SARS-CoV-2

An Analysis on Pathogenesis, Therapeutics, and Long-Term Impacts

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Abstract

The coronavirus family consists of relatively large, crown-shaped virions that cause upper-respiratory illness, with symptoms mimicking the common cold. There are hundreds of different coronaviruses, but the most notable are the SARS coronavirus (SARS-CoV) and the MERS coronavirus (MERS-CoV), both of which have resulted in severe respiratory disease. The spread of the novel coronavirus, SARS-CoV-2 from Wuhan, China in December 2019 has led to a lengthy pandemic with heavy losses sustained in the general population. The narrow focus of this project is to outline the pathogenesis, potential treatments, and future complications of the COVID-19 disease. Ultimately, the goal is to foster understanding of viral pandemics to adequately prepare and effectively respond to inevitable novel virus outbreaks in the future.

References

Full list:
https://docs.google.com/document/d/14HlOeaNgbKzdCeyqVi1RHoA5WWdEneLQ-1K31BUaBNU/edit?usp=sharing

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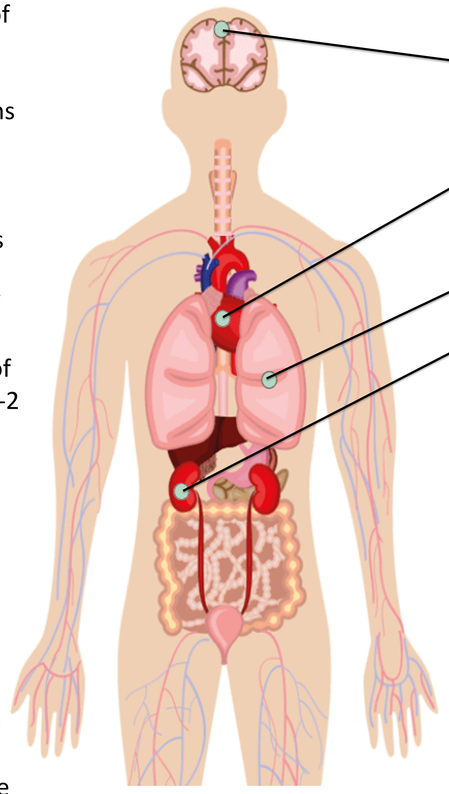

Pathogenesis

Organ	Target	Inflammatory Changes
Brain	Brain Pericytes	Inflammation of the olfactory bulbs and medulla oblongata
Heart	Cardiomyocytes, Interstitial cells, and Heart Pericytes	Myocarditis
Lungs	Secretory Goblet Cells and Type II Pneumonocytes	Diffuse alveolar damage (endotheliitis, macrothrombi, and microthrombi)
Kidneys	Renal cells	Epithelial cell tubular vacuolization and Fibrosis

Table 1. Inflammation and damage observed in target organs from autopsy data of lethal COVID-19 cases. All target cells were susceptible and permissive to SARS-CoV-2 through their Angiotensin-Converting Enzyme 2 (ACE2) receptor.

- **States of Infection**: There are three main states to a SARS-CoV-2 infection: asymptomatic, systemic, and future complications.
- **Cytokine Storm**: The significant damage done to the body by the COVID-19 disease is an effect from the release of cytokines during inflammation. May lead to ARDS.
- **Hypercoagulation**: Mass production of pro-inflammatory cytokines may lead to hypercoagulative events (eg. pulmonary embolism).
- **Secondary Infection and Co-infection**: Co-infection by bacterial pathogens is not unexpected, especially with the mix of treatments necessary to combat a SARS-CoV-2 infection.
- **Reinfection**: Instances of re-infection after months of immunity have been reported. It is theorized that mutant strains may be indistinguishable by previous antibodies.

Plausible Therapeutics

Treatment	Example(s)	Function
Antivirals	Remdesivir	Nucleoside analogue that inhibits RNA-dependent RNA Polymerase through early termination of transcription
Monoclonal Antibody Cocktail	Bamlanivima + Etesevimab or Casirivimab + Imdevimab	Intravenous, laboratory-synthesized monoclonal antibodies identical to the mechanism of biologically-synthesized antibodies of the adaptative immune system against SARS-CoV-2
Anti-coagulants	Low-molecular-weight heparin	Restricts blood clot formation and treats deep vein thrombosis/pulmonary embolism
Anti-inflammation Drugs	Tocilizumab or Sarilumab	Immunosuppressives that specifically block the proinflammatory cytokine IL-6
Convalescent Plasma	Transfer of blood plasma from individuals that have recovered from SARS-CoV-2	Contains antibodies synthesized against SARS-CoV-2 to support rapid recovery in infected individuals

Table 2. The most common therapeutics against an active SARS-CoV-2 infection. A combination of treatments may be necessary to effectively mitigate the damage.

Long-Term Impacts

Those diagnosed with COVID-19 typically recover after a few weeks. Many, however, have shown signs of long-term damage post-infection, regardless of the severity of the disease for that individual. Older people and those with previous medical conditions are more likely to show prolonged complications after the infection has run its course. There is ongoing research regarding the extent of harm on the human body; however, those currently known can be categorized based on the organ and/or system they affect:

- **Nervous System**: COVID-19 has shown to induce seizures, strokes, encephalopathy, and temporary paralysis in infected individuals. It is believed that neurological damage induced by a combination of hypercoagulation, cytokine storms, and a chance of viral infection within the CNS through the olfactory bulbs.
- **Cardiovascular System**: Type 1/2 myocardial infarction, myocarditis, or vasculitis.
- **Respiratory System**: Post-infection lung injury typically shows pneumonia and diffuse alveolar damage, resulting in difficulty breathing and hypoxia.