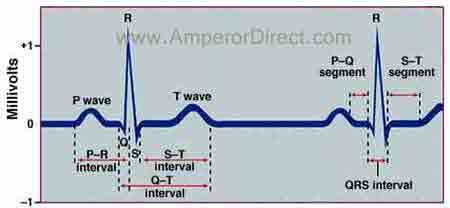
**Components of ECG**

Each ECG cycles consists of 5 waves: P, Q, R, S, T corresponding to different phases of the heart activities. The P wave represents the normal atrium (upper heart chambers) depolarization; the QRS complex (one single heart beat) corresponds to the depolarization of the right and left ventricles (lower heart chambers); the T wave represents the re-polarization (or recovery) of the ventricles. To interpret ECG, one needs to focus on the frequency (heart rate), regularity, shape and size of each individual waves and the timing and interaction between waves. The following diagram shows the components of a ECG cycle.



**P Wave**

The P wave occurs when both left and right atria are full of blood and the SA node fires. The signal causes both atria to contract and pump blood to the ventricles (lower chambers). Any abnormality is generally associated with the SA node and the atria.

[Lead II and V1](https://www.amperordirect.com/pc/help-ecg-monitor/z-what-is-ecg.html) are the best leads to observe p-waves.

**General characteristics :**

* Less than 100ms in duration
* Less than 2.5mm in amplitude

**Examples of abnormal P waves**

|  |  |
| --- | --- |
| **Abnormal Patterns** | **Possible Causes** |
| Inverted | 1. Atrial depolarization is in a different direction 2. Sinoatrial block: Pacemaker is no longer the SA node and is subsumed by another part of the heart. 3. The heart is in an abnormal location or orientation within the chest (dextrocardia). |
| Greaten than 2.5mm in amplitude | 1. Right atrial enlargement |
| Longer than 100ms with two lobes | 1. Left atrial enlargement |
| Invisible or absent | 1. Impairment of conduction at the sinoatrial node. 2. Sinoatrial block: SA node fails to discharge and AV junction takes over as the pacemaker. |

**PQ Segment**

When the signal from the SA node arrives the AV node, the signal is slowed and paused for a short period to allow blood from the atria to fill the ventricles.

**General characteristics :**

* 120 - 200ms in duration from the beginning of P wave to the beginning of QRS complex (PR interval)

**Examples of abnormal PR interval**

|  |  |
| --- | --- |
| **Abnormal Patterns** | **Possible Causes** |
| Greater than 200ms in duration | 1. AV block: Impairment of the conduction path between the atria and ventricles of the heart |
| Less than 120ms in duration | 1. Wolff-Parkinson-White Syndrome - pre-excitation of the ventricles due to an accessory pathway |

**Q Wave**

The Q wave is generated when the AV nodes releases the signal that travels through the inter-ventricular septum.

**General characteristics :**

* Less than 2mm or 3ms in duration
* Less than 25% of the corresponding R wave amplitude
* Normal Q wave in lead III may diminish or disappear on deep inhaling because of the change in the heart relative position; however the infarction related Q wave persists.

**R Wave**

R wave is the first positive deflection after the P wave regardless whether a Q wave exists or not. As the signal continues from the AV node and spreads to the ventricles, the signal triggers a contraction on the left ventricle that pumps blood out of the ventricle.

There may be multiple R waves.

**S wave**

S wave is generated when the basal parts of the ventricles are depolarized resulting in the contraction of the right ventricle.

**QRS Complex**

The Q, R and S waves together are referred to as QRS complex (even if some of its components are missing). It is the electrical forces generated by ventricular depolarization and represents the pumping action of the ventricles.

**General characteristics :**

* 80 - 120ms in duration

|  |  |
| --- | --- |
| **Abnormal Patterns** | **Possible Causes** |
| Greater than 120ms in duration | 1. Bundle branch blocks: Defect of the heart's electrical conduction system. 2. Wolff-Parkinson-White Syndrome - pre-excitation of the ventricles due to an accessory pathway |
| Less than 120ms in duration | 1. Wolff-Parkinson-White Syndrome - pre-excitation of the ventricles due to an accessory pathway |

**ST Segment**

The ST segment marks the time for the ventricles to pump the blood to the lung and body. In normal situations, it serves as the base line from which to measure the amplitudes of the other waveforms.

**Examples of abnormal ST segment**

|  |  |
| --- | --- |
| **Abnormal Patterns** | **Possible Causes** |
| Depressions | 1. Ischemia - decrease in blood supply caused by obstructions in blood vessels. |
| Elevations | 1. Myocardial infarctions - damaged heart issues. |

**T Wave**

After the contraction empties the blood in the ventricles, they begin to relax, which is marked by the T wave.

**General characteristics :**

* The normal T wave is asymmetrical; the first half has a more gradual slope than the second half.

**Examples of abnormal T wave**

|  |  |
| --- | --- |
| **Abnormal Patterns** | **Possible Causes** |
| Inverted | 1. Ischemia - decrease in blood supply caused by obstructions in blood vessels |
| Tall peaked | 1. Hyperkalemia - abnormally high concentration of potassium ions in blood when associated with flat P waves, and wide QRS complexes |
| Flat | 1. Hypokalemia - abnormally low concentration of potassium ions in blood when associated with flat U waves and U waves taller than T waves |

**Supraventricular premature beat**

Supraventricular premature beats are atrial contractions triggered by ectopic foci rather than the sinoatrial node. They arise within the atria (atrial premature beats) or, through retrograde conduction, in the atrioventricular node (junctional premature beats). Premature beats may be found in healthy individuals as well as patients with underlying heart disease. Certain triggers, e.g., alcohol, smoking or electrolyte imbalances, may also contribute to the condition. Premature beats do not significantly impair cardiac output on their own; however, they may lead to more severe forms of arrhythmia such as atrial fibrillation. Unless patients exhibit severe symptoms (e.g., tachycardia), those experiencing premature beats do not require treatment.

**Premature Ventricular Contractions**

Premature ventricular contractions can be associated with:

* Certain medications, including decongestants and antihistamines
* Alcohol or illegal drugs
* Increased levels of adrenaline in the body that may be caused by caffeine, tobacco, exercise or anxiety
* Injury to the heart muscle from coronary artery disease, congenital heart disease, high blood pressure or heart failure

Having frequent PVCs or certain patterns of them might increase your risk of developing heart rhythm problems (arrhythmias) or weakening of the heart muscle (cardiomyopathy).

**Fusion of ventricular and normal beat**

Ventricular fusion beats can occur when the heart's natural rhythm and the impulse from a pacemaker coincide to activate the same part of a ventricle at the same time, causing visible variation in configuration and height of the QRS complex of an electrocardiogram reading of the heart's activity. This contrasts with the pseudofusion beat wherein the pacemaker impulse does not affect the complex of the natural beat of the heart. Pseudofusion beats are normal. Rare or isolated fusion beats caused by pacemakers are normal as well, but if they occur too frequently may reduce cardiac output and so can require adjustment of the pacemaker