

Cardiovascular Considerations for Patients, Health Care Workers, and Health Systems During the Coronavirus Disease 2019 (COVID-19) Pandemic

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Heart transplantation

In addition to the mechanisms by which COVID-19 can affect patients with CVD risk factors, it is also important to consider COVID-19 in the context of an especially vulnerable group of patients, such as individuals awaiting or post heart transplantation. There are now case reports of COVID-19 infection among heart transplant patients (38,39). Two heart transplant patients in China, one with mild and one with severe disease, presented with symptoms typical of COVID-19 disease. Both were managed by withholding baseline immunosuppressive regimens and treating aggressively with high dose steroids, intravenous immunoglobulin, and antibiotics, and both survived without evidence of allograft rejection. Previous viral outbreaks have noted particularly severe infection in immunosuppressed solid organ transplant recipients (40). Formal treatment guidelines in these patients do not exist at this time. Heart allocation teams need to consider the optimal screening strategies in order to prevent severe infection in recipients including whether all donor hearts should be screened, given the existence of asymptomatic COVID-19, versus limiting screening to patients with a history of symptoms or exposure of COVID-19. During the H1N1 influenza pandemic, potential donors were screened if symptomatic or if they had significant exposure history in order to prevent infection in the recipient or as an impetus to initiate prophylaxis if the donor was positive (41). Similarly, screening recipients for a history of symptoms or exposure of COVID-19 to avoid a post-transplant flare will be reasonable to be considered. Utmost precautions in infection control must be employed when interacting with these vulnerable immunosuppressed patients.

Cardiomyopathy and heart failure.

Zhou and colleagues reported that heart failure was observed in 23.0% of patients with COVID-19 presentations (6). Notably, heart failure was more commonly observed than acute kidney injury in this cohort and was more common in patients who did not survive the hospitalization compared to those who did survive (51.9% vs. 11.7%). Whether heart failure is most commonly due to exacerbation of pre-existing left ventricular dysfunction versus new cardiomyopathy (either due to myocarditis or stress cardiomyopathy) remains unclear (53). Right heart failure and associated pulmonary hypertension should be also considered, in particular in the context of severe parenchymal lung disease and ARDS.

Cardiogenic and mixed shock. The predominant clinical presentation of COVID-19 is acute respiratory illness, which may lead to ARDS manifested as ground-glass opacities on chest imaging (54) and hypoxemia. However, similar features may be seen in the case of *de novo* or coexisting cardiogenic pulmonary edema. As such, it is important consider cardiogenic or mixed cardiac plus primary pulmonary causes of respiratory manifestations in COVID-19. Historically, right heart catheterization was used to determine pulmonary capillary wedge pressure in order to aid in this distinction, although this has been removed from the Berlin criteria used for the diagnosis of ARDS. Rather, the Berlin criteria utilize timing of symptom onset, imaging with bilateral pulmonary opacities, and lack of volume overload to identify patients with ARDS (55). In many cases, serum brain natriuretic peptide (BNP) and echocardiography can help clarify the diagnosis (56,57). However, if these tests are unclear and there remains concern for mixed presentation, pulmonary artery catheterization should be considered in select cases to assess filling pressures, cardiac output, and to guide clinical decision-making, given the different management approaches for ARDS and cardiogenic shock. Finally, it is crucial to determine whether or not a concomitant cardiogenic

component is present when considering mechanical respiratory and circulatory support with extracorporeal membranous oxygenation (ECMO) or other techniques, as this may lead to changes in device selection (e.g. venovenous vs. venoarterial ECMO cannulation). Regardless, in the most severe of infections with ARDS and necrotizing pneumonias, patient prognosis may be poor even with ECMO support. In a case series of 52 critically ill patients with COVID-19, 83.3% (5/6) of patients who were treated with ECMO did not survive. Further studies regarding the utility of ECMO support in advanced COVID-19, including which patients may (or may not) benefit and whether concomitant left ventricular venting should be done, are warranted (58).