



# The Effects of COVID-19 on Heart Function

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# Relationship between COVID-19 and Cardiovascular System Conditions/Concerns

- “COVID-19 exacerbates pre-existing cardiovascular conditions”
- “COVID-19 may result in inflammation-facilitated acute events” (Mai et. al)

## These conditions include:

### Ischemic/inflammatory heart disease

- Narrowing of the coronary arteries due to disease or complications in the heart's major blood vessels, which restricts blood flow to the heart

### Ventricular arrhythmias

- Abnormalities in heartbeat that originate in the ventricles (lower chambers of the heart)

### Conduction disturbances

- Electrical disturbances of the electrical system that enables heartbeats to travel in the heart

# Conditions:

## Thrombotic events at the level of the lungs

- "Thrombosis occurs when blood clots block your blood vessels. There are 2 main types of thrombosis: Venous thrombosis is when the blood clot blocks a vein. (Veins carry blood from the body back into the heart) Arterial thrombosis is when the blood clot blocks an artery." (Mai et. al)

## Systemic activation of the coagulation cascade

- "In severe sepsis, mononuclear cells, stimulated by pro-inflammatory cytokines, express tissue factor, which leads to systemic activation of coagulation [32]. Even in experimental low-dose endotoxemia in healthy subjects, a 125-fold increase in tissue factor mRNA levels in blood monocytes can be detected [33]." (Mai et. al)

## Configuring the scenario of disseminated intravascular coagulation

- "Which results in generation and deposition of fibrin, leading to microvascular thrombi in various organs and contributing to multiple organ dysfunction syndrome (MODS)." (Mai et. al)

# Factors & Cases

According to an article titled: “COVID-19 and cardiovascular diseases” in the Journal of Cardiology (2020) by Francesca Mai et. al

COVID-19 cases are more life-threatening for elderly individuals and for patients who suffer from two or more diseases/conditions simultaneously

## **[Case 1]**

Patient pool: 3335 Italian patients dying in-hospital as of June 4th and (for whom it was possible to analyze clinic charts),

- 136 deceased patients (4.1%) had no pre-existing pathologies,
- Already have 1-3 diseases/conditions: 493 (14.8%), 716 (21.5%), and 1990 (59.7%)

In order of most frequently reported for hospitalized COVID-19 student cases:

1. Hypertension
2. Diabetes
3. Ischemic heart disease

# Factors & Cases

## [Case 2] - Wuhan, China

44,672 confirmed COVID-19 cases

Increased case-fatality rates in the presence of

- Cardiovascular diseases (10.5%)
- Hypertension (6.0%)
- Overall case-fatality rate: 2.3% [11].

## [Analysis of Several Cases] - Italy

- Hypertension was the most common comorbidity among COVID-19 patients referred to the Intensive Care Unit (ICU) irrespective of age,
- Global prevalence: 49%
- Cardiovascular diseases (21%)
- Hypercholesterolemia (18%) [12].
- The prevalence of hypertension was higher among critically ill patients who died in the ICU compared with individuals discharged from the ICU
- "As the most common pre-existing conditions, cardiovascular diseases might have potentially exacerbated the severity of COVID-19."  
(Mai et. al)

# Relationship upon Onset & Effects

"COVID-19 is a lung disease however, it can begin with signs of a severe coronary artery disease or myocarditis in the absence of a history of cardiovascular diseases, or in the presence of isolated cardiovascular risk factors" (Mai et. al)

## Effects

"Like other respiratory tract infections, pre-existing cardiovascular disease (CVD) and CV risk factors enhance vulnerability to COVID-19. Furthermore, COVID-19 can worsen underlying CVD and even precipitate de novo (from the new) cardiac complications." (Bansal)

- These patients are more likely to develop COVID-19 and experience more severe clinical conditions (of COVID-19 and accompanying CVD)

"Myocardial damage can be caused by direct myocardial injury related to upregulation of angiotensin-converting enzyme 2 (ACE2) in the heart and coronary vessels." (Bansal)

- COVID-19 and cardiovascular diseases present a "reciprocal influence" as in "pre-existing pathologies exacerbate the infectious disease, and SARS-CoV-2 [induces or worsens] acute cardiovascular events."

# Further Effects on the Cardiovascular System

## [Direct Effect of COVID-19 on the Heart]

The long-term effects of COVID-19 on the cardiovascular system are unknown. However, COVID-19 patients with cardiovascular diseases/conditions should be closely monitored with respect to COVID-19 symptoms and the expression of the cardiovascular disease/condition

“Thrombosis (blood clots) in patients with COVID-19 are localized and occur in the lungs. Although, the site is “atypical,” patients are presenting clots even “without a history and absence of risk factors that may cause thrombosis.” (Mai et. al)

“They include the possibility of thrombotic manifestations in the form of local (i.e. pulmonary) or systemic (DIC) events, as well as QT interval prolongation.” (Bansal)

- Local, DIC and QT are types of clotting with varying degrees of severity of which life-threatening clots are included.

## [Indirect Effect of COVID-19 on the Heart]

“The therapy used to treat the viral infection, as well as some clinical manifestations of the disease, can trigger the development of ventricular tachyarrhythmias or conduction disturbances.” (Mai et. al)

- Irregularities in heart function such as irregular (fast and slow) heart beats and electrical signals are common especially amongst COVID-19 patients admitted to the ICU

# Cardiovascular Complication Mechanisms in COVID-19

- "Direct myocardial injury- SARS-CoV-2 binds to angiotensin-converting enzyme 2 (ACE2), a membrane bound aminopeptidase which, leads to acute myocardial and lung injury" (Bansal)
  - Myocardial - relating to muscle tissue of the heart
  - Angiotensin is a protein whose presence in the blood promotes aldosterone secretion and tends to raise blood pressure.
- "Systemic inflammation- More severe forms of COVID-19 can result in injury to multiple organs and multiorgan failure" (Bansal)
- "Acute myocardial injury can result due to an impaired myocardial oxygen demand-supply relationship" (Bansal)
- Acute myocardial infarction can result due to several associated factors e.g. plaque rupture, coronary thrombosis and inflammation (Bansal)
  - Infarction refers to the death of tissue due to lack of blood flow
- "Electrolyte imbalances- occur in critical systemic illness and precipitate arrhythmias, esp. in patients with underlying cardiac disorder." (Bansal)



# Clinical Implications

The impact of the therapies and drugs used to treat cardiovascular diseases/conditions must be thoroughly evaluated when treating COVID-19 patients so as not to exacerbate or act as a precursor to acute heart damage in CVD patients. The interactions of the drugs used to treat COVID-19 and pre-existing or underlying heart conditions must also be considered in retrospect. (Bansal)

# Laboratory Learning Model: Arrhythmia Heart Pump

According to [www.homesciencetools.com](http://www.homesciencetools.com); How To Make A Heart Pump Science Project

- Fill the jar half full of water.
- Cut the neck of the balloon off at the part where it starts to widen into a balloon. Set the neck part aside.
- Stretch the balloon over the opening of the jar, pulling it down as tightly as you can. The flatter you can get the surface of the balloon, the better.
- Carefully use the tip of a skewer to poke two holes in the surface of the balloon. Make them about an inch apart from each other and near opposite edges of the jar.
- Stick the long part of a straw into each hole. The straws should fit securely in the holes so no air can get through around the straws.
- Slide the uncut end of the balloon neck onto one of the straws and tape it around the straw.
- Set your pump in a large pan or the sink to catch the pumped water. Bend the straws downward. Gently press in the center of the stretched balloon and watch what happens to the water in the jar.
  - a. Tap the balloon at a pace of 2 beats per second until you reach 100. This represents Tachycardia. Watch how fast the water is moving. The chaos here represents the state of the heart. Tachycardia can increase risk of stroke, heart failure and can be life-threatening.
  - b. Tap 60 times slowly at a speed of 1 beat per second. This represents bradycardia. When left untreated bradycardias can also be life-threatening
- a & b are Arrhythmia representations I added on to the experient so Arrhythmias can be studied in the classroom using a hands-on model

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