

Effects of SARS-COVID-19 Infection on the Cardiovascular System

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Abstract: Introduction: SARS-CoV-2 seems to be a natural virus that may have originated in some animals, but the initial human infection has not been known yet. It causes a chain reaction in the human body, such as the constriction of blood vessels in the pulmonary circulation, which inevitably results in reduced oxygenation along with viral pneumonia. **Purpose:** The purpose of this narrative review is to delve into the effects of SARS-CoV-19 infection on the cardiovascular system and its treatment. **Methodology:** The research method followed was based on the bibliographic search of review and research studies drawn from the international databases Medline, Pubmed, Cinahl and from the Greek database Iatrotek. The exclusion criterion of articles was the language other than English and Greek. **Results:** Covid-19 is very likely to affect the cardiovascular system as well as other systems. Regarding the mechanisms that lead to such damage, they are related to the immune mechanisms, the toxicity of SARS-CoV-2, endothelium injury and inflammation, and finally blood vessel thrombosis. Increase, or generally, disturbances in the normal values of some specific laboratory tests of the patient may indicate myocardial injury, arrhythmias, cardiac arrest, myocarditis, etc. **Conclusions:** The holistic treatment of patients who show cardiovascular signs and symptoms after COVID-19 disease, by a team of health scientists is imperative, constituting a modern challenge for public health.

Key words: SARS-Covid-19, cardiovascular disease, effects, and treatment.

1. Introduction

As it is already known, the infectious and highly contagious Covid-19 disease is caused by the SARS-CoV-2 coronavirus. They were both detected at the end of the year 2019, in the most densely populated city of central China, Wuhan. Since the beginning of the year 2020, this disease has spread to almost all states; as a result, it has evolved into a pandemic that continues to exist [1].

In general, coronaviruses make up the family of single-helix RNA viruses, and SARS-CoV-2 contains ACE2 (Angiotensin Converting Enzyme 2) used as a

receptor. In addition to human ACE2 (hACE2), SARS-CoV-2 also recognizes the ACE2 of various animals (e.g., pig, dog, etc.). This wide-ranging recognition of the above receptor indicates the possibility of a broad-spectrum host with different sensitivities against SARS-CoV-2 [2].

Moreover, research on SARS-CoV-2 revealed that it seems to be a natural virus that may have originated in some animals, but the initial human infection has not been known yet. The fact of the intense and continuous spread of SARS-CoV-2 throughout the world had resulted in the recording of about 40 million cases and most importantly, there had been over 1 million deaths worldwide, with the US holding the highest number of cases by the month of October 2020 [3].

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More often than not, the incubation period of coronavirus infection, until the disease occurs, lasts up to 14 days, with 97.5% of symptomatic people showing symptoms up to 12 days of infection. It is very rare that symptoms appear after the lapse of 14 days [4].

It was also found that Covid-19 infection causes a chain reaction in the human body, such as the contraction of blood vessels in the pulmonary circulation, which inevitably results in reduced oxygenation along with viral pneumonia [5].

Due to systemic inflammation and pronounced disorders of the immune system during the progression of Covid-19, the rates of cardiovascular symptoms end up being quite high [6].

Taking that into account, the applied methods for the treatment of such people who survive an acute episode of Covid-19, should be the most appropriate and aim primarily at the smooth functioning of their cardiovascular system [7].

The purpose of this narrative review is to delve into the effects of SARS-CoV-19 infection on the cardiovascular system and its treatment.

The research method followed was based on the bibliographic search of review and research studies drawn from the international databases Medline, Pubmed, Cinahl and the Greek database Iatrotek, with key words such as, SARS-Covid-19, cardiovascular disease, effects, and treatment. The exclusion criterion of articles was the language other than English and Greek.

2. Effects of SARS-COVID-19 Infection on the Cardiovascular System

Many studies carried out so far show that Covid-19 is very likely to affect the cardiovascular system. Regarding the mechanisms that lead to such damage, they are related to the immune mechanisms, the toxicity of SARS-CoV-2, endothelium injury and inflammation, and finally blood vessel thrombosis. Increase, or generally, disturbances in the normal

values of some specific laboratory tests of the patient may indicate myocardial injury, arrhythmias, cardiac arrest, myocarditis, etc [8].

It has also been found that Covid-19 disease can and does affect the heart, then using it as a 'means of transportation' to enter the body cells. This unfavorable progress can cause myocardial infarction and, sometimes damage to the cardiovascular system [6].

A recent large study on the long-term effects of Covid-19 on the cardiovascular system of patients has shown that, after the first 30 days of the illness and until the completion of the first year, these people are at great risk for the development of a cardiovascular disease, such as vascular diseases of the brain, ischemic heart disease, myocarditis, heart failure, thromboembolic disease, etc [7].

Research so far has shown that Covid-19 may exacerbate the risk factors of the patient's cardiovascular system, a pre-existing cardiovascular disease and increase the chances of developing a new heart condition or thromboembolism as well [9].

Some such cases are the following:

- ❖ Acute coronary syndromes (ACS): They make up a range of pathological conditions including acute myocardial ischemia or myocardial infarction. Covid-19 in this case can cause endotheliitis which is an impact not only due to the infection by the virus but also due to the inflammatory response by the host [10].
- ❖ Myocarditis: It is known that acute viral infections create complications of heart damage and acute myocarditis. Studies have shown that myocarditis may be a cause of acute heart damage in patients with Covid-19. According to the research, acute myocarditis due to the coronavirus, is found at a rate of 0.24% in hospitalized patients with Covid-19 [11].
- ❖ Cardiac arrhythmias: Studies show that about 17% of patients who had contracted Covid-19, subsequently, they experienced cardiac arrhythmia,

while for those hospitalized in the ICU this percentage reaches 44%. Also, 7% of experienced ventricular tachycardia (VT) or ventricular fibrillation (VF). These studies suggest that SARS-CoV-2 infection and heart injury can increase the risk of arrhythmias. The most common types of cardiac arrhythmias that may occur in a patient with Covid-19 are atrial tachycardia or bradycardia, atrial or ventricular fibrillation and continuous ventricular tachycardia [12].

❖ **Heart failure:** People suffering from heart failure are more vulnerable to the Covid-19 virus. Heart failure as a complication of Covid-19 does not occur frequently in patients without a prior diagnosis of heart failure, but when it occurs, and then it leads to serious inpatient complications. Studies show that sometimes systemic hyperinflammation resulting from Covid-19, cardiac arrhythmia, as well as the disorder caused in the hemodynamic and respiratory systems of the patient can cause cardiac stress. Furthermore, stress is a factor that can cause severe myocardial injury, causing long-term onset of heart failure [13].

Regarding the diagnosis of diseases of the cardiovascular system, this is usually done through specific and scientifically predetermined stages, starting from the simplest to those that are considered complex. They are as it follows [14]:

- √ **Electrocardiogram (ECG):** It essentially makes an electrical record of the heart's activity on a special paper and can, for instance, detect an arrhythmia or a heart attack.
- √ **Echocardiogram:** It is performed through the scanning of ultrasounds directed to the heart, and the signals generated are interpreted accordingly by specialists. A more improved variant of this is Doppler.
- √ **Ergometry** (heart disease anxiety test): It is a method that, while the patient is running on a treadmill or riding a stationary bicycle, the simulation of real situations within a controlled

environment is made. In this way, the patient's heart can be studied while reproducing real conditions.

- √ **Holter monitor:** It is a test where a long-term electrocardiogram is essentially performed (for 1 or 2 days) that can diagnose hidden heart disease. To achieve this, patients use a mobile device to record the electrical activity of the heart muscle, through which various specialized measurements are recorded and monitored.
- √ **MRI:** A non-radiant force is used to monitor the heart.
- √ **Cardiac catheterization:** This is essentially a surgical operation as a catheter is inserted into the circulatory system that reaches the heart, through which various measurements, repairs or removal of clots in the coronary arteries are made, for example.
- √ **Computed tomography of the heart (CT):** It uses the emission of X-rays and is applied only to the heart tissue.

3. Treatment of Cardiovascular Diseases Due to COVID-19

The basic treatment of Covid-19 viral infection is a symptomatic one, and therefore, includes the appropriate management of symptoms, isolation of the patient and supportive care [15].

What's more, some anti-inflammatory drugs can prevent the fatal progression of Covid-19 and prove to be a lifesaver for those who have contracted the SARS-CoV-2 coronavirus. Those drugs, which often come with high expectations of benefits, are aspirin, fenofibrate, antifungal fluconazole, bactericidal agent isoniazid, resveratrol and 2-methylestradiol [16].

Moreover, the health care and various treatments of cardiovascular diseases for patients who have contracted the Covid-19 viral infection are as follows, depending on the case:

Acute Coronary Syndromes (ACS): Treatment of ACS, among others, involves the administration of

antithrombotic drugs such as aspirin tablets in combination with clopidogrel or inhibitors of platelet glyco-protein receptors IIb/IIIa intravenously or anticoagulant drugs, for example, low molecular weight heparin. In the case of people with a high level of ACS suspicion, the administration of nitrites is recommended on a case-by-case basis, beta-blockers, Ca^{++} channel blockers of the order of dihydropyridines, intravenous morphine and oxygen supply if necessary, in case of patient's intolerance to statins [17].

Myocarditis: The treatment of myocarditis is achieved with diuretics, vasodilators; in the most serious cases with inotropes and/or mechanical support with an intra-aortic pump, devices to assist the ventricles of the heart or systems of prolonged extracorporeal circulation and oxygenation. Then, after the acute symptoms subside and the patient stabilizes, the medication is started, which is also used in chronic heart failure, and specifically, with inhibitors of neurohormonal systems, as provided by the relevant guidelines [18].

In parallel with the above applied heart failure treatment, all patients should rest and abstain from sports until the functionality of the left ventricle is restored to normal limits, especially in the case of acute and hypoxia phase of myocarditis. Moreover, in the case of acute - hypoxia or chronic phase of myocarditis, it may be necessary to use some devices (e.g. pacemaker, defibrillator) as appropriate [19].

Cardiac arrhythmias: There are important factors for the treatment of arrhythmias, such as the knowledge of how the administered drugs interact with each other, routinely monitoring patient's QTc interval through the surface ECG, as well as the special interest in patients with heredity in arrhythmia [20].

Great progress has been made as regards the treatment of arrhythmias in recent years and research interest has shifted from antiarrhythmic drugs into the treatment of the cardiac substrate. Nowadays the

invasive treatment of arrhythmias with ablation is most common. With the progress made in electrophysiology, the focus that causes the origin of arrhythmia can be identified, and with special electrodes it can be destroyed; in this way, the arrhythmia can be cured permanently [21].

Also, great progress has been made and there are many different developments concerning implantable devices (e.g. pacemakers, defibrillators), which serve to treat heart rhythm [22].

Heart failure: The treatment of heart failure has also been greatly improved by the addition of beta-blockers to its treatment, particularly in asymptomatic patients with left ventricular dysfunction. Later research found that greater benefit is gained with the addition of beta-blockers to patients with severe chronic heart failure treated with high doses of enzyme converting inhibitors and diuretics [23].

Moreover, after some other studies, eplerenone was included in the official lists of drugs for symptomatic heart failure [24].

Apart from the treatment with the use of drugs, pacing devices have been available on the market for many years, which by pacing both ventricles of the heart; achieve a better synchronized contraction that has an increased pulse volume [25].

4. Conclusions

Due to the frequent subclinical myocardial infestation of COVID-19, it is advisable that patients who have recovered undergo regular cardiac examinations. The holistic treatment of patients who show cardiovascular signs and symptoms after Covid-19 disease, by a team of health scientists is imperative, constituting a modern challenge for public health.

Also, people who have recovered from a Covid-19 infection, regardless of whether or not, they have a cardiovascular disease, should be closely monitored for the possible occurrence of cardiac complications.

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