Dept. of Clinical Pharmacy
Therapeutics (I)/ 5th level

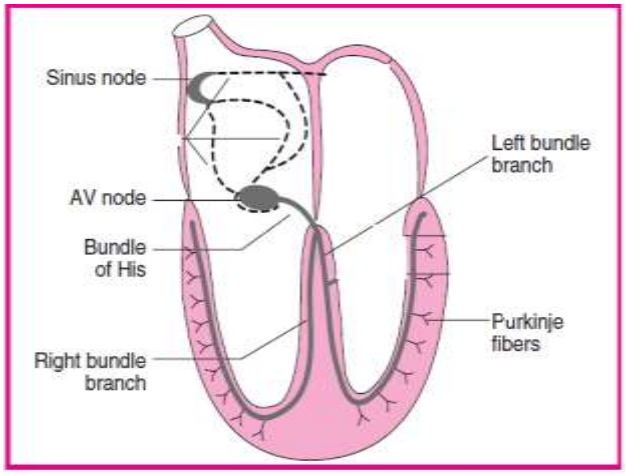
Arrhythmias (I)

Arrhythmia is a term which refers to any change in the normal **rate or rhythm** of the heart [1].

Normal activity of the heart [1].

Four structures are key to the conduction of electrical impulses through the heart muscle:

- **The sinoatrial (SA) node** located in the right atrium.
- **The atrioventricular (AV) node** located between the right atrium and right ventricle.
- **The bundle of His** (or AV bundle) & **bundle branches (right & left bundle branches RBB & LBB)**, which convey current from the AV node to **both** ventricles.
- **The Purkinje fibers**, which conduct the current throughout the ventricular tissue.



The cardiac conduction system.

In the healthy heart the SA node acts as the cardiac pacemaker, generating electrical impulses which are then conducted via AV node to the ventricles, hence the term "sinus rhythm".

The normal resting heart rate is approximately 70 beats per minute (range 60-80 or 100) beats per minute.

Etiology [2].

Arrhythmias result from **abnormal impulse formation or abnormal impulse conduction** and these forms may be brought about due to.

1. An infarction may cause the death of pacemaker cells or the conducting element (s).
2. A cardiac tissue disorder, e.g. fibrosis or rheumatic fever, *disrupts the conduction network.*
3. Sympathetic or parasympathetic abnormalities, e.g. stress, anxiety, exercise or smoking.
4. Systemic **drugs**, e.g. antiarrhythmics, drugs effecting sympathetic or parasympathetic pathway, inotropic drugs or other substances, e.g. caffeine, or alcohol.
5. Hypothyroidism, hyperthyroidism, hyperkalaemia and hypokalemia or other electrolyte disturbances may predispose the heart to arrhythmias.

Patients who **have pre-existing cardiac disorders** including heart failure, hypertension or a **recent infarction** are at greater risk of arrhythmias.

Description of arrhythmias

All cardiac rhythms can be described by a phrase which includes terms that relate to **rate**, **origin** and **pattern**. (Table 22.1) [2]**.** ***Paroxysmal*** refers to self-terminating episodes of **up to 7 days**, although in practice they are usually less than 1 day in duration [2]**.**

Table 22.1 Nomenclature for describing arrhythmias

Term	Notes
Origin	
Sinus	SA node
Atrial	From the atria but not the SA node
Nodal	Atrioventricular node
Supraventricular	Usually, but not necessarily, from the AV node
Re-entrant	A circuit involving retrograde (backward) conduction and an accessory pathway whereby impulses travel in a loop, e.g. the Wolff–Parkinson–White syndrome
Ventricular	From the ventricular tissue
Pattern	
Ectopic	From a focus other than the SA node
Premature contraction	May be isolated or repeated
Paroxysmal	Occurs in bursts
Flutter	A fast, regular rhythm from a single ectopic focus
Fibrillation	A fast, chaotic rhythm from multiple foci
Block	A delay in, or absence of, conduction through the AV node
Mobitz	Terms used to describe particular varieties of second-degree block
Wenckebach	
Torsades de pointes	A form of ventricular tachycardia with complexes of varying amplitude

Pathogenesis of arrhythmias

Arrhythmias develop by one of two mechanisms:

1- **Altered impulse generation**, for example,

a- changes in ability of the pacemaker cells in the SA node to generate electrical impulses spontaneously, or

b- Through the occurrence of action potentials from sites other than the SA node.

2- Altered impulse conduction, for example, complete or partial block of **conduction pathways** within the myocardium (AV node or the bundle branches) [1].

Classification of Arrhythmias

1-All arrhythmias originating above the bundle of His are referred to as supraventricular arrhythmias [3].

2-Arrhythmias originating below the bundle of His are referred to as ventricular arrhythmias [3].

3-An alternative method of classifying arrhythmias is based on the rate: bradyarrhythmia (<60 beats/minute) or tachyarrhythmia (>100 beats/minute) [3].

Signs and consequences of arrhythmias

1-Arrhythmias are associated with increased morbidity and mortality. **Atrial fibrillation** (AF) roughly **doubles the risk of a person having a stroke**, triples the risk of heart failure and doubles mortality risk [2].

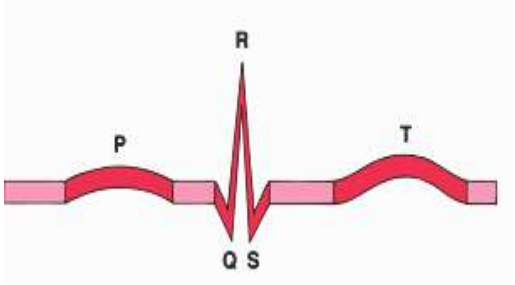
2- Bradycardias tend to cause symptoms that reflect low cardiac output: fatigue,

lightheadedness and syncope (**syncope**: is a sudden loss of consciousness due to reduced cerebral perfusion) [4].

3-Tachycardias cause rapid palpitation, dizziness, chest discomfort or breathlessness. **Extreme** tachycardias can cause syncope because the heart is unable to contract or relax properly at extreme rates [4].

4- Extreme bradycardias or tachycardias can precipitate cardiac arrest or sudden death [4].

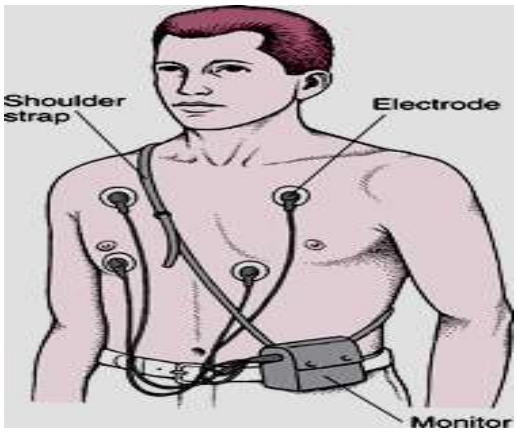
5-Since **these signs are not unique to arrhythmias**, arrhythmias are not always easy to diagnose and 24-hour recordings of the ECG (Holter monitoring) may be used [2].



Diagnosis of Arrhythmia

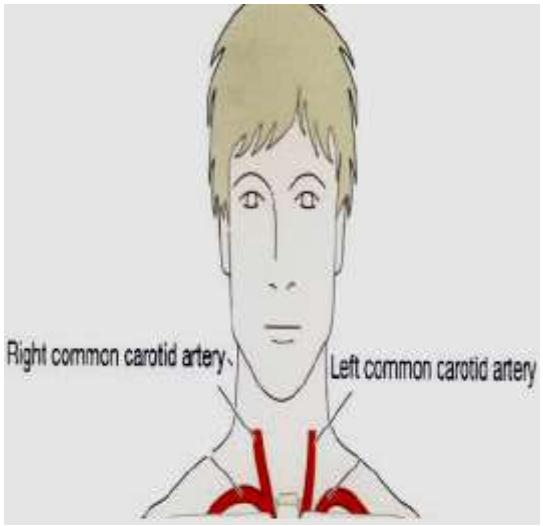
1-Electrocardiogram (ECG)

2-Holter monitoring: Ambulatory, portable ECG monitor that can record the electrical activity of the heart for 1 to 2 days at a time to detect episodes of arrhythmia [1].



Bradycardia

A heart rate of less than 60 beats per minute is considered a bradycardia. If the heart rate slows but the rhythm remains unchanged (i.e, is **still controlled by impulses generated in the SA node**) this is known as **sinus bradycardia**. It can be entirely normal, for example in **athletes** (well-conditioned heart and large stroke volume) or **during sleep**, but it may also occur secondary to acute myocardial infarction, ***sick sinus syndrome*** [1] **(**sinoatrial disease e.g. fibrosis of the SA (sinus) node) [4]or drug therapy, particularly beta-blockers [1].



The condition is characterized by a variety of arrhythmias including:

A-Sinus bradycardia due to a **reduction in the frequency of impulse generation** within the nodal pacemaker cells (reduced automaticity).

B-Sinus arrest if the **node completely fails to generate an action potential**.

Bradycardias can also be of neurocardiogenic origin, for example, they can be due to excessive vagal tone or can arise during carotid sinus massage which results in stimulating vagal activity [1]. (**Carotid**: The two main arteries in the neck).

Heart block

Bradycardias can be caused by heart block, where there is a failure to conduct the electrical signal. AV nodal block is the most commonly identified in clinical practice. In this situation, the electrical impulse generated by the SA node is **blocked at the level of the AV node** before it can be conducted to the ventricles[1].

AV block may be classified into three types.

1-First degree AV block: ***all beats are conducted through the AV node, but with some delay***. This does not require treatment but may be a warning to avoid drugs that would worsen the block, such as β-blockers and class IV agents (verapamil, diltiazem) [2].

2-Second degree AV block: ***some, but not all, beats are conducted*** through the AV node [2].

Second-degree AV block is further distinguished into two types: ***Mobitz type I*** (also known as Wenckebach) and ***Mobitz type II*** [3].

The need for treatment depends upon whether a satisfactory ventricular rate and output can be maintained or not [2].

3-Third degree or complete heart block implies that there ***is no conduction of sinus or atrial beats through the AV node.*** (The ventricles initiate their own depolarizations). Treatment is usually required [2].

Bundle branch blocks (BBB)

Right bundle branch block (***RBBB***) occurs in normal healthy individuals and heart diseases (e.g. ischemic heart diseases) while Left Bundle branch block (***LBBB***) indicates underlying cardiac pathology [5].

Tachycardias

A heart rate of more than 100 beats per minute is considered a tachycardia. They can be divided into: **Supra-ventricular** arrhythmias **and Ventricular** arrhythmias**.**

1-Supra-ventricular arrhythmias (supra-ventricular tachycardias)

A-Sinus tachycardia

1-Sinus tachycardia occurs if the heart rate increases but the rhythm remains unchanged [1]. It is usually due to an increase in sympathetic activity [4].

2-Sinus tachycardia is common during exercise or excitation but may also occur during infection, hypovolemia, anaemia, thyrotoxicosis, and shock. It can also occur as a side effect of many drugs, such as beta 2 agonists, thyroxine and aminophylline [1].

B-Atrial ectopic beats (extrasystoles, premature beats)

These usually cause no symptoms but can give the sensation of a missed beat or an abnormally strong beat (due to the increased output of the post-ectopic beat). In most cases these are of no consequence. Treatment is rarely necessary [4].

C-Atrial flutter (regular irregularity):

1- Atrial flutter occurs less frequently than atrial fibrillation (AF) [1]. The atrial rate is approximately 300/min [4]. **The resulting ventricular rate is usually regular**, but slower than the atrial rate as the AV nodal delay prevents these rapid atrial impulses from being conducted to the ventricles in a 1:1 ratio [1]. Conduction may be 2:1 (one ventricular depolarization for every two atrial impulses), 3:1 or 4: 1) [1].

2- The rapid atrial rate and disturbance of conduction pathways in atrial flutter increases the risk of localized thrombus formation and secondary embolic events (ie, thrombotic stroke) in this group of patients [1].

D-Atrial fibrillation (AF) (irregular irregularity):

1- AF is one of the **most common arrhythmias** and it is **a major cause** of morbidity and mortality. Risk factors include increasing age, hypertension, coronary artery disease and heart failure. Other causative factors include hyperthyroidism and high alcohol consumption [1].

2- The inappropriate electrical signals lead to repetitive and chaotic فوضوي depolarization of the atrial myocardium. The atria fail to contract in a coordinated fashion (ie, they fibrillate) and atrial rates of between 350 and 600 beats per minute result. The ventricular rate is usually rapid (around 100-180 beats per minute) and **irregular** [1].
(In general, when compared with **atrial flutter**, AF is associated with higher atrial rates, a slower ventricular rate, and an irregular ventricular rhythm) [6].

3-The condition is **not acutely life threatening** but failure of coordinated atrial contraction results in stasis of blood within the atria. This can lead to the **formation of local thrombi**. As a result, one of the most important complications of AF is the increased risk of **thromboembolic stroke** [1].

Notes:

1-Atrial clots form most often in small side pouches on the atria called atrial Appendages [4] particularly in the left atrial appendage, which subsequently may travel through the mitral valve into the left ventricle and may be ejected during ventricular contraction into the brain, resulting in an ischemic stroke [6].

2-Because the frequency of right atrial appendage thrombosis is less than that of left atrial appendage thrombosis in AF patients, the risk of stroke is enhanced much more than the risk of pulmonary embolism [4].

3- The risk of stroke increases after restoration of normal sinus rhythm (by drugs or by **direct current cardioversion** (DCC) which allows more efficient cardiac contractility and expulsion of the **already formed thrombus** [4].

2-Ventricular arrhythmias (OR Ventricular tachyarrhythmias)

A-Ventricular ectopic beats (extrasystoles, premature beats)

1- Ectopic beats produce a **low stroke volume because left ventricular contraction occurs before filling is complete**. The pulse is therefore irregular, **with weak or missed beats**.

2- Patients are usually asymptomatic but may complain of an irregular heartbeat, **missed beats**, or abnormally **strong beats** (due to the **increased output of the post-ectopic beat**). The significance of ventricular ectopic beats (VEBs) depends on the presence or absence of underlying heart disease [4].

A-Ventricular ectopic beats in otherwise healthy subjects: Treatment is not necessary unless the patient is highly symptomatic, in which case ß-blockers can be used [4].

B-Ventricular ectopic beats associated with heart disease (e.g. recent MI or heart failure): Treatment is usually needed [4].

B-Ventricular tachycardias (VT)

1-VT is defined as **three or more** consecutive ventricular ectopic beats.

2-VT is defined as non-sustained if it lasts less than 30 seconds and terminates spontaneously; sustained VT lasts greater than 30 seconds and does not terminate spontaneously, but rather requires therapeutic intervention for termination.

3-Ventricular rates during episodes of VT vary from 120-250 beats per minute [1, 3, 7].

Torsades de pointes (TdP)

1- **TdP** is a specific form of VT that is **associated with prolongation of the QT interval** which can occur mostly secondary to drug therapy, particularly anti-arrhythmics (and other drug therapy such as erythromycin, clarithromycin, anti-depressants (particularly tricyclics)……) [(1)].

2-Torsades de pointes can rapidly degenerate into ventricular fibrillation and must therefore be treated as a medical emergency [(1)].

C-Ventricular fibrillation

1-Ventricular fibrillation (VF) is a **rapid** & **uncoordinated contraction** of the ventricular tissue. It **severely** reduces cardiac output [(1)] (resulting in no cardiac output [(8)]) to the extent that patients usually **lose consciousness** within 10-20 seconds of onset [(1)].

2-It is responsible for most deaths caused by ***myocardial infarction*** and there is high risk of VF in patients with **severe** ischemic heart disease.

3-VF is a **medical emergency**, because without prompt treatment irreversible cerebral and myocardial damage will occur [(1)].

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