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Case Report

Role of Lung Doppler Study [Color and Spectral] in Differentiation Between the Pulmonary Infarction and Pulmonary Infection in COVID-19 Pneumonia

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Abstract

Introduction: SARS-CoV-2 virus can cause severe ARDS, as well as pulmonary infarction, and differentiation between both will positively impact on the patient management, Lung U/S can differentiate between the two by the presence of typical lesion of pulmonary infarction, together with absent flow in color Doppler, we present a 50-year-old male patient admitted to our ICU with confirmed COVID-19 Pneumonia and we did advanced critical care U/S including Lung U/S by a 3.5MH phase array probe Samsung HM70, we found 2 types of sub pleural consolidation lesions, we did full Doppler study [color and spectral] to the lesions, we found that Doppler can differentiate between the 2 lesions by the presence of blood flow in inflammatory lesion of ARDS and absence in PE.

Conclusion: Doppler study [color and spectral] may have an important role in differentiation between the sub pleural consolidation of ARDS and pulmonary embolism.

Keywords: *COVID-19 Pneumonia; Lung U/S In COVID-19 Pneumonia; Lung U/S in PE*

Introduction

Reports of acute pulmonary embolism associated with COVID-19 have emerged in the literature. For example, Chen., *et al.* described 25 pulmonary CT angiograms examinations from COVID-19 patients; 10 were positive for pulmonary embolism mostly as segmental or sub-segmental APE [1] In addition, D-dimer levels have been reported as elevated in patients with COVID-19 [2,3], with the suggestion of an independent association between the severity of the disease and the level of D-dimer [4].

Ian Leonard., *et al.* demonstrated that of 106 pulmonary CT angiograms performed for COVID-19 patients over a one-month period in a tertiary care center; 32/106 (30%) of patients had acute pulmonary embolus. This rate of pulmonary embolus is higher than usually encountered in critically ill patients without COVID-19 infection (1.3% [5]) and emergency Department 10% [6].

Also, ARDS is a common presentation of COVID-19 patients, in 20-30% of these COVID-19 patients admitted to the intensive care unit (ICU), severe hypoxemia is associated with compliance values < 40 ml/cmH_2O, indicating severe ARDS [7].

In ICU, the main indication of admission in COVID-19 patient is severe shortness of breath, SARS-CoV-2 virus can cause severe ARDS, as well as pulmonary infarction, and differentiation between both will positively impact on the patient management, one of the important, available, cheap, noninvasive imaging tool in ICU to help in diagnosis is Lung U/S.

Several studies confirmed the utilities of lung U/S in diagnosing pulmonary embolism, they described a specific pleuropulmonary lesion by Lung U/S, pleural based wedge or round shaped (mean, 2.3 lesions per patient) averaging 15.5 x 12.4 mm in size, with localized pleural effusion, and color Doppler may reveal absence of flow denoting consolidation without perfusion which will confirm pulmonary infarction with absent flow [8-11].

But, also, sub pleural consolidation is a common finding of ARDS by Lung U/S [12].

So, differentiation between this two types of sub pleural consolidation will be very important in management of COVID-19 patients.

We present a 50-year-old male patient admitted to our ICU with confirmed COVID-19 Pneumonia and we did advanced critical care U/S including Lung U/S, we found 2 types of sub pleural consolidation in both lung fields, both are associated with confluent B-Lines, applying full Doppler study of the 2 lesions revealed that, one lesion is wedge shaped, multiple, variable size with the largest 2 cm length with absent flow in both color and spectral Doppler denoting PE and infarction, the other sub pleural lesion was round, larger and with full Doppler study [color and spectral], color Doppler revealed pulsating arterial flow inside the lesion, applying 3 mm sample volume of spectral Doppler inside the lesion, we found a low resistance pulmonary arterial circulatory blood flow with a peak velocity of 30 cm/sec and end diastole velocity of 10cm/sec, both color and spectral Doppler flow confirmed the presence of pulmonary perfusion which diagnose pneumonia instead of pulmonary infarction for these lesion.

Case Study

A 50-year-old male patient was admitted to our ICU because of severe ARDS, he was fully sedated, paralyzed, and connected to high setting mechanical ventilator [AC, P/C 30 mmgh, PEEP 12 mmgh, FIO_2 90%, I:E 1:1, RR 26/min] with ABG PH 7.26, PCO_2 55, PO2 79, HCO_3 21.

Investigations

Hematology: Revealed leukocytosis, neutrophilia, lymphopenia [WCC 16000/cmm, 89% neutrophils, 6.7% lymphocytes, PT 10sec, INR 0.92, PTT 37sec, D-Dimer 7.5 micg/l.

Chemistry: Revealed DM, increased inflammatory markers, and mild renal impairment [RBS 335 mg/dl, serum urea 16 mmol/l, serum creatinine 140 micmol/l, LDH 606 IU/L, serum ferritin 2000 micg/l, serum albumin 2.3 gm/dl].

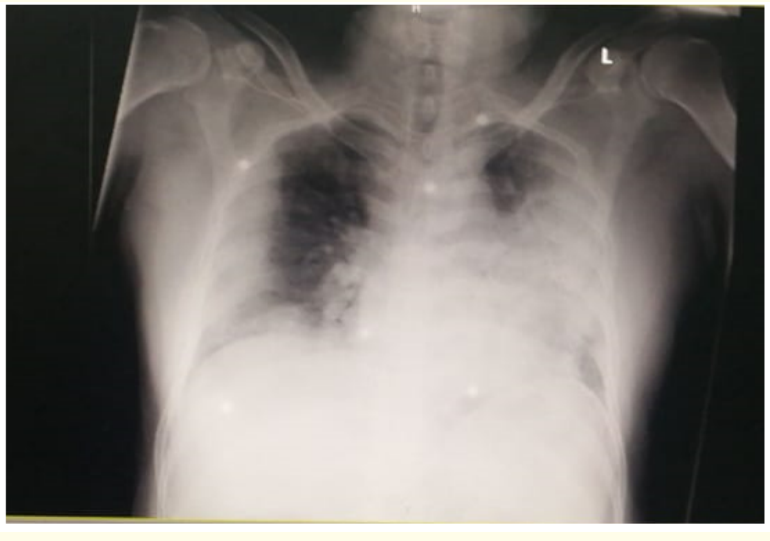

Figure 1: *X-ray chest, bilateral opacities.*

We use to do critical care U/S for all our COVID-19 Pneumonia patients on admission.

Critical care U/S

First, IVC

It was dilated non distensible.

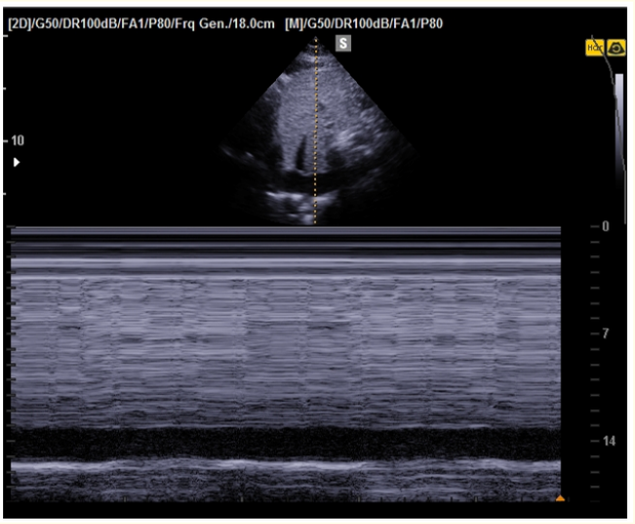

Figure 2: *Dilated non distensible IVC.*

Second, the heart

Dilated RT side with dyskinetic septum denoting RT ventricle pressure overload.

Third, focused U/S for DVT

Both CFV, SFV, and Popliteal veins are compressible denoting no DVT.

https://www.dropbox.com/s/lcw9k2bdp3x6wcj/heart%20dvt.mp4?dl=0. Link of 4 chambers view Echo revealing dilated RT side with dyskinetic septum, and compressible Lower extremities veins [CFV, SFV.PV].

Fourth, the Lung

We found, 1- wide spread confluent B- Lines over both Lung fields, 2- 2 types of sub pleural consolidation lesions at the mid axillary and posterior basal of both lungs.

The first one is pleural based, multiple wedge shaped, and with Doppler study [color and spectral] of this lesion by putting the sample volume inside it, there was no color flow and no spectral flow.

The second sub pleural lesion, is larger than the first one and round in shape, and with applying Doppler study, there was clear color and spectral Doppler, the spectral Doppler flow was of low resistance circulation with peak systolic velocity 30 cm/sec, end diastolic velocity 10 cm/sec.

Both sub pleural consolidation lesions were associated with confluent B-Lines.

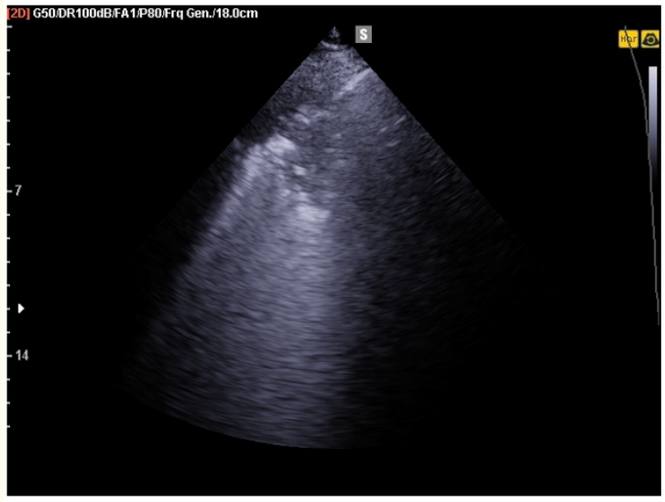

Figure 3: *Pleural based wedge shaped subpleural consolidation, with confluent B-Lines.*

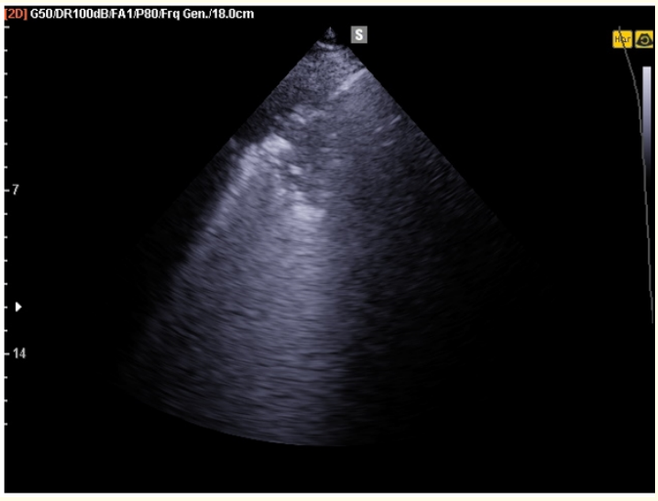

Figure 4: *Pleural based wedge shaped subpleural consolidation, with confluent B-Lines.*

https://www.dropbox.com/s/amc9v0gav9e89r4/wedge%20lesion.mp4?dl=0. Link for video demonstrating the sub pleural consolidation of PE, pleural based wedge shaped, multiple with no blood flow by both color and spectral Doppler.

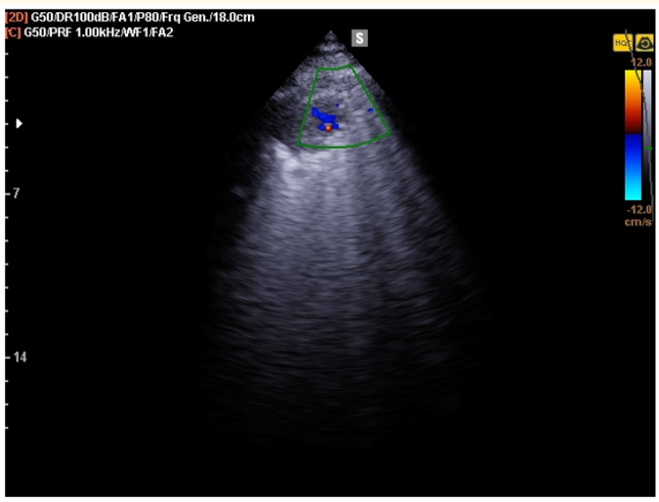

Figure 5: *Pleural based wedge shaped subpleural consolidation, with confluent B-Lines.*

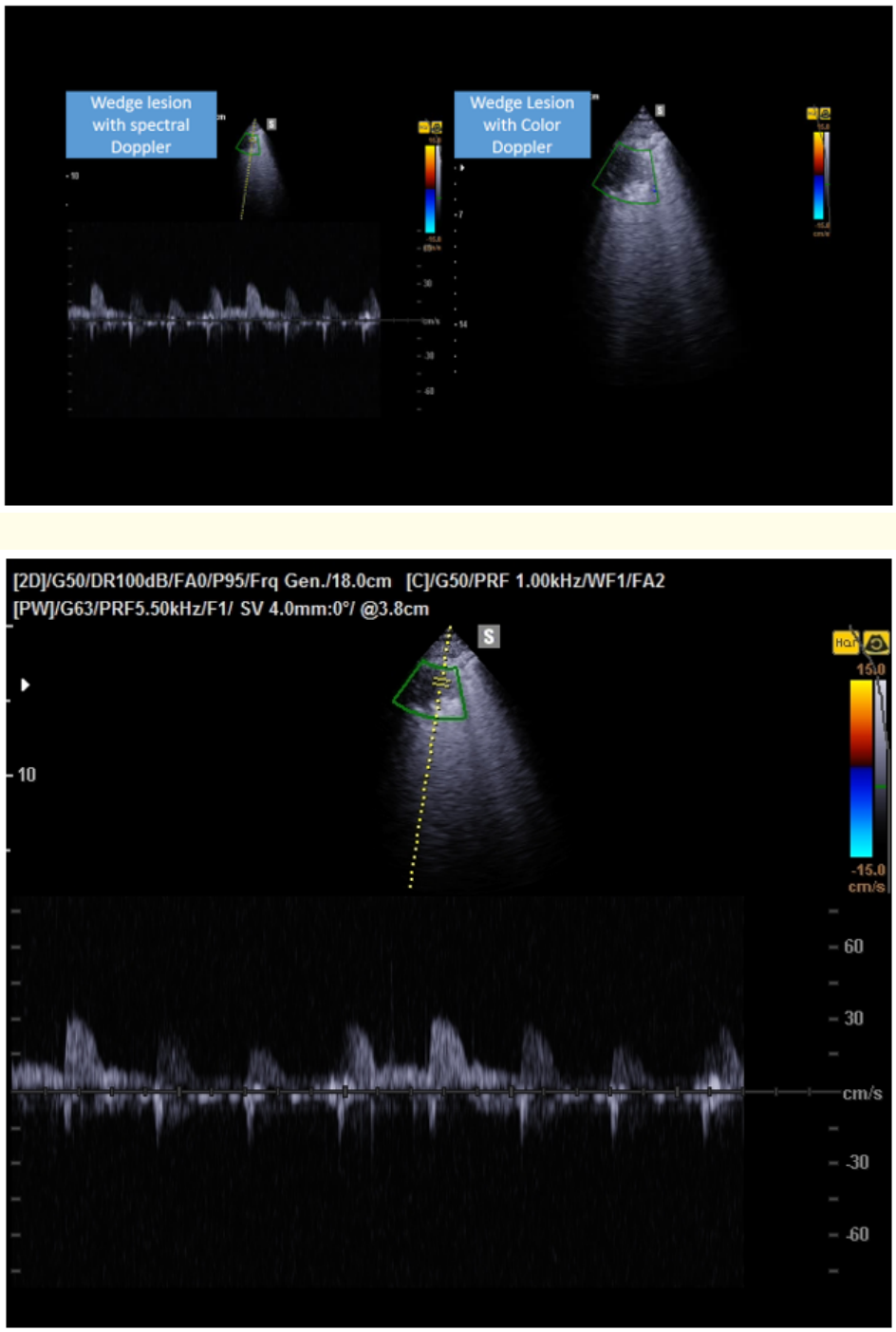

Figure 6: *Clear spectral Doppler of the round subpleural consolidation with low resistance pulmonary arterial flow with peak systolic velocity 30 cm/sec, and end diastolic velocity 10 cm/sec.*

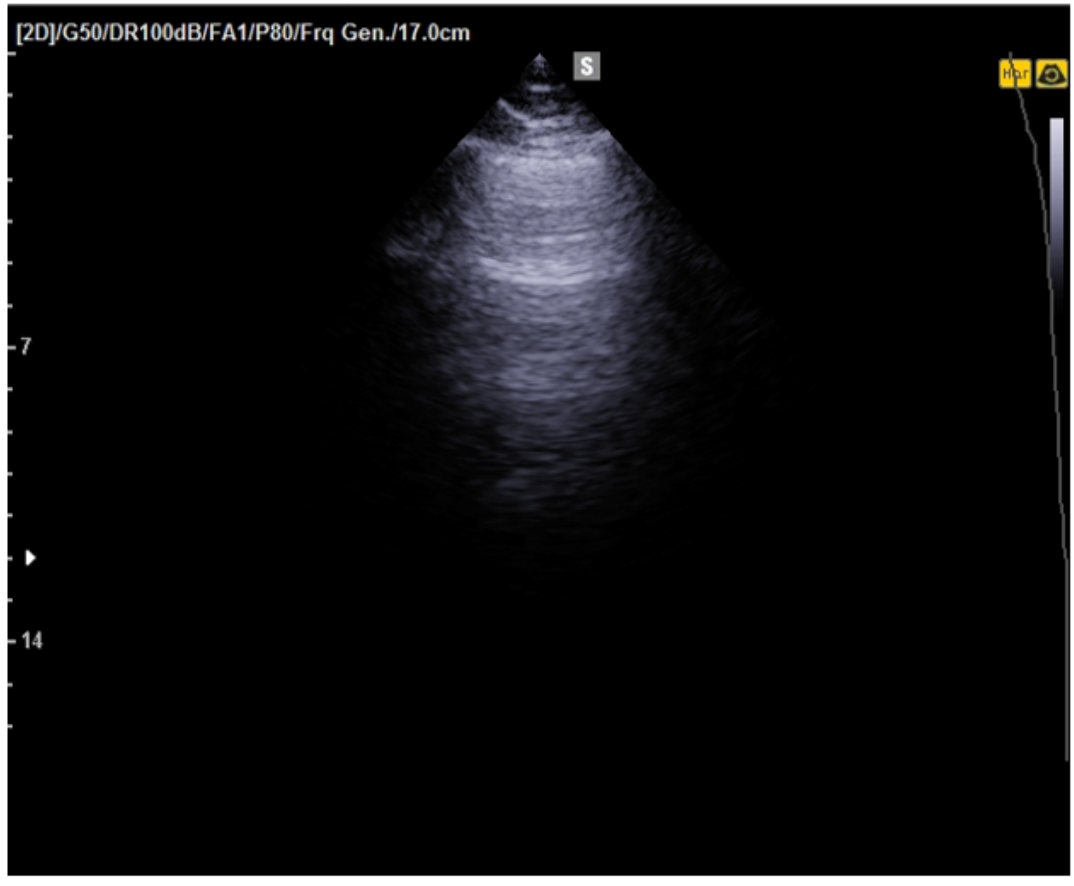

Figure 7: *Spared area of A-Lines.*

https://www.dropbox.com/s/cd4byb449j9vmlt/round%20lesion.mp4?dl=0. Link of the pleural based round sub pleural consolidation, with clear pulmonary arterial blood flow by both color and spectral Doppler, denoting inflammatory consolidation.

My case report of a simple way to differentiate between PE and ARDS in COVID-19 by lung U/S.

Discussion

In ICU, the main indication of admission in COVID-19 patient is severe shortness of breath, SARS-CoV-2 virus can cause severe ARDS, as well as pulmonary infarction, and differentiation between both will positively impact on the patient management, one of the important, available, cheap, and noninvasive imaging tool in ICU to help in diagnosis is Lung U/S, We did Lung U/S for a 50-year-old patient with COVID-19 pneumonia and severe ARDS, on mechanical ventilation.

We found confluent B-Lines on both Lung fields with spare areas of A-Lines in between, we found 2 types of subpleural consolidation lesions, both were at basal lung zones, the first lesions were multiple with variable size, the largest 2 cm length, they are wedge shaped pleural based lesion, with applying Doppler study, there was no flow by both color and spectral wave Doppler which was going with pulmonary embolism and infarction, the second lesion is a single, larger, round subpleural and pleural based, with applying Doppler study, there was a pulmonary arterial flow pattern with color and spectral Doppler, the arterial flow was of low resistance circulation with peak systolic arterial velocity 30 cm/sec and end diastolic velocity 10 cm/sec, which is going with consolidation of pneumonia.

Our Lung U/S findings [confluent B-Lines with spared areas of A-Lines, sub pleural consolidation] was similar to previous studies, Peng., *et al.* reported that focal B lines are the major ultrasonographic feature of early-stage COVID-19 pneumonia [12].

Huang., *et al.* reported the ultrasonographic manifestations of patients with COVID-19 and found that the most common findings are B lines, patchy consolidations, and unsmooth pleural lines [13].

Reports of acute pulmonary embolism associated with COVID-19 have emerged in the literature. For example, Chen., *et al*. described 25 pulmonary CT angiograms examinations from COVID-19 patients; 10 were positive for pulmonary embolism mostly as segmental or sub-segmental APE [1]. In addition, D-dimer levels have been reported as elevated in patients with COVID-19 [2,3], with the suggestion of an independent association between the severity of the disease and the level of D-dimer [4].

In our case report, we found 2 types of sub pleural consolidation, the first lesions were multiple with variable size, the largest 2 cm length, they are wedge shaped pleural based lesion, with applying Doppler study, there was no flow by both color and spectral wave Doppler which was going with pulmonary embolism and infarction, this lesion was going with pulmonary embolism and infarction, these findings were confirmed in other previous studies.

several studies confirmed the utilities of lung U/S in diagnosing pulmonary embolism, they described a specific pleuropulmonary lesion by Lung U/S, pleural based wedge or round shaped (mean, 2.3 lesions per patient) averaging 15.5 x 12.4 mm in size, with localized pleural effusion, and color Doppler may reveal absence of flow denoting consolidation without perfusion which will confirm pulmonary infarction with absent flow [8-11].

In comparing Lung U/S lesions with CT- pulmonary angio in 30 patients with confirmed pulmonary embolism, Sevda., *et al.* found that Lung U/S was true positive in 27 patients and false positive in eight and true negative in 12 and false negative in three. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of TUS in diagnosis of PE for clinically suspected patients were 90%, 60%, 77.1%, 80%, and 78%, respectively [11].

Mathis., *et al.* in a prospective multicenter study of 352 patients with suspected pulmonary embolism, he found that PE was diagnosed in 194 patients. On Lung U/S, 144 patients had a total of 333 sub pleural lesions (mean, 2.3 lesions per patient) averaging 15.5 x 12.4 mm in size. Additionally, a narrow pleural effusion was found in 49% of the patients. Lung U/S yielded the following results under application of the strict criteria 1 and 2: PE true-positive, n = 144; PE false-positive, n = 8; PE true-negative, n = 150; and PE false-negative, n = 50. The sensitivity was 74%, specificity was 95%, positive predictive value was 95%, negative predictive was value 75%, and accuracy was 84%, at a prevalence of 55%. The sensitivity in patients with criterion 1 was 43% and a specificity of 99% [9].

To our Knowledge, it is the first time to find the 2 types of sub pleural consolidation lesions, one is going with pulmonary embolism and the other with inflammatory consolidation in COVID-19 Patient.

In our case report, we used not only the color Doppler but also we apply the sample volume of spectral wave Doppler inside the lesion, it revealed very clearly the pulmonary arterial flow with low resistance circulation type in inflammatory consolidation and absent flow in pulmonary embolism lesion.

To our knowledge it is the first time to use spectral Doppler in differentiation between sub pleural consolidation of PE and pneumonia, in our case report spectral Doppler revealed very clear waves compared to blurred color Doppler flow.

Conclusion

Doppler study [color and spectral] may have an important role in differentiation between the subpleural consolidation of ARDS and pulmonary embolism.

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