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Rapid Deterioration of Hospital-Acquired COVID-19 in a Patient on Extracorporeal Left Ventricular Assist Support

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ABSTRACT

Importance: As the Coronavirus disease 2019 (COVID-19) pandemic accelerates, our hospitals have become overwhelmed.

Objective: To describe detection of COVID-19 in asymptomatic hospitalized individuals awaiting advanced therapies for HF and the management of complications of COVID-19.

Design: We present a unique case report of hospital-acquired COVID-19 in a patient on temporary mechanical circulatory support.

Main Outcome: Despite intensive care and monitoring, he developed rapid progression of hypoxic respiratory failure which led to his death.

Conclusion: This case highlights various considerations for a patient with temporary MCS. It illustrates the high risk for development of COVID-19 for vulnerable hospitalized patients.

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Learning Objectives

Identify COVID-19 in hospitalized patients even when they are asymptomatic.

Emphasize the importance of early advanced care planning in patients with heart failure and COVID-19.

Understand clinical phenotyping in COVID-19 to allow for more targeted and timely therapeutic interventions.

Clinical presentation

The patient is a 55-year-old male who presented with chest pain, and was found to have a non-ST elevation myocardial infarction. The medical history included prior coronary bypass graft surgery (known occluded grafts), hypertension, and diabetes mellitus. He developed cardiogenic shock and required intra-aortic balloon placement. Due to refractory cardiogenic shock, MCS was escalated to peripheral veno-arterial extracorporeal membrane oxygenation and Impella CP® (Abiomed, Inc.; Danvers, Mass). In the setting of severe hemolysis and the continued need for temporary MCS, he underwent placement of a central extracorporeal left ventricular assist device (LVAD) [CentriMag® (Levitronix LLC; Waltham, Mass)]. His course was complicated by acute kidney injury requiring renal replacement therapy, liver failure, stroke, ventricular arrhythmias, and prolonged intubation causing vocal cord paralysis and debilitation. By hospital day (HD) 20, he had neurologic recovery, normalization of liver function tests and improvement of renal function. The plan was to transition him to durable LVAD. In keeping with hospital protocol amidst the COVID-19 pandemic, he underwent COVID-19 screening prior to laryngoscopy for vocal cord paralysis evaluation.

Assessment and Diagnosis

Real-time polymerase chain reaction for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was positive on HD 21. At this time, several markers of disease severity were outside of normal limits (Figure 1A and Table 1). He was deemed high-risk for serious complications from COVID-19 given his comorbidities.

Treatment and Prognosis

The patient was quarantined in a negative-pressure room following test results. On HD 24, he developed cough, tachypnea and hypoxemia with an oxygen saturation of 90% on room air requiring...
Figure 1. (A) Timeline of Disease Progression. Trends in laboratory values, imaging, and pulse oximetry. The patient was found to be SARS-CoV-2 positive on hospitalization day 21 and he died 3 days after. Several markers of disease severity were abnormal including absolute lymphocyte count, C-reactive protein, D-dimer, ferritin, cardiac enzymes and LDH. Abbreviations: CRP = C-reactive protein. LDH = lactate dehydrogenase. ESR = erythrocyte sedimentation rate. (B) Important Considerations for Hospital-Acquired COVID-19 in Advanced HF Patients.
3 liters/minute of supplemental oxygen. A repeat chest x-ray revealed new diffuse bilateral opacities. He was initiated on hydroxychloroquine that morning (baseline QTc 455 msec). Over the course of 2 hours the patient developed severe hypoxemia with oxygen saturations of 70%, followed by hypotension and low flows through the Centrimag®. The mean arterial pressure dropped to 50-mmHg followed by an immediate drop in Centrimag® flows and asystole. Given his current transplant ineligibility or option for durable LVAD support, advanced cardiac life support was not performed as his prognosis on continued temporary support was extremely poor and he expired.

**Discussion**

First, this case underscores the rapidity of deterioration in COVID-19 patients once hypoxia starts. Second, COVID-19 must be considered in hospitalized patients even when they are asymptomatic. Lastly it emphasizes the importance of early advanced care planning (Figure 1B).

**Window of Opportunity to Treat**

While predictors of rapid disease progression have yet to be elucidated, early trends of inflammatory markers may be helpful to risk stratify COVID-19 patients and identify those who are likely to become critically ill. Biomarkers of cytokine storm include lymphopenia, C-reactive protein, prothrombin time, LDH, ferritin, D-dimer, and troponin. Siddiqi and Mehra recently proposed a schema to assess the severity of “systemic hyperinflammation” in a patient with COVID-19 to guide therapies. In this case, there was a correlation between the onset of decompensation and an increase in inflammatory markers, as he progressed from Stage I (Early infection) to Stage III (Hyperinflammation) in a matter of hours. This raises questions about the rate of progression of COVID-19 in MCS patients and the optimal timing to initiate therapy. During this pandemic, whether patients with INTERMACS profiles 1-3 should have early introduction of medications against COVID-19 and even early consideration for mechanical ventilation to improve their chances of survival is unknown.

There are currently no anti-SARS-CoV-2 therapies or vaccines that have been approved by the Food and Drug Administration due to the absence of adequate evidence, yet there are several ongoing randomized trials evaluating different treatments.

Another phenomenon in COVID-19 is occlusion and microthrombosis of pulmonary small vessels. The viral infection causes endothelial cell dysfunction, which creates a hypercoagulable state associated with thrombosis. Hence, early use of anticoagulant therapy has been suggested to improve outcomes in select cohorts with markedly elevated D-dimers. The patient in this case received anticoagulation because he was on a Centrimag® but his aPTT was subtherapeutic for 48 hours prior to his deterioration, which raises the question of a thromboembolic event as a contributing factor to his acute decompensation.

**Risk of Hospital-Acquired COVID-19**

In nosocomial diseases the source of infection is often unknown, any healthcare worker (HCW) or visitor is capable of transmitting it to a patient. Our institution has adopted a no visitor policy. HCWs follow appropriate hand hygiene and wear protective gear (surgical mask, gloves and gowns). But at times cross contamination between patients and HCW (reservoirs or asymptomatic carriers) can happen despite best practices. Long incubation period [median of 5.1 days (95% CI 4.5 to 5.8 days)] and the concern for asymptomatic carriers of SARS-CoV-2 further undermine the goals of infection control within the hospital. Presently broad testing of asymptomatic patients and HCW for COVID-19 is not available but may have impacted disease transmission in this case.

The development of COVID-19 in this patient was particularly problematic as it precluded his chance to receive a cardiac transplant or undergo durable LVAD insertion until recovery and clearing of the virus was demonstrated. Furthermore, the mid to long-term effects of COVID-19 pneumonia on residual lung function is unknown.

**Advanced Care Planning**

Hospitalized patients with advanced HF are vulnerable to contracting COVID-19 with a potentially fulminant course. As such conventional practices of using MCS as a “bridge to decision” may not be practical during this pandemic where the balance of limiting exposure must be weighed against prolonged hospital stay for definitive HF therapies. The mortality rate reported in critically ill COVID-19 patients ranges from 15% in the Wuhan experience to 50% in the Seattle Registry. Pre-emptive early palliative care discussions with the patient and the family members are

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**Table 1**

| Laboratory | Reference value | Hospitalization Day |
|------------|-----------------|---------------------|
| WBC (x10^9/μL) | 4.5-11 | Day 18 12.6 11.9 11 | Day 20 11.9 11 | Day 21 8.3 8.7 9 |
| Absolute Lymphocyte (x10^9/μL) | 1.0-4.5 | Day 22 8.3 | Day 23 8.7 | Day 24 9 |
| Platelet (x10^9/μL) | 150-450 | 378 234 198 207 207 |
| Creatinine (mg/dL) | 0.70 - 1.30 | 5.06 4.06 3.78 3.55 3.69 3.85 |
| AST (U/L) | 1 - 35 | 33 24 26 28 33 |
| ALT (U/L) | 1 - 45 | 20 15 14 21 14 14 |
| Total bilirubin (mg/dL) | 0.1-1.2 | 0.5 0.4 0.4 |
| INR | 1.3 1.3 1.4 1.3 1.5 1.5 |
| aPTT (sec) | Therapeutic range: 70-110 | 81 70 70 70 63 55 |
| CRP (mg/L) | 0-5.0 | 61 170 234 |
| LDH (U/L) | 100-220 | 499 417 454 484 |
| D-dimer (ug/mL) | 0.00-0.50 | 6.34 5.74 3.71 |
| Ferritin (ng/mL) | 30-400 | 426 418 610 548 |
| Troponin (ng/mL) | 0.00-0.03 | 0.62 0.48 0.43 |
| Creatine Kinase (U/L) | 30 - 200 U/L | 65 |
| ESR (mm/hr) | 0-145 |

Abbreviations: AST = aspartate aminotransferase. ALT = alanine transaminase. INR = international normalized ratio. aPTT = activated partial thromboplastin time. CRP = C-reactive protein. LDH = lactate dehydrogenase. ESR = erythrocyte sedimentation rate.
more essential now than ever given restrictions placed on family visitation, and potential for rapid deterioration both of advanced HF and of COVID-19 in this population.

Conclusions

This case highlights various considerations for a patient with temporary MCS. It illustrates the high risk for development of COVID-19 for vulnerable hospitalized patients.

Declaration of Competing Interest

No conflict of interest or disclosures relevant for this publication

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