Electrocardiogram for Diagnosis of Cardiovascular Diseases

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Cardiovascular disease (CVD) is a global public health problem. It is a disease of multifactorial origin, and with this characteristic, having an accurate diagnosis of its incidence is a problem that health personnel face every day. Time is an essential factor when identifying heart problems, specialists look for and develop options to improve this aspect, which requires a thorough analysis of the patient, electrocardiograms being the factor standard for diagnosis and monitoring of patients.

Keywords: cardiovascular disease ; electrocardiogram ; diagnosis cardiovascular disease ; CVD

1. Introduction

Cardiovascular diseases (CVD) consist of a group of pathologies that in some way affect the normal functioning of the heart. Acute myocardial infarction is a complication of these, and consists of the lack of oxygenation of a part of the cardiac tissue, generating areas of necrosis, which prevents the propagation of the electrical impulse, which leads to an alteration of the rhythm and, sometimes, causes it to come to a halt completely [1]. This pathology is of multifactorial origin and can appear in the different stages of a human being, which makes its treatment difficult in a specific way. The WHO and the Pan American Health Organization have highlighted them as the main cause of premature death worldwide, considering them a red light of attention because they have not been able to reduce the number of cases, on the contrary, they have increased in recent years [2][3].

Risk factors for CVD are smoking, cholesterol, high blood pressure, diabetes mellitus, and obesity [4][5]. In a report published by the AHA in 2011, it is mentioned that 40.6% of cardiovascular diseases were due to high blood pressure, 11.9% to a sedentary lifestyle, 13.2% to a poorly balanced diet, 13.7% to smoking, and 88% to poorly controlled diabetes mellitus [6]. In these studies, it was established that it is possible to directly control blood pressure, total cholesterol, and smoking, which will lead to a significant reduction in cardiovascular risk. While for the control of obesity and diabetes mellitus, more time will be required to find formulas that serve to reduce their impact on society. A point to note is that CVD was considered a disease that affected mostly men, but over the years it has been shown that this is not entirely true, since there are underlying pathologies, such as diabetes and smoking, that cause more CVD problems in women [7][8].

The electrocardiogram (ECG), the electrical activity of the heart, has been studied extensively because of its high relevance in clinical practice. In most cases, it can provide insights into the heart condition. Also the electrocardiogram is considered as the “gold standard”. The importance of its study and use lies in its low cost, it is a non-invasive method and it provides information about the patient. It even allows the identification of different cardiac pathologies based on the morphology of the signal [9][10][11].

There are currently two global public health problems that, although they are not part of the risk factors, have been seen to directly affect the development of CVD. One of them is environmental pollution, not only because of its impact on the environment, presenting itself as part of global warming, but as an entity that in itself causes millions of premature deaths around the world. It has been found to be associated with 60% to 80% of CVD deaths [12]. It is made up of two main composition groups: particles of different sizes and gaseous components. The particles vary in their constitution and size, depending on the emitting source; generally, they are mainly organic elements. With regard to gasses, these are more specific, since they are variations of ozone, sulfur oxides, nitrogen oxides, and carbon monoxide. These gasses react with each other and with particles in the same environment, causing the appearance of more harmful compounds [12][13]. There are studies that have observed that having a concentration of PM 2.5 at a value of 10 mg/m^3, increases the arterial pressure of the exposed individual by 3 mmHg in a state of rest, simply by breathing these pollutants. Therefore, when

exposed to constant concentrations, the individual with normal blood pressure over time can develop arterial hypertension, which is a risk factor for the appearance of CVD [14].

2. Electrocardiogram for Diagnosis of Cardiovascular Diseases

Common but important events physicians track are the arrhythmias, which are any disturbance in rate, regularity, site of origin, or conduction of the heart signal activity. An arrhythmia can be a single aberrant beat or a sustained rhythmic disturbance that can be present through a time period. ECG signal is represented in a waveform graph shape, and it is considered the heart's primary source of information, as well as the primary source for detection of cardiac irregularities. An arrhythmia may lead to severe heart disease or CVD such as atrial premature contraction (APC), premature ventricular contraction (PVC), right bundle branch block (RBBB), etc. As an example of arrhythmia, there have ventricular extrasystoles, which are a reflection of the activation of the ventricles from a site below the AV node. Its outcome is linked to an underlying disease, and there could be three causes for it: reentry, increased automatism, and triggered activity. The increased automatism suggests an ectopic group of cells in the ventricle. This process is the underlying mechanism of arrhythmias secondary to hyperkalemia. Reentry occurs in patients with underlying scarring ischemic heart disease or myocardial ischemia. This mechanism can produce isolated ectopic beats or trigger ventricular tachycardia and eventually sudden cardiac death. Although ECG signals have been used for diagnosis for over a century, manually tracking these arrhythmias over even a thousand heartbeats is an infeasible task, even for expert physicians, because of the amount of time required to perform such endeavors. These kinds of tasks require automated mechanisms to detect and classify all these events such algorithms based on Artificial Intelligence. On an ECG, rhythm refers to the part of the heart that is controlling the initiation of electrical activity. Under normal circumstances, the sinoatrial node (SAN) initiates electrical activity because it undergoes spontaneous depolarization first at a rate of 60–100 bpm. When a rhythm originates from above the ventricles in the atria, it is termed a supraventricular (SVB) rhythm (narrow QRS or <120 ms), and when a rhythm originates from within the ventricles, it is termed a ventricular (VB) rhythm (broad QRS or >120 ms). A new cause of CVD that is very relevant nowadays is called COVID-19. This cause of CVD begins with respiratory symptoms, but in its natural evolution triggers a generalized systemic inflammation in the host. Although initially identified as a totally respiratory disease, the inflammation affects countless organs and systems, producing a series of damages and sequelae with which surviving patients will have to live [15].

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