**ELECTROCARDIOGRAM (ECG)**

**1.0 Introduction**

Electrocardiogram (ECG) is a diagnostic tool that gives graphical measurements and recordings on the electrical activity of the heart over time. It is commonly used for diagnosing diseases by deducing the signal. Cardiovascular diseases and abnormalities alter the ECG wave shape; each portion of the ECG waveform carries information that is relevant to the clinician in arriving at a proper diagnosis which makes the correct interpretation and processing of the signal important. [1]. An ECG is generated by a nerve impulse stimulus to the heart. [1]

This paper briefly discusses the basic steps and techniques used in performing an ECG with a description of the stages on signal processing applied to the electrocardiogram.

**1.1 Steps and Technique for performing ECG**

The electrocardiogram is simply a voltmeter that uses up to 12 electrodes (leads) placed on designated areas of the body. [1] The potential difference between two electrodes placed on the skin surface is seen as an input on the ECG plotter.

Electrocardiogram electrodes are devices which connect to the electrocardiograph and the electric data of the heart is obtained through them for tracing and printing of the Electrocardiogram. [2]

Preparation

The skin of the patient is kept clear and clean of excess hair in the areas which the electrodes will be placed in order to ensure they stick to the skin to reduce noise.

Positioning

A standard 12 lead (6 limbs, 6 precordial) ECG is usually carried out with the patients lying in the supine position. The electrodes are placed on the chest, arm and legs. [2] The electrodes are attached to the limb and precordial leads which are basically wires connected to the ECG machine that produce information on a graph. It is important that the electrodes are properly placed as improper placement can yield a tracing that gives an appearance of a disease when none is present. [2]

Interpretation of result

After describing the predominant heart rhythm, the mean electrical axis, and the position of the heart in the chest, the next step of the ECG analysis is to evaluate the shape, amplitude, and duration of the waves, segments and intervals. [3].

The ECG signal is a combination of sinusoidal and triangular waveforms (P wave, QRS complex and T wave) as show in Figure 1 and these waveforms can be separated into; the **isoelectric line** (horizontal line with no electric activity), **segments** (the duration of isoelectric line between waves), and **intervals** (the time between the same segments of adjacent waves). [1] [3]

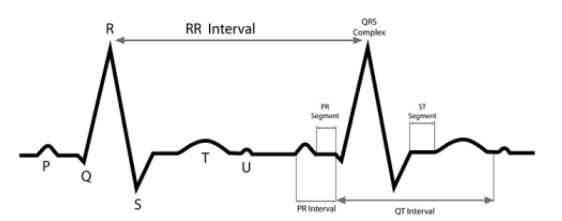


Fig 1: A typical ECG trace showing waves, segments and intervals [3]

**1.2 ECG Signal Processing**

The purpose of signal processing is to improve measurement accuracy and reproducibility and the extraction of information not readily available from the signal through visual assessment [4]. Signal processing can be split into 2 major stages;

**1.2.1 Pre-processing** (Noise Filtering)

Pre-processing helps remove or supress contaminants (noise) that are usually in the same frequency band as the raw ECG signal. This involves the use of filters to remove powerline interference, baseline wander and muscle noise. Application of filtering should be carried only when the desired signal of the ECG is undistorted.

**1.2.2 Feature extraction**

One heart beat consists of QRS complex, ST segment and PR segment, PR intervals and P, T, U waves and feature extraction involves the extraction of diagnostic information from the ECG signal. Feature extraction comprises of the following steps;

QRS detection: Detection of a heartbeat over a period of time, with critical ECG information shown as a combination of 3 graphical deflections (QRS complex). The focus is on improving the SNR to achieve a good performance. [4]

Wave delineation: Once QRS detection is complete, analysis of the T wave can begin. [4]. Delineation defines boundaries of each wave in the PQRST complex and once this is completed, characterization of wave in terms of amplitude and structure is made possible. Delineation can also help detect what wave is absent.

Data compression: The volume of data acquired makes compression of necessary for storage for future reference or review. The overall goal is to represent a signal as accurately as possible with the fewest number of bits by applying a lossy or lossless compression. [4]

Storage or Transmission

**1.3 REFERENCES**

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