



Cardiac Science

“Arrhythmias”

Highly recommend to study the ECG lecture first.

Objectives:

- Describe sinus arrhythmias
- Describe the main pathophysiological causes of cardiac arrhythmias
- Explain the mechanism of cardiac block
- Explain the origin of an ectopic foci
- Enumerate the common arrhythmias and describe the basic ECG changes.

Color Index:

Black: original Content

Pink: Female's Slides

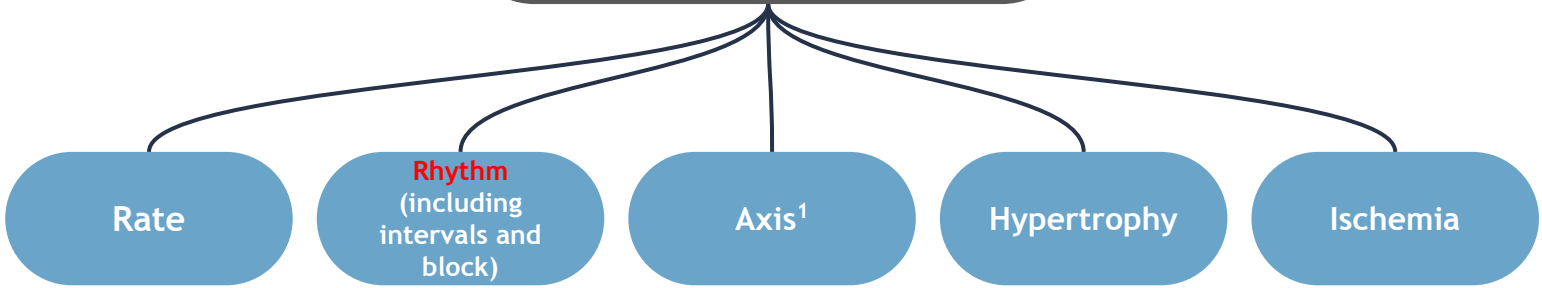
Blue: Male's Slides

Gray: Extra explanations/notes

Red: Important

Females slides only

Develop a systematic approach to reading ECG



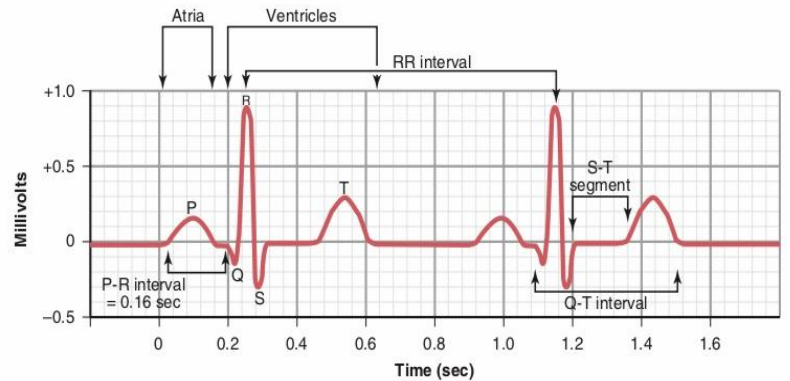
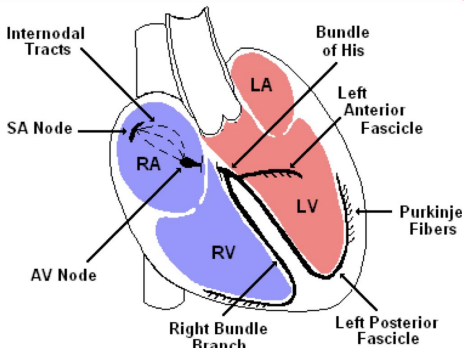
¹ the major direction of the overall electrical activity of the heart. (0 to +90 degrees)

Normal Sinus Rhythm:

- Regular
- Originating from SA node
- Single P-wave precedes every QRS complex
- P wave in same direction as QRS
- P-R interval is constant and within normal range
- P-P interval is constant

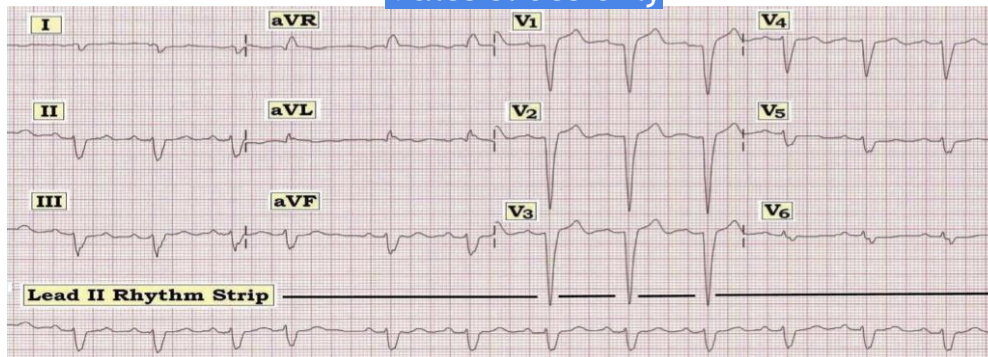
Rate:

- Rule of 300: Divide 300 by the number of boxes between each QRS = rate
- HR of 60-100 per minute is normal
 - HR >100 → tachycardia
 - HR <60 → bradycardia



The left bundle branch further divides into the left anterior fascicles and the left posterior fascicles, because the left ventricle is larger.

Males slides only



Lead I → Lateral	aVR	V1 → Septal	V4 → Anterior
Lead II → Inferior	aVL → Lateral	V2 → Septal	V5 → Lateral
Lead III → Inferior	aVF → inferior	V3 → Anterior	V6 → Lateral

Arrhythmias

refers to any change from the normal sequence of electrical impulses. causing the heart to beat too fast, too slowly, or erratically.

Causes of Cardiac Arrhythmias:

- Abnormal rhythmicity of the pacemaker.
- Shift of the pacemaker from the SA node to another place in the heart.
- Blocks at different points during the spread of the impulse.
- Abnormal pathways of impulse transmission.
- Spontaneous generation of spurious impulses in almost any part of the heart.
- Trigger & Reentry

Classification of Cardiac Arrhythmias:

- Rate above or below normal.
- Regular or irregular rhythm.
- Narrow or broad QRS complex
- Relation to P waves
- **Supraventricular vs. ventricular**

Supraventricular (originate from above the ventricles)

Also known as paroxysmal atrial tachycardia (PAT)

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Common Types Of Arrhythmia

origin	SA node	Atria	AV node	Ventricles
Bradycardia	- Sinus Bradycardia - Sick Sinus Syndrome	—	- Conduction Blocks (1 st , 2 nd , 3 rd) - Junctional escape rhythm	- Ventricular escape rhythm
tachycardia	- Sinus tachycardia	- Atrial Premature Beats - Atrial Flutter - Atrial Fibrillation - Paroxysmal SVT - Multifocal Atrial Tachycardia	—	- Ventricular premature Beats - Ventricular Tachycardia - Torsades de pointes - Ventricular Fibrillation

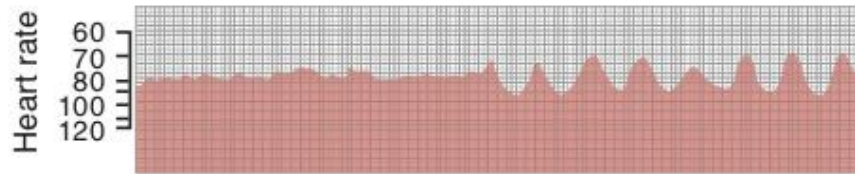
Differential Diagnosis of Tachycardia Females slides only

- Sinus tachycardia - supraventricular tachycardia - Atrial flutter	- Sinus tachycardia with aberrancy - supraventricular tachycardia with aberrancy - Ventricular Tachycardia	- Atrial Flutter with variable conduction - Atrial Fibrillation - Multifocal Atrial Tachycardia	- Atrial Fibrillation with aberrancy - Atrial Fibrillation with WPW - Ventricular Tachycardia
Regular & narrow complex	Regular & wide complex	irregular & narrow complex	irregular & wide complex

classified into narrow and wide complex based on the QRS complex, Mostly narrow from atrium & wide from ventricles.

Sinus Arrhythmia

- Result from spillover of signals from the medullary respiratory center into the adjacent vasomotor center during inspiration and expiratory cycles of respiration. causes alternate increase and decrease in the number of impulses transmitted through the sympathetic and vagus nerves to the heart.



Abnormal sinus rhythm

Tachycardia:

increase the heart rate (> 100bpm). Cause:

- Increased body temperature
- Sympathetic stimulation
- Drugs e.g. digitalis
- Inspiration

Bradycardia:

Slow the heart rate (< 60bpm). Causes:

- Parasympathetic stimulation
- Expiration

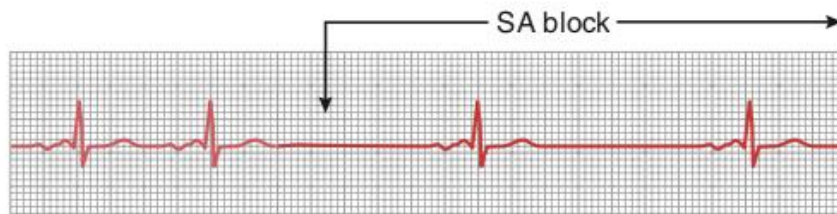


Abnormal Cardiac Rhythms that Result from Impulse Conduction Block

Sinoatrial block:

Blockade of the S-A node impulse before entering atrial muscle.

- Cessation of P wave In the ECG



Abnormal Cardiac Rhythms that Result from Impulse Conduction Block

AV block:

When impulse from the S-A node is blocked,

Causes:

- Ischemia of the A-V node
- Compression of the A-V node by scar formation
- Inflammation of the A-V node
- Strong vagal stimulation

Types of AV Block

1st degree block

2nd degree block

3rd degree block

1st degree AV block (incomplete):

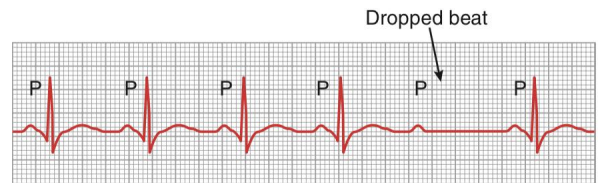
- Constant **Prolonged** P-R interval (0.2 seconds) **WITHOUT** drop beat.

A delay in the conduction from the atria to the ventricles but not actual blockage of conduction.



2nd degree AV block:

- P-R interval > 0.25 second
- Only few impulses pass to the ventricles:
 - **atria beat faster than ventricles**
 - **“dropped beat”** of the ventricles NO QRS-T wave



Males slides only

2nd degree AV block

Mobitz (I):

Progressive PR prolongation + drop beat.



Mobitz (II):

Constant PR prolongation + drop beat.



3rd degree AV block (complete):

- **Complete dissociation** of P wave and QRS waves.
- **Ventricle escape from the influence of S-A node.** establish their own signal, from AV node or AV Bundle
- **Atrial rate is 100 beats/min. however, Ventricular rate is 40 beats/min**

Stokes-Adams Syndrome: AV block comes and goes. a periodic fainting in which there is a onset and offset of blockage of heart due to disorder of heart rhythm



Premature Contractions

Premature¹ contractions, extrasystoles, or ectopic beat result from **ectopic foci** that generate abnormal cardiac impulses (pulse deficit²), Causes:

- Ischemia
- Irritation of cardiac muscle by calcified foci
- Drugs like caffeine

Ectopic foci can cause premature contractions that originate in:

- Atrium
- A-V junction
- ventricles

¹ heart contraction before the normal contraction would be expected.

² the ventricles will not have filled with blood completely and Stroke volume output is depressed leading to weak pulse. thus defect in the number of radial pulse compared with actual numbers of heart contraction.

Premature Atrial Contraction:

- **Short P-R interval** depending on how far the ectopic foci from the AV node
- Pulse deficit if there is no time for the ventricles to fill with blood
- The time between the premature contraction and the succeeding beat is increased (**Compensatory pause**)



Premature Ventricular Contraction:

- **Prolong QRS complex:** because the impulses are carried out to the myocardial fibers with slower conduction rate than Purkinje fibers
- **Increase QRS complexes voltage:** because QRS wave from one ventricle can not neutralize the one from the other ventricle
- After PVCs, the **T wave** has an electrical potential of **opposite polarity** of that of the QRS because of the slow conduction in the myocardial fibers, the fibers that depolarizes first will repolarize first. (re-entrant signal)
- **Causes:** drugs, caffeine, smoking, lack of sleep, emotional irritations



Ventricular Fibrillation:

The most serious of all arrhythmias.¹ impulses stimulate one part of the ventricles, then another, then itself. Many part contracts at the same time while other parts relax (Circus movement²).

Causes: sudden electrical shock, ischemia

- Tachycardia
- Irregular rhythm
- Broad QRS complex
- No P wave

Treatment: DC Shock

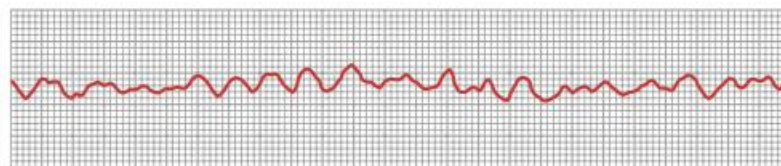
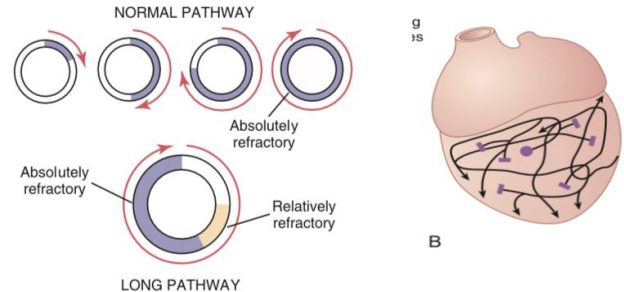
1 invariably fatal

2 conditions leads to the "re-entry":

-the pathway around the circle is much longer than normal.

- velocity of conduction decreased.

- the refractory period of the muscle might become greatly shortened.

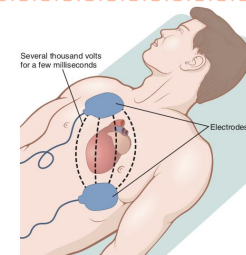
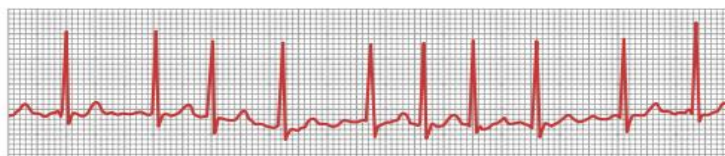


Atrial Fibrillation:

Same mechanism as ventricular fibrillation. It can occur only in atria without affecting the ventricles.

- It occurs more frequently in patients with enlarged heart
- The atria do not pump if they are fibrillating
- The efficiency of ventricular filling is decreased 20% to 30%
- No P wave, or high frequency of low voltage P wave. Only QRS-T wave.
- A person can live for years with atrial fibrillation.

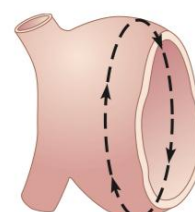
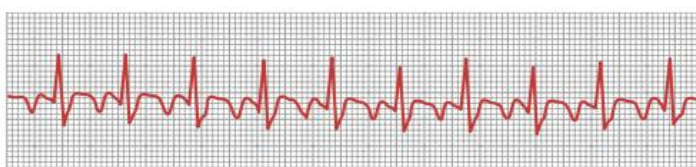
Treatment: DC shock (A single strong electric shock through the heart which throws the entire heart into refractoriness for few seconds, a normal rhythm often follows if the heart is capable of generating a normal rhythm)



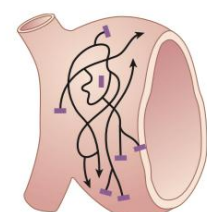
Atrial Flutter:

A single large wave travels around and around in the atria. it contracts at high rate (250 beats/min)

- Because one area of the atria is contracted and another one is relaxed, the amount of blood pumped by the atria is slight.
- The refractory period of the AV node causes 2-3 beats of atria for one single ventricular beat 2:1 or 2:3 rhythm.
- Inverted P wave



Atrial flutter



Atrial fibrillation

Ischemia and the ECG:

One of the common uses of the ECG is in acute assessment of chest pain Causing restriction of blood flow to the myocardium.

Ischemia → injury → infarction

- Reversible → angina pectoris
- Irreversible → myocardial infarction

Reversible ischemia:

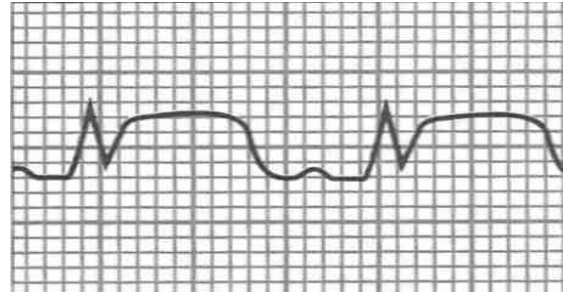
- **Inverted** T wave
- ST segment **depression**



Myocardial Infarction:

Complete loss of blood supply to the myocardium resulting in necrosis or death of tissue.

- ST segment **elevation**
- Deep Q wave

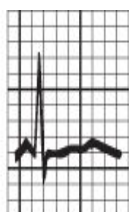


Potassium and the ECG:

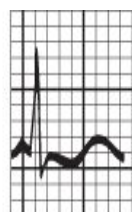
- Hypokalemia: flat T wave
- Hyperkalemia: Tall peaked T wave



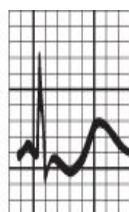
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2.0

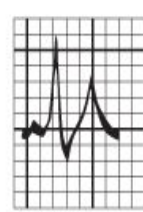


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Hypokalemia



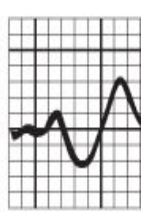
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8.0



9.0

Hyperkalemia

Quiz

1- A 50-year-old man has been having fainting for about 2 weeks. During the episodes, his ECG shows a ventricular rate of 25 beats/min and 100 P waves per minute. After about 30 seconds of fainting, a normal sinus rhythm recurs. What is his likely diagnosis?

- A) Atrial flutter
- B) First-degree A-V block
- C) Second-degree A-V block
- D) Stokes-Adams syndrome

2- 50-year-old man has a blood pressure of 140/85. He reports that he is not feeling well, his ECG has no P waves, he has a heart rate of 46 beats/min, and the QRS complexes occur regularly. What is his likely condition?

- A) First-degree heart block
- B) Second-degree heart block
- C) Third-degree heart block
- D) Sinoatrial heart block

3- Circus movements in the ventricle can lead to ventricular fibrillation. Which condition in the ventricular muscle will increase the tendency for circus movements?

- A) Decreased refractory period
- B) Low extracellular potassium concentration
- C) Increased refractory period
- D) Increase in parasympathetic impulses to the heart

4- The following ECG tracing was obtained for a 60-year-old man. What is his diagnosis?



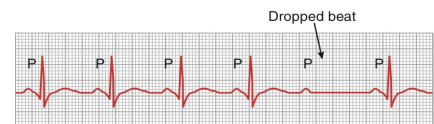
- A) Atrial flutter
- B) First-degree A-V heart block
- C) Second-degree A-V heart block
- D) Third-degree A-V heart block

5- A 55-year-old man had the below ECG tracing recorded at his doctor's office at a routine physical examination. What is his diagnosis?



- A) Normal ECG
- B) Atrial flutter
- C) Ventricular Fibrillation
- D) Atrial Premature Contraction

6- A 65-year-old man had ECG tracing re-recorded at his annual physical examination. What is the likely diagnosis?



- A) Atrial paroxysmal tachycardia
- B) First-degree A-V block
- C) Second-degree A-V block
- D) Atrial flutter

7- In which condition Sinus Tachycardia Can happen?

- A) Parasympathetic stimulation
- B) Expiration
- C) Sleep
- D) sympathetic stimulation

8- which one is the most serious arrhythmia ?

- A) Ventricular fibrillation
- B) Atrial flutter
- C) Sinus Tachycardia
- D) Atrial Fibrillation



Good luck!

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Sources:

- Dr's slides
- Guyton & Hall chapter 13