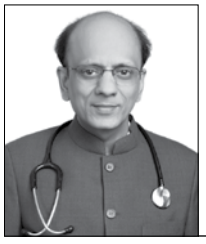

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Autopsy Reports of COVID-19 Patients

- Every organ in the body seems to be affected.
- Conducting autopsies on coronavirus disease (COVID) patients has been like a police line-up where it might not be possible to identify the perpetrator but it may be possible to eliminate the unlikely suspects.
- Autopsy has revealed that there's no direct tissue pathology that can explain the acute symptoms seen in the heart, kidney and brain.
- Certain hypotheses have been postulated regarding the causes of extensive organ damage in COVID-19. One of them states that hypoxia resulting from compromised lung function may cause secondary injuries.
- Obesity is a predisposing factor in the infected for worse morbidity and mortality. Obesity in itself is a pathologic state. It causes atherosclerosis, increased clotting, fatty liver disease and often, enlarged hearts.
- Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has shown a selectivity for the lungs. In one of the deceased, bone marrow response was observed with many myeloid precursors in the peripheral blood vessels, which is characteristic of an overwhelming infection.
- SARS-CoV-2 may be targeting the type II pneumocytes.
- These lung surface cells secrete a fatty substance that keeps the lobes pliable. And that is accountable for the diffuse alveolar damage and acute respiratory failure.
- Immunohistochemistry testing and electron microscopy have confirmed viral tropism for pulmonary II pneumocytes.
- Viral antigen in lung tissue has been found to be higher than with SARS or MERS (Middle East respiratory syndrome).
- Extensive detection in epithelial cells of the upper respiratory tract is unique among these highly pathogenic coronaviruses.
- Autopsies have also confirmed the reports of increased clotting. The virus may be infiltrating the endothelium and causing injury to the blood vessel.
- Myocarditis is typical of viral diseases, but it has been inconsistent in COVID-19 autopsies. Most have reported very little inflammation of the heart muscle. At least one death has been directly related to COVID-19-induced lymphohistiocytic and eosinophilic myocarditis. Researchers from Germany have reported in *JAMA Cardiology* that 60 out of 100 patients who had recovered from COVID-19 had ongoing myocardial inflammation, as evidenced by cardiovascular magnetic resonance imaging (MRI).
- But, it looks like, what they see on MRI is not true myocarditis but something else as per Richard S. Vander Heide, MD, PhD, MBA, a professor of pathology at Louisiana State University Health Sciences Center in New Orleans.
- Thus far, autopsy studies have shown no typical myocarditis in nearly every case.
- Vander Heide and colleagues reported cardiopulmonary findings from 10 autopsies on African Americans who died from COVID-19 in *The Lancet* in May. The report was updated with additional 12 cases in *Circulation* in July. Six of these 22 were found to have a history of heart

disease. All had diffuse alveolar damage, which is a histopathologic marker of acute respiratory distress syndrome (ARDS), in addition to pulmonary thrombi and microangiopathy. The virus was not found in the heart muscle cells and there was no evidence of typical lymphocytic myocarditis. In the newer study, investigators used electron microscopy to find what appeared to be viral particles in the vascular cells in the heart, lungs and kidneys. Vander Heide, whose primary research interest is myocardial cell injury and adaptation, believes that the infection of these endothelial cells is resulting in clotting abnormalities in the heart's small vessels, causing inflammation. The heart cells are dying, but that can't be attributed to myocarditis. According to him, it's likely that the clotting is causing cell death from ischemia.

- Some pathologists are evaluating the vascular changes, which are among the unique features of COVID-19, according to Maximilian Ackermann, MD, and colleagues in an article published in May in the *New England Journal of Medicine*.
- Comparing the lungs of 7 patients who died from COVID-19 with 7 who died from ARDS secondary to influenza, and those from 10 age-matched, uninfected patients, investigators noted that the COVID-19 lungs exhibited severe endothelial injury, which appeared to be associated with intracellular SARS-CoV-2 virus.
- There was extensive vascular thrombosis with microangiopathy and occlusion of alveolar capillaries and significant new vessel growth from an unusual form of angiogenesis, known as intussusceptive angiogenesis — a reactive formation of new vessels where one splits into two.
- Investigators have also observed venous thromboembolism in patients, including in a study at the University Medical Center Hamburg-Eppendorf in Germany that was published in May in the *Annals of Internal Medicine*.
- Coronavirus infections may trigger venous thromboembolism.
- The potential mechanisms include endothelial dysfunction, systemic inflammation, and a pro-coagulatory state.
- Investigators at Hospital Graz II in Graz, Austria, also focused on thrombosis, with evidence of it in all 11 autopsies, reported an article published in *Annals of Internal Medicine*.
- While pathologists were initially not willing to conduct COVID-19 autopsies, particularly those that would involve aerosol-generating procedures, the College of American Pathologists worked towards lessening the fears and came out with guidelines that recommend techniques that minimize those procedures, including using hand shears or other alternatives to an oscillating bone saw (also recommended by the CDC) or using a vacuum shroud with the bone saw.
- There have been no reported cases of SARS-CoV-2 transmission from a corpse to any pathologist, morgue technician or assistant. An informal survey in March of pathologists on a LISTSERV revealed that only 6 out of 50 respondents were conducting autopsies. A month later, that number rose to 30.
- The CDC recommends that autopsies should be done in a negative pressure suite, which are more common at academic centers.

With input from Dr Monica Vasudev (Medscape excerpts)

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