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CHEST

# A 58-Year-Old Man With Coronavirus Disease 2019 Pneumonia and Undifferentiated Shock



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A 58-year-old man with intellectual disability presented to the hospital with dyspnea. Results of the initial physical examination were significant: the patient was tachycardic, hypotensive, hypoxemic on a nonrebreather mask, and in significant respiratory distress. Laboratory data revealed a normal leukocyte level (6.9 K/μL), lymphopenia (0.7 K/μL), and elevated inflammatory markers (C-reactive protein, 279 mg/L; ferritin, 3,895 ng/mL; IL-6, 136 pg/L). Arterial blood gas analysis showed the following: pH, 7.44; $P_{CO_2}$, 53 mm Hg; $Pa_{O_2}$, 71 mm Hg; and lactate, 0.9 mM. A nasopharyngeal swab for coronavirus disease 2019 (COVID-19) produced a positive result. A chest radiograph and ECG were obtained (Figs 1 and 2). The patient was intubated for acute hypoxic respiratory failure and admitted to the ICU. A goal-directed echocardiogram for undifferentiated shock and acute respiratory failure was obtained (Video 1, subcostal views).


Figure 1 – *Chest radiograph on admission, showing enlarged cardiac silhouette and bilateral patchy opacities.*

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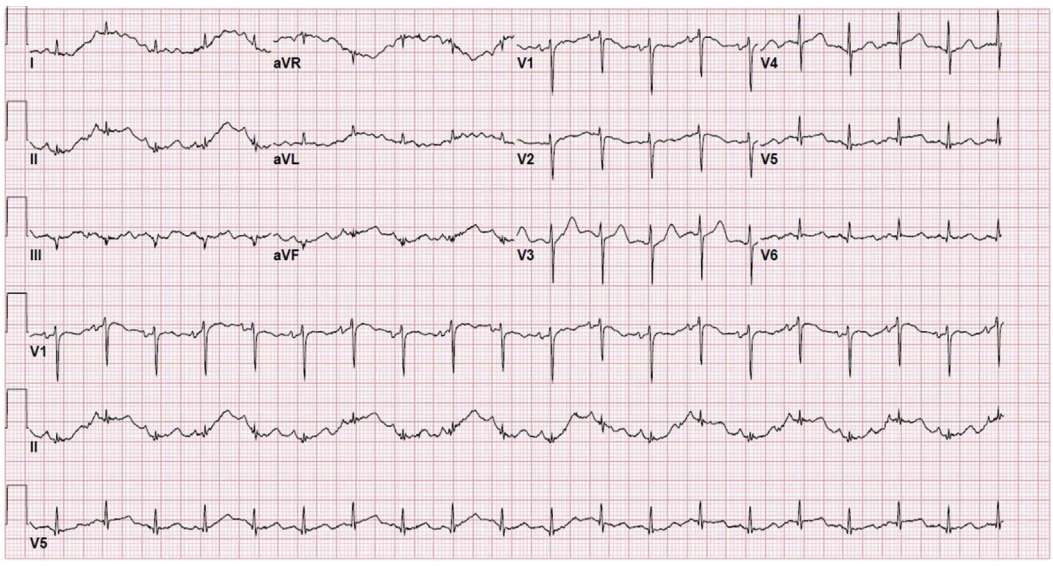


Figure 2 – *ECG on admission, showing sinus tachycardia and low-voltage QRS complexes.*

*Question: On the basis of the clinical scenario and the findings on point-of-care ultrasound (POCUS), what is the most likely diagnosis for this patient?*

*Answer:* Obstructive shock secondary to cardiac tamponade as well as respiratory failure with noncardiogenic pulmonary edema due to COVID-19

Video 1 demonstrates a moderate-sized pericardial effusion with possible right ventricular collapse in early diastole. Additional views show right atrial invagination and a fixed and nonvariable inferior vena cava (IVC) measuring larger than 2 cm. Lung ultrasound showed a diffuse B-line pattern, irregular pleura, and a trace anechoic right-sided pleural effusion. Despite large-volume crystalloid infusion to increase venous pressures, the shock state persisted and pericardiocentesis was performed by interventional cardiology. Three hundred milliliters of straw-colored fluid was removed, and a pericardial drain was left in place for 24 h. Video 2 shows a trivial pericardial effusion after pericardiocentesis. Pericardial fluid samples taken for cytology and COVID-19 PCR both produced negative results. After drain removal, daily point-of-care ultrasound was done to monitor for recurrence of the pericardial effusion; none was noted.

The patient was extubated to high-flow nasal oxygen on hospital day 4, having received hydroxychloroquine, azithromycin, corticosteroids, and colchicine for COVID-19 and the associated pericardial effusion. However, because of his poor premorbid functional status, the patient experienced recurrent aspiration events with significant hypoxia and was transitioned to comfort care, dying on hospital day 16.

## Discussion

POCUS is a powerful tool for the intensivist evaluating undifferentiated shock states and acute respiratory failure. Goal-directed echocardiography can quickly and reliably identify pericardial effusions and tamponade physiology.[1] Previous reports have shown that non-cardiology-trained ED physicians and intensivists can identify sonographic signs of pericardial effusion with 95% accuracy.[1]

A pericardial effusion is defined by an excess of 50 mL of fluid in the pericardial space.[2] Etiologies include malignancy, trauma, uremia, rheumatologic conditions, and infections. Because the pericardial space exhibits a nonlinear pressure-volume relation, acuity and hemodynamic consequence depend on the rate of fluid accumulation. An effusion that rapidly accumulates will lead to worsening interventricular dependence at smaller volumes, resulting in tamponade physiology and reduced cardiac output. On the other hand, a pericardial effusion that slowly accumulates to a large volume may not result in significant hemodynamic consequence, as the pericardium is able to stretch.[2] Qualitative echocardiographic signs of tamponade include diastolic right ventricular collapse and systolic right atrial collapse. Quantitative signs include a dilated and nonvariable IVC larger than 2.1 cm, and more advanced measurements including pulse wave Doppler to evaluate for variations of tricuspid and mitral in-flow velocities (40% and 25%, respectively).[2] A fixed and dilated IVC carries a 92% sensitivity for tamponade for a patient in shock with a pericardial effusion present; however, this finding has a lower specificity as it can be seen in other forms of obstructive shock such as acute pulmonary embolism.[2]

Pericardial effusions associated with hemodynamic compromise and suspected tamponade mandate urgent pericardiocentesis. Pericardial drainage under ultrasound guidance is both safe and effective with a success rate as high as 97%, a total major and minor complication rate of 4% to 20%, and an associated mortality of less than 1%.[1]

Video 1 shows a moderate pericardial effusion, diastolic right ventricular collapse, systolic right atrial collapse, and a dilated and nonvariable IVC. Not all POCUS findings need to be present to diagnose pericardial tamponade, if seen in the appropriate clinical setting (eg, tachycardia, hypotension, and elevated jugular venous pressures).[1] In equivocal cases, those trained in advanced critical care echocardiography may use measurements of variation in transmitral and transtricuspid flow, using pulse wave Doppler to further clarify the clinical picture.[2]

POCUS is also valuable for identifying noncardiogenic pulmonary edema. As seen in Video 1, lung windows show diffuse B-line patterns. Detection at multiple points on the anterior chest of more than three B-lines in a single rib space identifies interstitial syndrome.[3] Furthermore, the presence of diffuse B-lines and an irregular pleural line can be consistent with noncardiogenic pulmonary edema as in ARDS. These findings are consistent with prior reports of COVID-19-related lung disease: diffuse B-lines with an irregular pleural line without significant pleural effusions.[4]

Here, we report a COVID-19 case associated with pericardial effusion resulting in obstructive shock, POCUS findings summarized in Video 3. Although the

pathogenesis remains unclear, suspected viral or immunological inflammation of the pericardium and subsequent fluid accumulation resulting in tamponade may be considered.

In COVID-19, shock has been identified in up to 6% of patients, including various case reports of cardiogenic, septic, and hypovolemic shock.[5-7] Goal-directed echocardiography and lung ultrasound should be performed for all patients with undifferentiated shock and acute respiratory failure, including patients with COVID-19. If a pericardial effusion is found, POCUS can be used to confirm a diagnosis of cardiac tamponade, allow for safe drainage of fluid, and monitor for reaccumulation through follow-up serial examinations.

To our knowledge, our description here represents the fourth case of pericardial effusion and the second case of cardiac tamponade in a patient with COVID-19.[5,8,9] With no prior cardiac history or clear alternative explanation for pericarditis and pericardial fluid accumulation, we hypothesize the possibility of cardiac tamponade secondary to COVID-19 as an etiology of this patient's shock and recommend consideration of this and further evaluation of patients with COVID-19 by POCUS.

## Reverberations

1. *Point-of-care ultrasound can quickly and reliably identify a pericardial effusion.*
2. *Tamponade is an important diagnosis to consider in all patients with hemodynamic instability—and should be considered in patients with COVID-19.*
3. *Point-of-care ultrasound can help diagnose and guide management of cardiac tamponade with the presence of a moderate to large pericardial effusion, dilated and nonvariable IVC, and no other clear etiology for a shock state.*


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**Additional information:** To analyze this case with the videos, see the online version of this article.


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