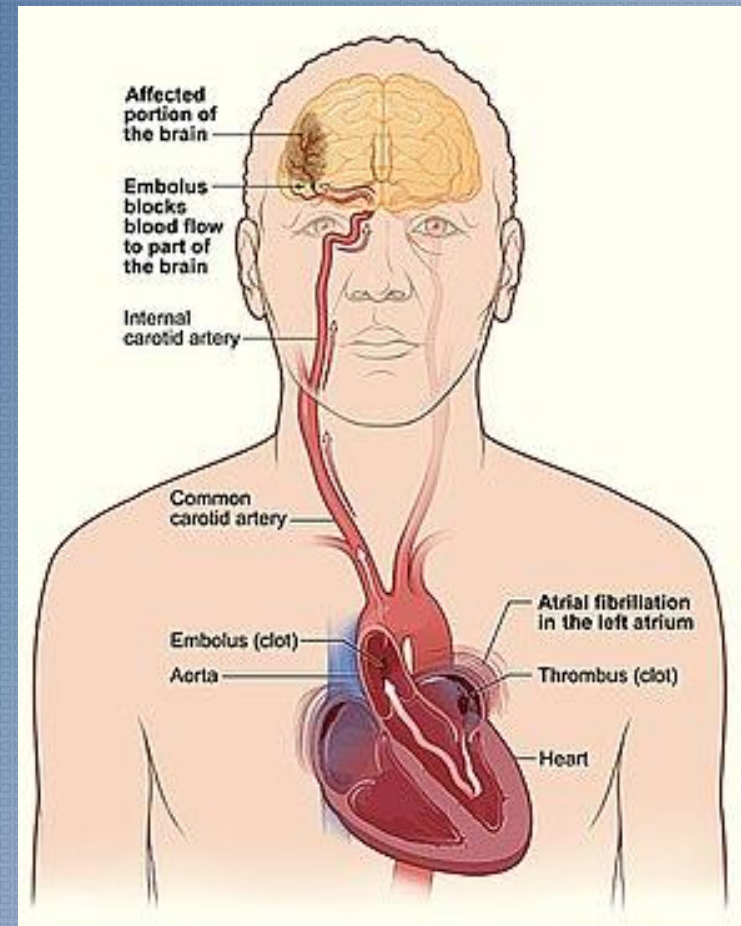
- **Problems of Atrial fibrillation:**

⇒ Impaired CO due to rapid ventricular rate.

⇒ Can lead to thromboembolic events, particularly stroke.

- **Treatment:**

anticoagulation, rate control, rhythm control, and/or cardioversion. Definitive treatment is catheter ablation.



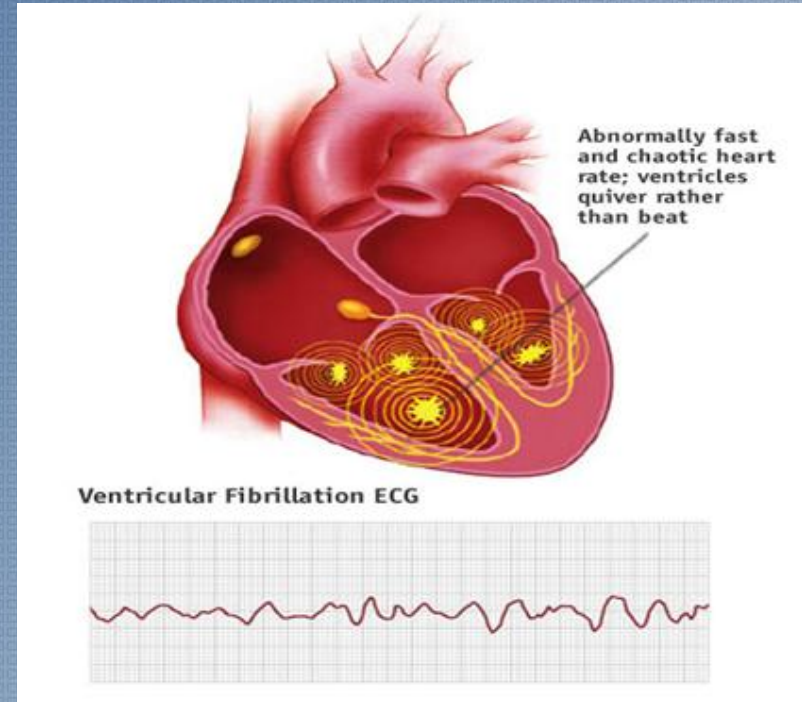
Ventricular fibrillation

⇒ Fatal if not treated promptly by immediate CPR and defibrillation.

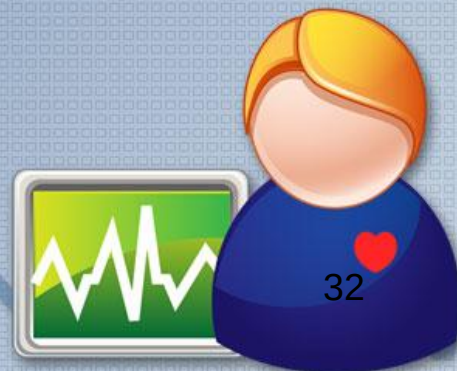
⇒ The ventricular muscle contract in irregular ineffective way.

⇒ Mostly, VF develops from untreated sustained VT in patients with underlying heart disease.

⇒ In a minority of cases, idiopathic VF can develop.



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⇒ **ECG**: A completely irregular inconstant rhythm with no identifiable waves.

Ventricular Fibrillation



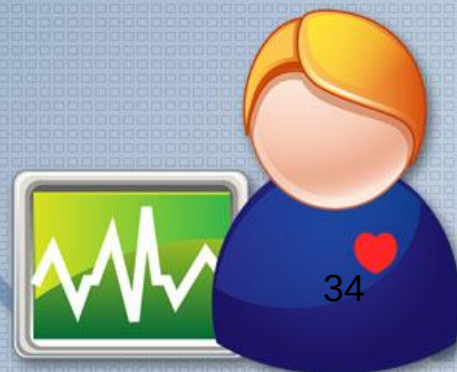
Heart Rate	Rhythm	P Wave	PR interval (in seconds)	QRS (in seconds)
300-600	Extremely irregular	Absent	N/A	Fibrillatory baseline

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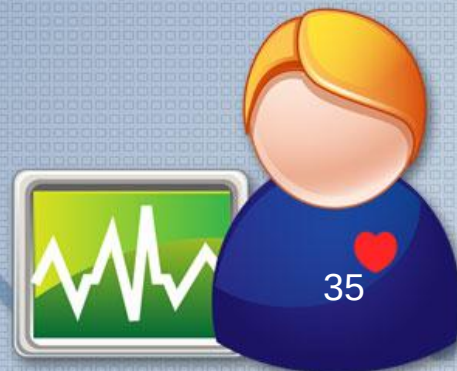
Abnormal conduction

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Sinoatrial block

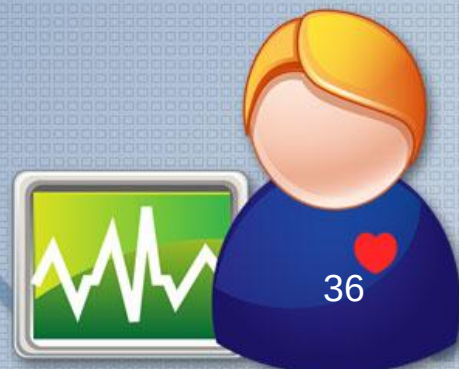
- The impulse fails to escape from the SAN.
- The whole beat is missed.
- If the condition is permanent the heart picks up a new rhythm from the AVN.
- If the condition is temporary as in sick sinus syndrome the sinus rhythm returns again.



Sinus Pause



Heart Rate	Rhythm	P Wave	PR interval (in seconds)	QRS (in seconds)
N/A	Irregular	Before each QRS identical. Dropped beat. The P to P interval is undisturbed.	.12 to .20	<.12

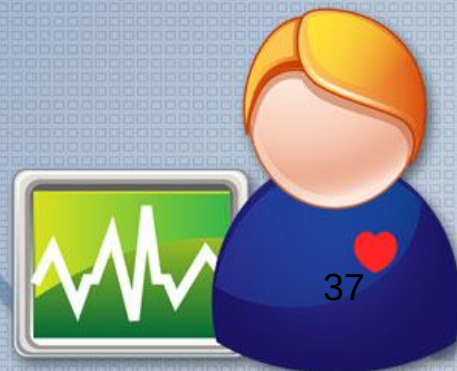


A-V nodal block

⇒ A delay or failure in conduction through the AV node.

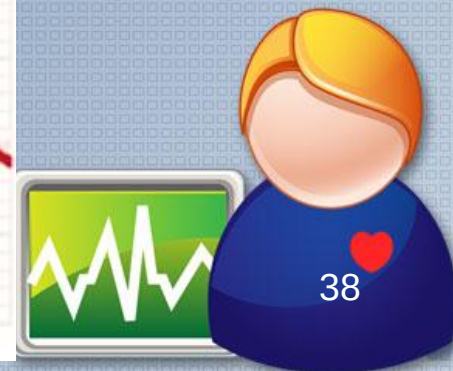
⇒ **has three types (or degrees):**

- 1st degree heart block.
- 2nd degree AV block.
- 3rd degree (complete) AV block



1st degree AV block

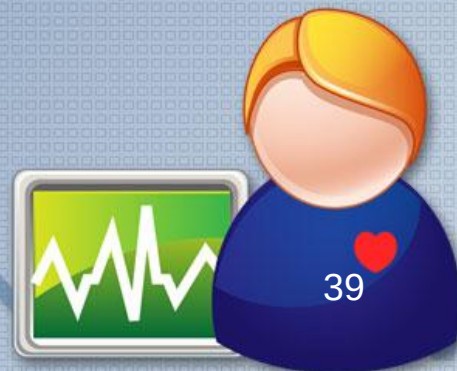
- ⇒ There is only prolongation of the P-R interval (above 0.20 second) but still all impulses from the SAN reach the ventricles.
- ⇒ Benign and asymptomatic. No treatment required except that of underlying cause to prevent progression to more advanced degrees.



Causes of AV block

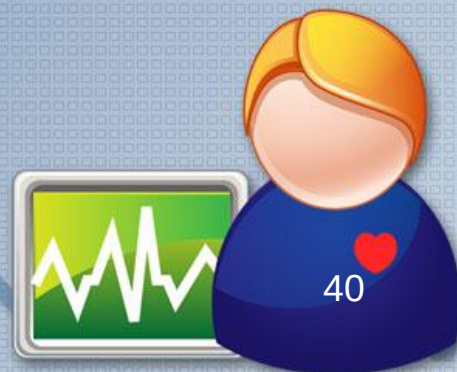
Reversible transient causes:

- High vagal tone.
- Transient ischemia.
- Drugs: β -blockers, nondihydropyridine CCBs, antiarrhythmics.
- Lyme disease.
- Commonly due to myocarditis.



Permanent structural cause:

- Myocardial infarction.
- Amyloidosis and sarcoidosis.
- Aging due to degeneration of the AV node conduction pathways.



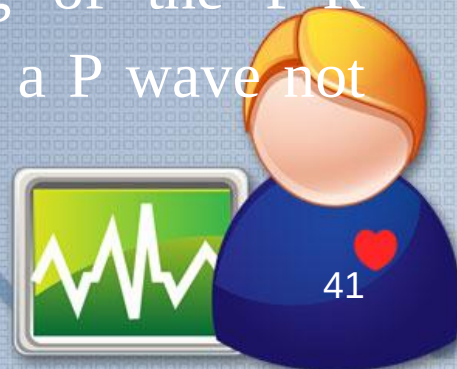
2nd degree heart block

⇒ Intermittent failure of AV conduction that results in a P wave not followed by QRS complex.

⇒ subdivided into Mobitz type I & Mobitz type II:

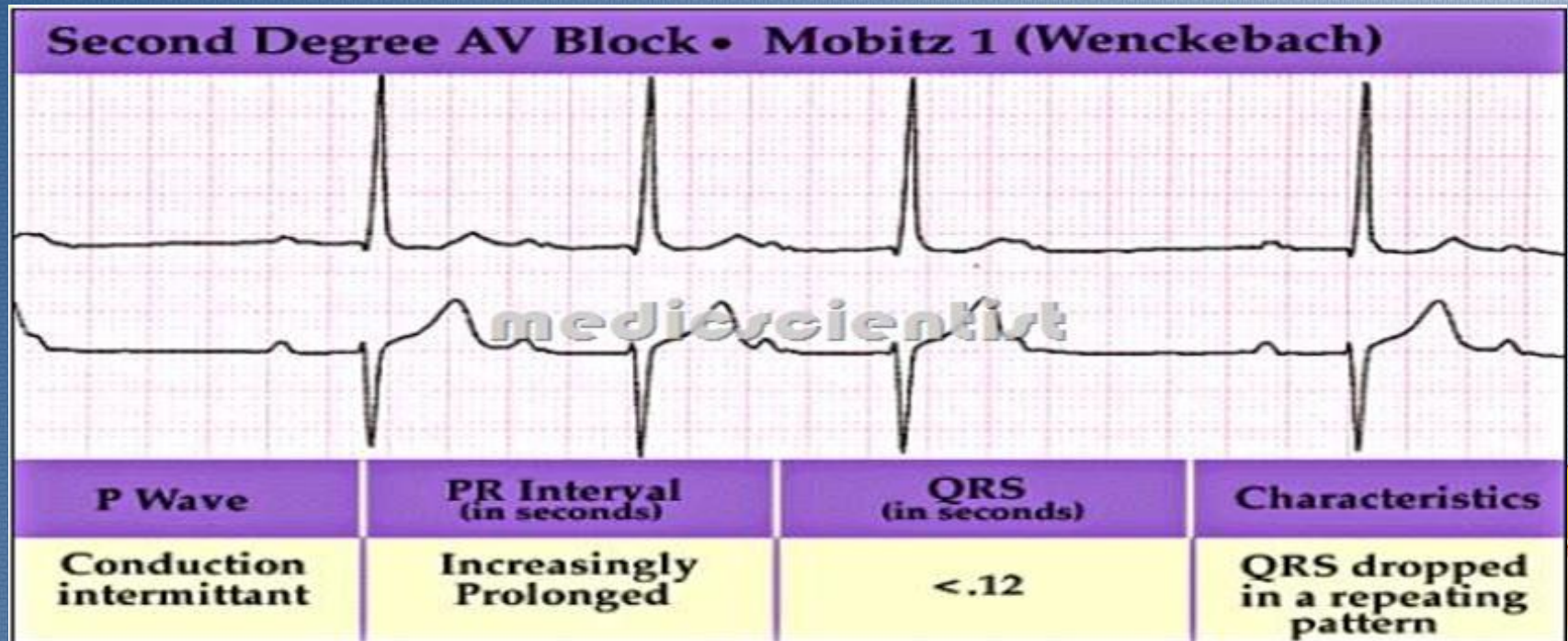
a) Mobitz type I “Wenckebach’s phenomenon”

⇒ ECG: there is progressive lengthening of the P-R interval for several successive beats until a P wave not followed by QRS complex.



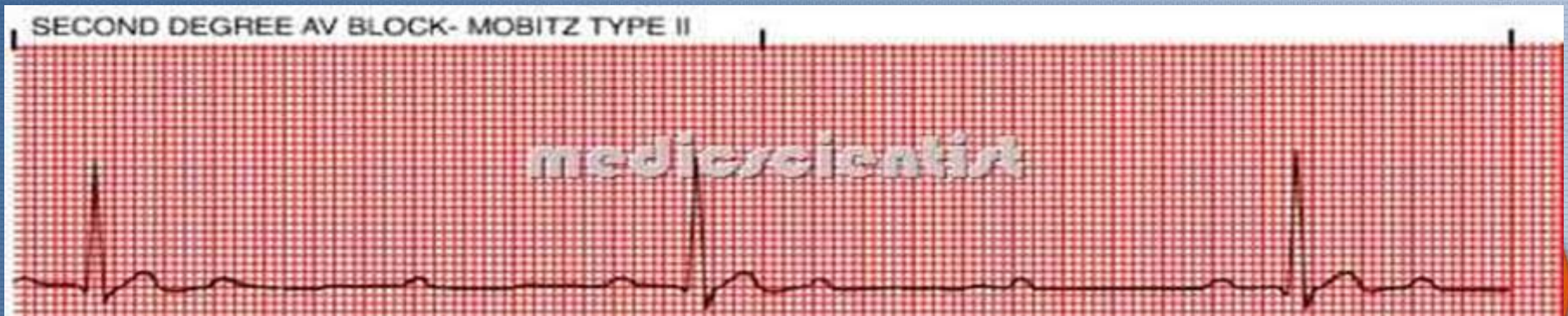
⇒ Variable RR interval with a pattern (regularly irregular).

⇒ Usually asymptomatic but may Needs pacemaker insertion.



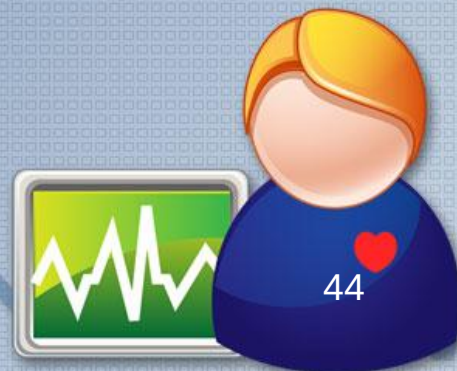
Mobitz type II:

- ⇒ ECG: the atrial rate is normal & regular. Every 2, 3 or 4 consecutive P waves are followed by one QRS complex (2:1 or 3:1 or 4:1 rhythm)
- ⇒ May progress to 3rd-degree block without warning.
- ⇒ Often treated with pacemaker even if asymptomatic.



3rd degree heart block

- ⇒ Complete block of AV nodal conduction → no impulses pass from atria to ventricles.
- ⇒ The atria will beat according to sinus rhythm (70 b / min) while the ventricles beat according to idioventricular rhythm (25-40 b / min).



⇒ **ECG**: complete dissociation between P-wave and QRS complexes. But the P waves alone are regular = 70 / min and the QRS complexes are regular = 25 / min

Third Degree (complete) AV Block



P Wave

**PR Interval
(in seconds)**

**QRS
(in seconds)**

Characteristics

**Normal but not
related to QRS**

None

N/A

**No relationship
between P&RS**

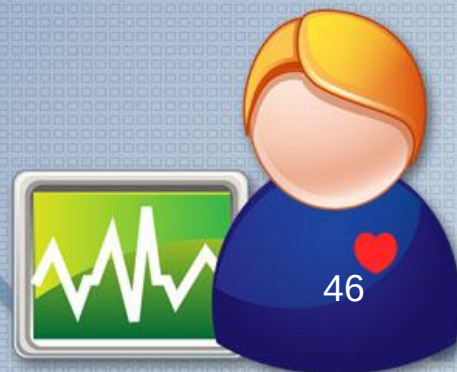
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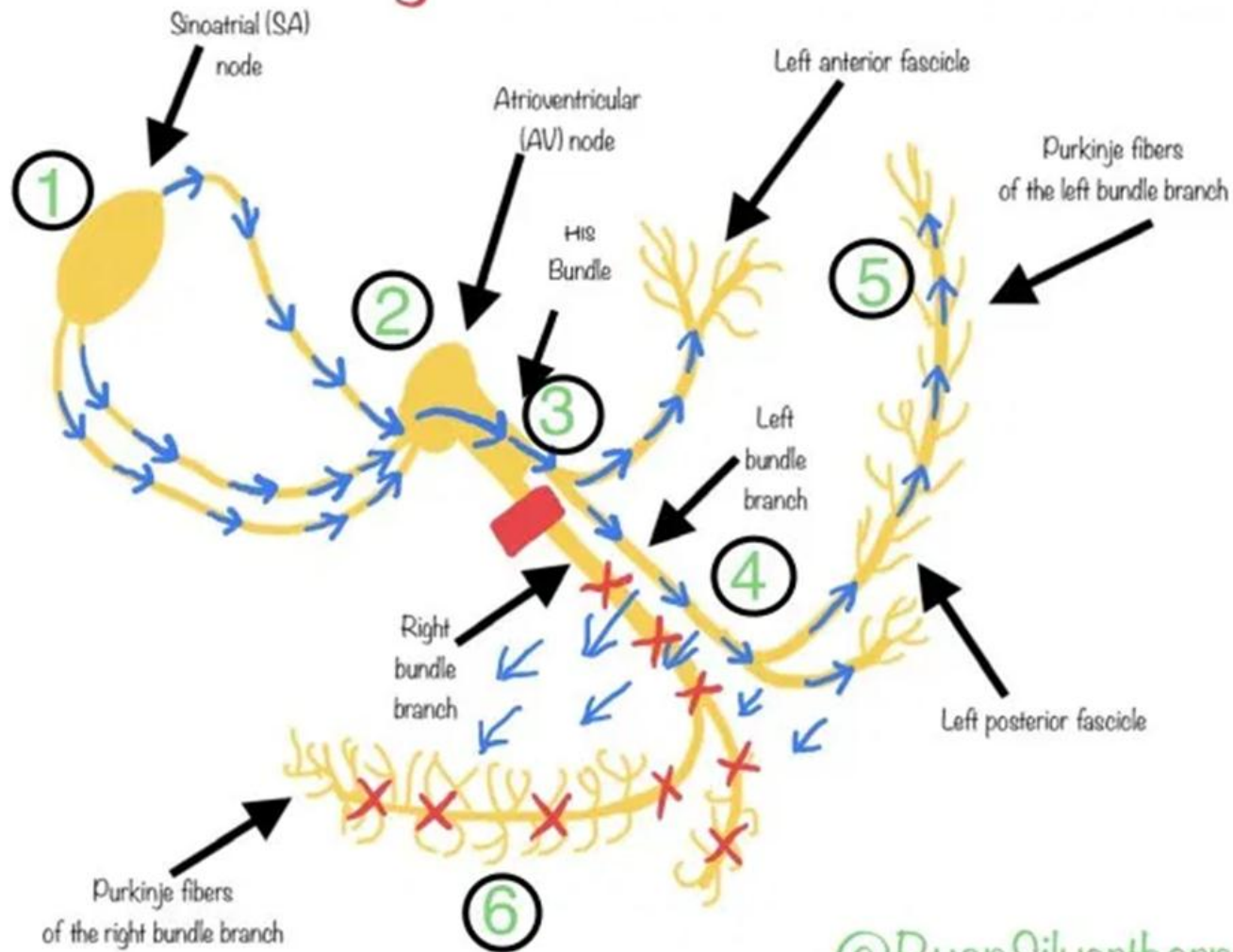
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Bundle Branch Block (BBB)

- ⇒ It may be right or left bundle branch block.
- ⇒ The impulse passes normally in the intact bundle and then reaches the other ventricle through the ventricular muscle.



Right Bundle Branch Block



@RyanSilverthorn

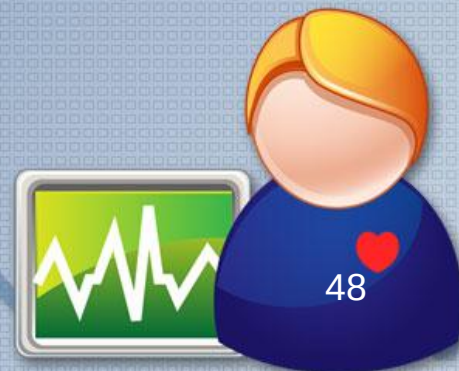
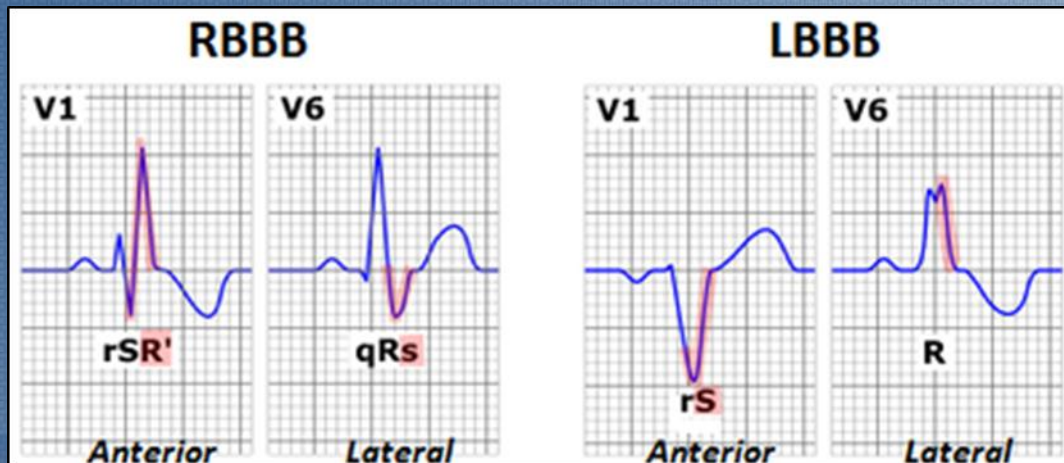
⇒ ECG:

- ✓ HR is normal.
- ✓ P wave is normal.
- ✓ QRS is widened with:

⇒ In Rt BBB it is M-shaped RSR' complex (“bunny ears”) in V1.

⇒ In Left BBB: Prominent S wave (no R wave) in V1.
Wide and notched R wave in V6.

- ✓ Inverted T wave.



Right Bundle Branch Block



P Wave	PR Interval (in seconds)	QRS (in seconds)	Characteristics
Before each QRS, identical	.12 to .20	>.12	RSR' in V1



Classification of arrhythmias according to heart rate

A. Arrhythmias with heart rate less than 60 b/m
(**bradyarrhythmias**):

sinus bradycardia, 2nd or 3rd degree AV block,

B. Arrhythmias with heart rate more than 100 b/m
(**tachyarrhythmias**):

sinus tachycardia, paroxysmal tachycardia, atrial flutter and atrial fibrillation.

C. Arrhythmias with normal heart rate: extrasystole, 1st degree AV block, BBB & respiratory sinus arrhythmia.



ECG changes in myocardial lesions

After few hours: elevation of ST segment in leads overlying the infarction & ST depression in leads of the opposite side of the heart.

After few days:

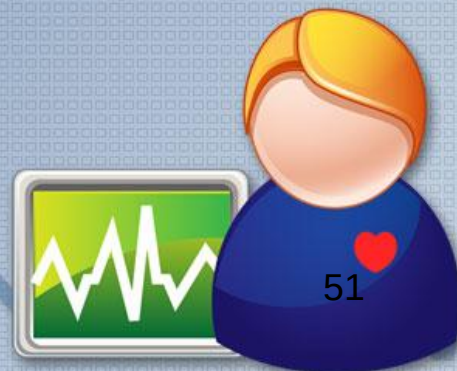
- ⇒ ST segment still elevated.
- ⇒ T wave becomes inverted.
- ⇒ Appearance of deep Q (pathological Q).

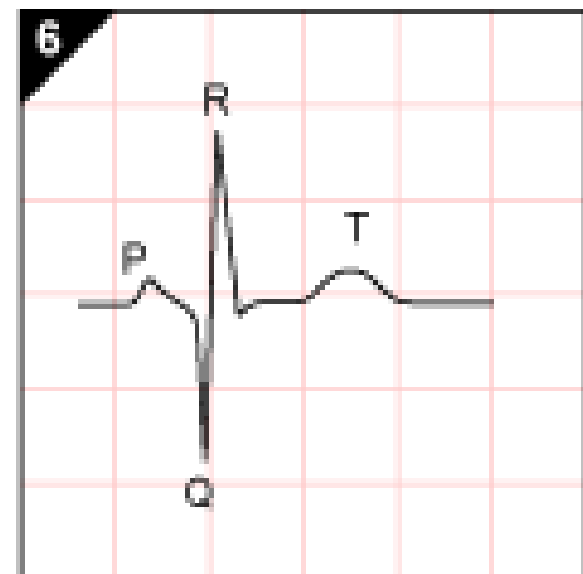
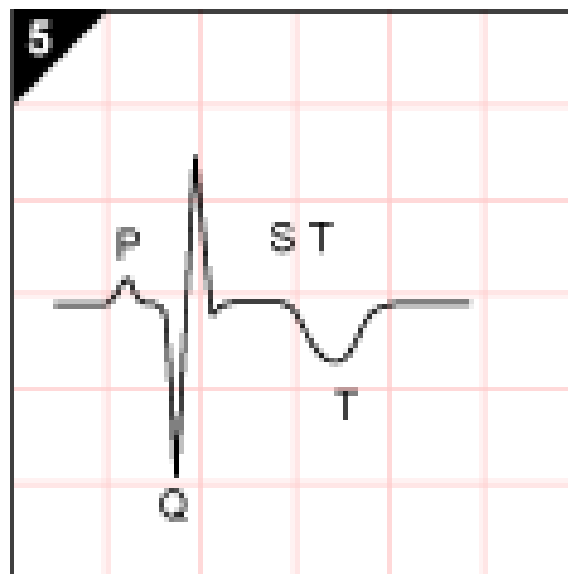
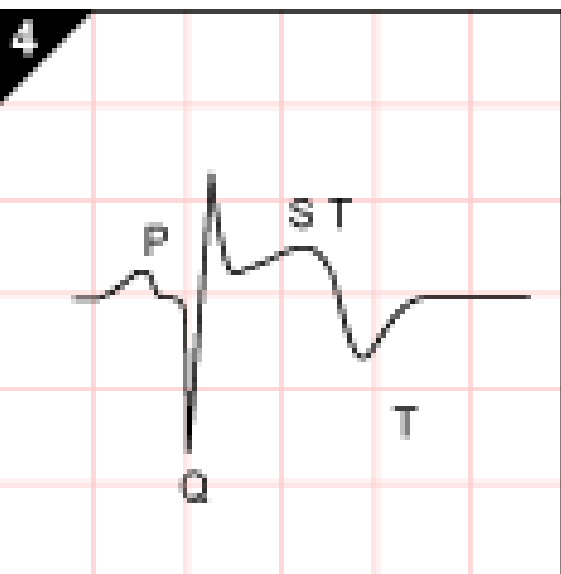
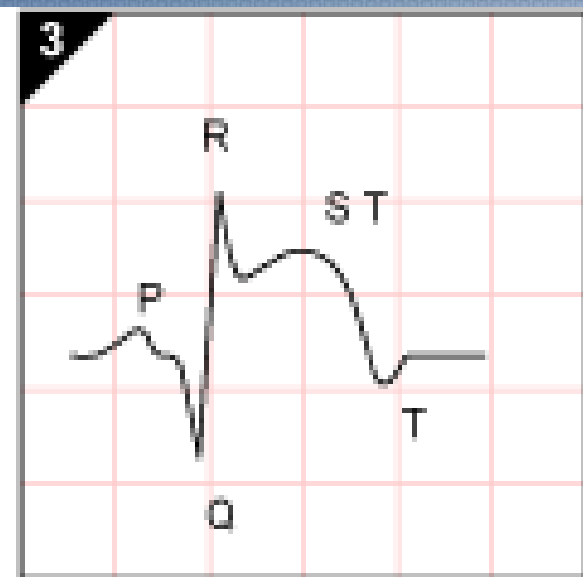
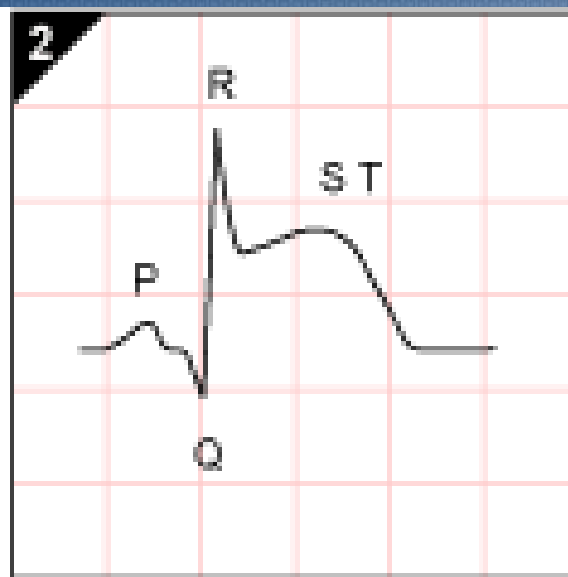
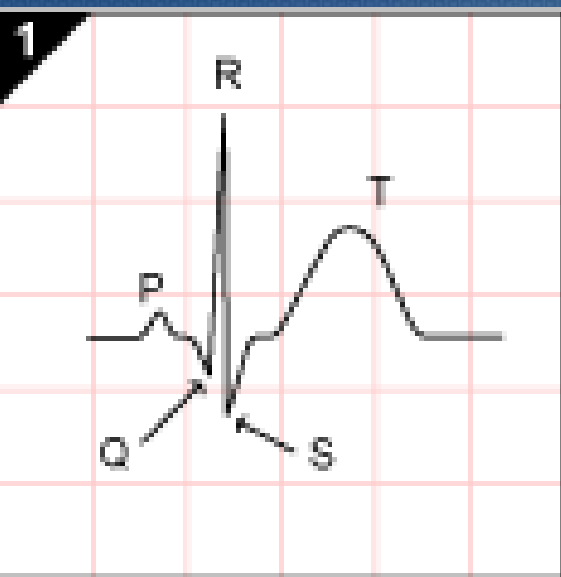
After few weeks:

- ⇒ ST segment returns to normal.
- ⇒ T wave and Q wave changes persist.

After few months:

- ⇒ T wave → returns to normal.
- ⇒ Deep Q persists.







Last slide
It is over

Any questions?

