NANOTHERAPEUTICS: A WAY TO CURE CARDIAC COMPLICATIONS ASSOCIATED WITH COVID-19

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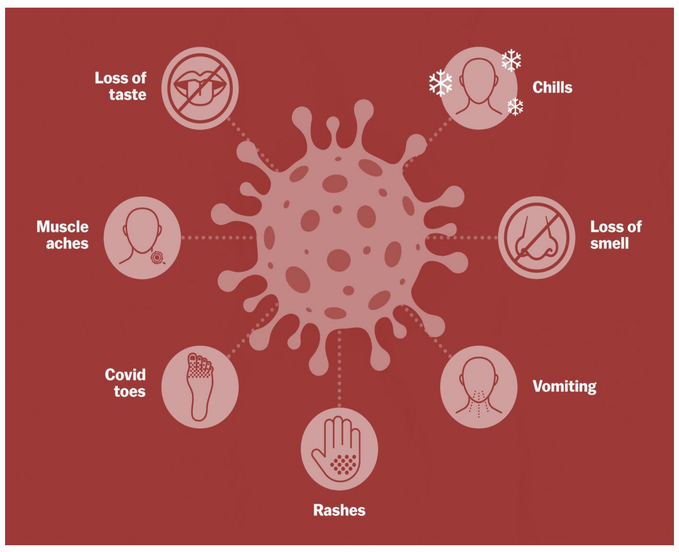
Abstract: The outbreak of SARS-CoV-2 has caused a catastrophe in the world. With significant efforts from the medicine and scientific communities, millions of people all around the world have been vaccinated. Irrespective of that, individuals are getting infected due to mutations in the virus. Noticeable aftermath damage is seen in most of the major organs of the body. Although it is primarily a respiratory infection, the previously healthy patients have mostly developed cardiovascular diseases. Natural products can be used as a cure to such newly developed diseases. Targeted drug delivery of natural products through nanotechnology (nanoparticles and nanorobots) can be an efficient way to tackle this modern-day problem. This review aims to discuss the ways nanotherapeutics can be used to treat cardiac complications. Essentially, it will help to develop an idea that can be used in the future as a solution to the problem under discussion.

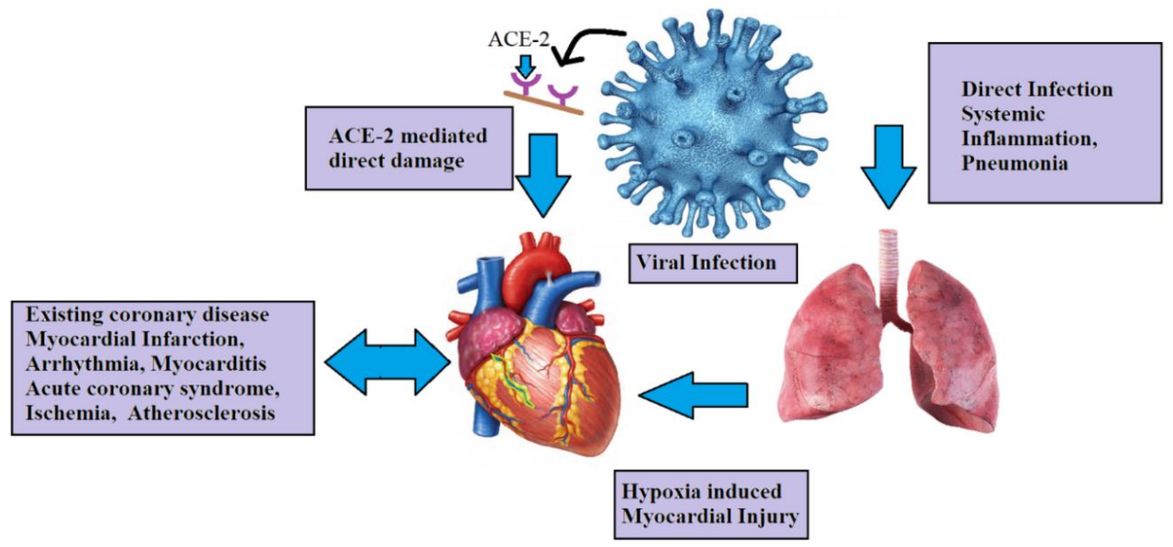
Keywords: Cardiovascular System; COVID-19; Herbal medicine; Natural Products; Nanotechnology; Nanorobots; SARS-Cov-2.

Introduction

- The outbreak of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was identified as a pandemic within the year 2020 by the World Health Organisation (WHO).
- The infected patients often presented with symptoms like fever, fatigue, cough, shortness of breath (or dyspnea), and other symptoms identifying respiratory distress.
- Following the mode of transmission and the presented symptoms, the disease was identified as a respiratory infection.
- With the absence of any standardized treatment protocol, a call for urgency in research was felt.
- Slowly, the symptoms of the disease were studied and the effect of the virus on the various parts of the body was analysed.
- By 2022, this viral disease has been identified as a multi-organ disease.



Probable Cardiovascular complications associated with COVID 19



Pathophysiology of SARS-CoV-2

Inhaled SARS-CoV2 binds to the nasal epithelium's ciliated secretory cells via ACE-2.

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With a limited immune response, the viral replication starts along with the local progression of the virus

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From the conducting airways the virus passes to the upper respiratory tract and then passes into the lower respiratory tract

↓

The virus binds with ACE2 receptors and invades the Type II pulmonary alveolar epithelial cells.

↓

Release of inflammatory mediators such as IL-1, IL-6, TNFα etc. which in turn leads to "Cytokine storm"

↓

Neutrophils, CD4, and CD8 cells are attracted to the chemo-attractants and the B cells starts differentiation

↓

Inflammatory cells are sequestered in lung tissues, also, cytotoxicity is mediated by CD8 that causes lung damage.

→ Acute Respiratory Distress Syndrome as a result of diffusive alveolar damage

Apoptosis of the host cells is mediated by viral replication which leads to discharge of viral particles

↓

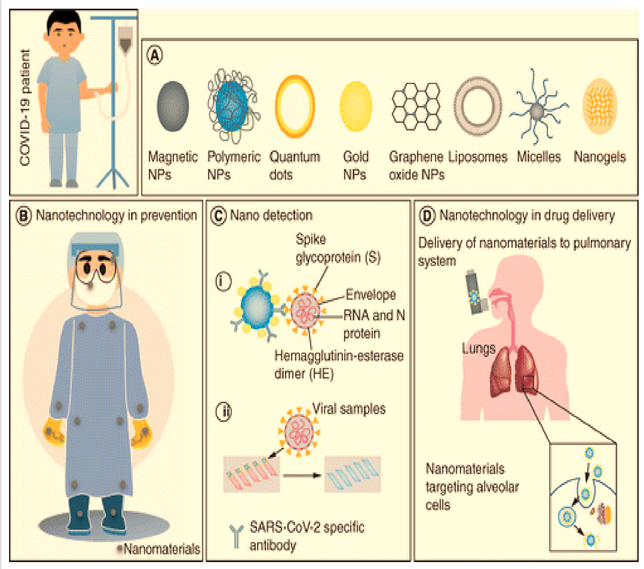
Virus multiplication and infection of nearby healthy alveolar epithelial cells continues, resulting in loss of both Type II and Type I pneumocytes.

↓

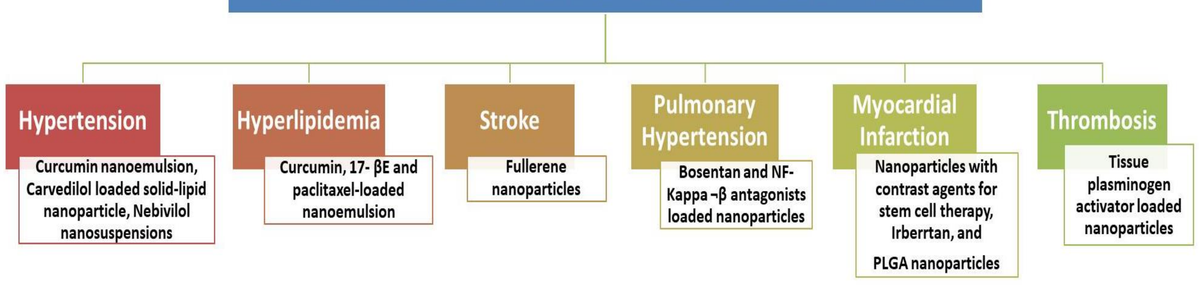
Acute Respiratory Distress Syndrome as a result of diffusive alveolar damage

Nanotherapeutics in COVID 19

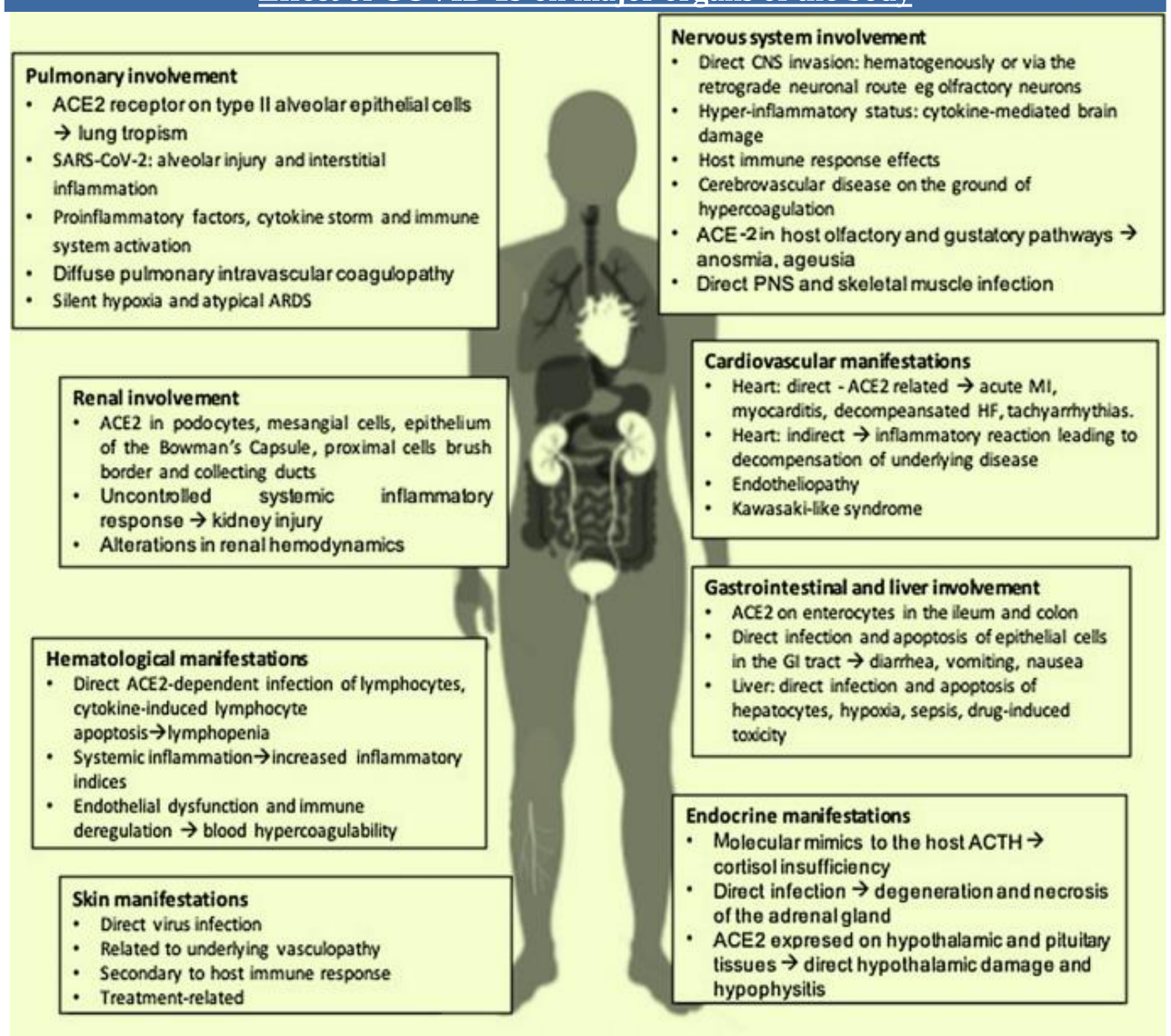
- Nanotechnology has been used extensively in developing vaccines and also as a diagnostic tool in COVID-19.
- Nanobiosensors can be used as a diagnostic tool that is both extremely sensitive as well as cost-effective.
- It can recognise the entire virus or a certain element of the virus (like spike protein or nucleocapsid protein).
- The addition of nano engineered fabrics within personal protective equipment kits can help to reduce the transmission of the virus. For instance, silver nanoparticles have antimicrobial activity, and fabrics containing the same will show similar activities.
- Gold, zinc, graphene oxide, and gold nanoparticles also show intrinsic antiviral properties & can be used as antiviral agents.
- Encapsulation of the viral genome can do the work of vaccination without any significant side effects. Example- BNT162b by Pfizer-BioNTech.
- Multidrug therapy through nanotechnology can help to control the severity of the disease by controlling the systemic inflammation.
- Previously proved nanotechnology assisted therapy can be used to the treatment of the clinical manifestations.
- During the pandemic, the use of programmable nanorobots allows for the detection of varied quantities of certain proteins in the bloodstream which could aid in the identification of a specific virus.
- The development of proof-of-concept nanorobots capable of early detection and destruction of infections, genome editing, and smart therapeutic delivery, could be crucial in the fight against the disease.



Utilisation of Nanoformulations to Treat Cardiovascular Disorders

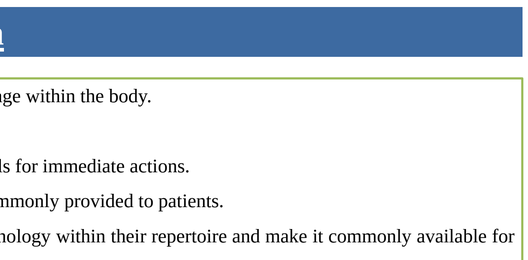


Effect of COVID 19 on major organs of the body



Role of Natural Product in the treatment of Cardiovascular disease

- Natural products play a significant role in the treatment of the cardiovascular disorder.
- Dietary flavonoids obtained from citrus fruits are known to lower the risk of ischaemic stroke.
- Theaflavins obtained from apples and grapes help to regulate blood pressure.
- Thymoquinone, nicotinamide, emodin, and osthole show cardioprotective potential.



Potential of Natural Product Derived Nanotherapeutics in Curing Cardiovascular Complications Associated with COVID-19

- Nanotherapeutics has its application in the treatment and management of various cardiovascular alignments. Hence, the incorporation of natural products within the nanoformulation could one of the ways to achieve therapeutic potential during cardiovascular damage during COVID-19 infection.
- For example, resveratrol, is known to provide protection against vascular damages that are caused by cardiovascular diseases. But it has low oral bioavailability. Resveratrol loaded in PLGA nanoparticles have shown a significant increase in bioavailability.
- Another strategy that can be identified is the utilization of nanorobots for targeted drug delivery.
- For instance, ginsenosides can be loaded within nanoparticles that can be further loaded within the nanorobots. These nanorobots can unload the drug-containing nanoparticles near the ACE2 receptors near the myocardium. This can block the said receptors and therefore, the injury within the heart tissue can be stopped.

Conclusion

- COVID-19 caused by SARS-CoV-2 has the potential to cause a wide array of damage within the body.
- In worst-case scenarios, it can lead to multi-organ failure and finally death.
- The number of cardiac complications associated with the disease is huge which calls for immediate actions.
- Nanotechnology can be a good alternative to the traditional therapy that is most commonly provided to patients.
- The scientific and medical communities need to find ways to incorporate nanotechnology within their repertoire and make it commonly available for people.

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