Use of point-of-care lung ultrasonography in the critical care setting as an aid to identifying the correct diagnosis in an acutely desaturating patient with COVID-19-related acute respiratory distress syndrome

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SUMMARY
A 64-year-old man was intubated and ventilated for COVID-19-associated acute respiratory distress syndrome. He had a background history of chronic obstructive pulmonary disease and ischaemic heart disease. His oxygen saturations dropped rapidly to 80% on day 9 of ICU admission. Chest auscultation revealed absent breath sounds over the left upper chest which raised suspicions for pneumothorax, of which a small stable left apical pneumothorax was documented on a recent CT scan of the thorax. Point-of-care ultrasonography was performed prior to attempting chest drain insertion which demonstrated sliding pleura on the left side (GE Healthcare model: Vscan Extend—display: 5 inches, 720×1280 pixels resolution, sector probe—broad bandwidth: 1.7–3.8 MHz, 24 cm penetration and linear probe—broad bandwidth: 3.3–8 MHz, 8 cm penetration). A portable chest X-ray was obtained which demonstrated left upper lobe collapse secondary to mucus plugging. The mucus plug was successfully suctioned from the patient’s airway using bedside bronchoscopy subsequently improving the patient’s oxygen saturation. A follow-up chest X-ray and CT scan of the thorax demonstrated interval resolution of the left upper lobe collapse. While expansion of his existing pneumothorax was first on the list of differential diagnoses, the use of ultrasonography early in the patient’s assessment ensured it was ruled out prior to attempting chest drain insertion, thus prompting the acquisition of the chest X-ray which subsequently demonstrated the left upper lobe collapse as the correct diagnosis.

BACKGROUND
Acute desaturation is a common occurrence in ventilated ICU patients of which there are many possible causes. Multiple studies suggest that point-of-care ultrasonography has a role in helping to differentiate between several potential diagnoses with great sensitivity/specificity. Here, we present the case of an acute desaturation in a critically ill patient in whom the use of bedside ultrasonography aided in the timely diagnosis and treatment of the cause.

CASE PRESENTATION
A 64-year-old man with a background history of chronic obstructive pulmonary disease and ischaemic heart disease was admitted to the ICU with COVID-19-associated acute respiratory distress syndrome (ARDS). On day 9 of his admission, he developed an acute oxygen desaturation requiring his FiO2 to be increased to 100% to achieve saturations of 90%–92%. On examination, the patient was sedated and ventilated. He was coughing and in respiratory distress. There was patient-ventilator dyssynchrony despite ongoing fentanyl and propofol infusions, so we administered some short acting muscle relaxant. Coarse crackles were audible from the patient’s bedside. Auscultation of the chest demonstrated absent breath sounds over the left upper zone. His pulse was 95 beats per minute, his blood pressure was 150/75 mm Hg.
and he was afebrile at 36.7°C. His ventilation was being maintained on volume control-synchronised intermittent mechanical ventilation. Peak inspiratory pressures ranged from 25 cmH₂O to 30 cmH₂O at the time of the desaturation. Peak inspiratory pressures had been averaging 20 cmH₂O earlier in the day. Lung compliance was 25–30 ml/cmH₂O. Earlier that day, lung compliance had averaged around 40 ml/cmH₂O which we felt was reflective of the patient’s COVID-19-related ARDS. The positive end expiratory pressure was 8 mmH₂O. The set tidal volume was 450 mL but only tidal volumes of about 200 ml were being achieved at the time of desaturation. When the set volume was briefly increased to 500 ml, there was no increase in the patient’s achieved tidal volume.

INVESTIGATIONS
Three days prior to the acute desaturation event, the patient had a CT scan of the thorax reported as demonstrating bilateral multifocal peripheral ground glass opacities, consolidation and air bronchograms with vascular enlargement. It was also reported as showing a small left apical pneumothorax.

Point-of-care lung ultrasonography performed following the onset of the acute desaturation demonstrated a sliding ‘moth-eaten’ pleural line on both sides of the chest, in addition to confluent B lines and patchy areas of consolidation. A portable chest X-ray was subsequently obtained demonstrating left upper lobe collapse secondary to a mucus plug.

DIFFERENTIAL DIAGNOSIS
A prior CT scan of the thorax obtained 3 days earlier in the patient’s intensive care admission demonstrated a small left apical pneumothorax. In the setting of continued positive pressure ventilation, expansion of this pneumothorax was high on the list of differentials as a cause for the patient’s desaturation. While chest drain equipment was being prepared, efforts were made to suction the patient’s airway for secretions with no improvement in oxygenation. The patient also received boluses of midazolam, morphine and atracurium in an effort to deepen his sedation and improve ventilator synchrony but this did not improve the oxygenation either. At this juncture, point-of-care lung ultrasound was used to further investigate the patient’s chest. It demonstrated a sliding ‘moth-eaten’ pleural line in all regions of the left chest in addition to confluent B lines and patchy areas of consolidation in keeping with the documented ultrasound findings of COVID-19 ARDS in the current literature (videos 1–4). There were no signs of compromised ventricular pump function, ventricular dilatation or plethoric vena cava that would be suggestive of acute congestive cardiac failure (videos 5 and 6). The sliding lung sign demonstrated on bedside ultrasound ruled out pneumothorax as the cause of the patient’s acute desaturation. A portable chest X-ray was obtained immediately following point-of-care ultrasound. It demonstrated a left upper lobe collapse which was felt to be due to a mucus plug.

TREATMENT
Bedside bronchoscopy was performed with a 30ml NaCl 0.9% washout and a moderately sized mucus plug was suctioned from one of the patient’s left upper segmental bronchi online supplemental figure 1. Full personal protective equipment (including FFP3 mask, eye protection, visor, gown, gloves and hat) was used throughout this patient’s care, as were the appropriate donning and doffing procedures.

OUTCOME AND FOLLOW-UP
The patient’s oxygen saturation subsequently returned to a baseline of between 95% and 98% allowing for the FiO₂ to be slowly weaned. The peak inspiratory pressures also reduced to between 19 cmH₂O and 21 cmH₂O.

Follow-up chest radiograph that evening and CT scan of the thorax the following day demonstrated interval resolution of the left apical pneumothorax and left upper lobe collapse.

DISCUSSION
There is evidence to suggest that point-of-care lung ultrasound is effective, if not more so, than traditional radiology and even clinical examination, in the diagnosis of several different causes of respiratory pathology. Two studies suggest that point-of-care lung ultrasound is almost 100% sensitive for the detection of pneumothorax. As pneumothorax was of particular concern in this patient’s case, the use of point-of-care lung ultrasound

Video 2 Sliding ‘moth-eaten’ (irregular) pleural line, confluent B lines and patchy consolidation.
prior to considering the insertion of a chest drain was the correct course of action. As such, the promptness with which images can be obtained and replicated makes it a useful tool in aiding clinical decision making at the bedside. The portability of the particular ultrasound device used in this case, in addition to the case with which it can be decontaminated, makes it a particularly useful diagnostic tool in the current COVID-19 pandemic. All of these positive statements regarding bedside ultrasonography are made on the assumption that the operator has an appropriate level of training and experience to both carry out and replicate an ultrasound-based assessment as well as sufficiently interpret and report on the results. In this patient’s case, all bedside ultrasound assessments were carried out by an ICU consultant who is recognised as a level 1 point-of-care ultrasound practitioner (FUSIC mentor) and has experience in point-of-care ultrasonography.

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Contributors CL: writing/drafting of this case report. CMN: provision of ultrasound imaging/expertise in the writing/drafting of this case report, direct involvement in the patient’s care, supervision and guidance in the writing/drafting of this case report and provision of appropriate references for the writing/drafting of this case report.

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Learning points

► There are many causes for an acute desaturation in ventilated ICU patients.
► Point-of-care lung ultrasonography has the potential to differentiate between several possible diagnoses with great sensitivity and specificity.
► With no risk of exposing patients to potentially harmful radiation, point-of-care lung ultrasound can be performed serially at minimal risk of harm to patients.
► In the hands of an appropriately trained and experienced operator, point-of-care lung ultrasonography has the potential to provide an accurate diagnosis more rapidly than traditional radiography enabling physicians to make therapeutic decisions at the bedside.

Video 5  Incomplete subcostal cardiac view demonstrating cardiac contraction.

Video 6  Inferior vena cava as it enters right atrium.

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