December 2015 Critical Care Case of the Month

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History of Present Illness

The patient is a 32-year-old woman who presented with flank pain for 3 days to an outside hospital. She was diagnosed with pyelonephritis and begun on ceftriaxone. She was discharged against medical advice on cephalexin.

She returned to the same hospital 3 days later by ambulance with labored breathing and weakness and was emergently intubated. She was transferred for ventilator management and respiratory failure.

Past Medical History

She has a long history of poorly controlled diabetes mellitus.

Physical Examination

She is orally intubated and sedated.

Vitals: Temperature - 100.9° F, Blood Pressure - 117/75 mm Hg, Heart Rate - 148 beats per minute, Respiratory Rate - 31 breaths/min, SpO₂ - 88 % on assist control of 30, tidal volume of 350 mL, PEEP 15, and an FiO₂ 100%.

There is scattered rhonchi and rales but the remainder of the physical examination is unremarkable.

Radiography

Her admission portable chest X-ray is shown in Figure 1.

Figure 1. Admission portable AP of the chest.

Which of the following should be ordered as part of her **initial work-up**?

1. Administer broad spectrum antibiotics
2. Blood and urine cultures
3. Rapid influenza test
4. 1 and 3
5. All of the above

Correct!
5. All of the above

The patient's SpO₂ is low on 100% oxygen and considerable positive end expiratory pressure (PEEP). Arterial blood gases are indicated to assess her oxygen status as well as her acid-base status. Based on her history she likely has urosepsis and blood and urine cultures are indicated. As we enter influenza season it is important that influenza be considered on cases of diffuse pneumonia and respiratory failure.

The patient's arterial blood gases were pH 7.34, pO₂ 85, pCO₂ 35, HCO₃⁻ 18. Blood cultures showed no growth but a urine culture showed *E. coli* which was pan-sensitive to the test antibiotics. Rapid influenza test was positive for influenza B.

Which of the following are **indicated next?**

1. Begin oseltamivir (Tamiflu)
2. Biopsy of the lung with transbronchial biopsy or video-assisted thorascopic biopsy
3. Lower FiO₂
4. 1 and 3
5. All of the above

Correct!
4. 1 and 3

Lung biopsy is not indicated at this time and has risk in this patient who is profoundly hypoxic on 100% FiO₂. It is unclear whether she has the adult respiratory distress syndrome (ARDS) from sepsis or diffuse viral pneumonia from influenza. Oseltamivir is indicated but otherwise the therapy is supportive. Something does need to be done about her high FiO₂. 100% oxygen will eventually prove toxic to the lungs. The level that is safe is unclear but generally considered to be both concentration and time-dependent. Most consider an FiO₂ of 60% to be a reasonable goal.

At times the pO₂ seems little affected by the FiO₂, i.e., lowering the FiO₂ results in a pO₂ little different from the pO₂ on an FiO₂ of 100%. The reason for this is that in ARDS there are two sets of alveoli, those that are ventilated and perfused and those that are not ventilated but perfused with the later causing the hypoxia. Lowering the FiO₂ does not profoundly affect the alveoli that are both ventilated and perfused. Unfortunately, lowering the FiO₂ in this patient resulted in rapid desaturation.

Which of the following might be considered to **lower of the FiO₂**?

1. Extracorporeal membrane oxygenation (ECMO)
2. Increase PEEP
3. Proning
4. 1 and 3
5. All of the above

Correct!
5. All of the above

All of these are reasonable to lower the FiO₂ with proning and increasing PEEP being the simplest maneuvers. Increasing PEEP can result in barotrauma and usually levels above 15 cm H₂O result in no further FiO₂ improvement. Prone positioning may help if the lung is not evenly affected which can result in better ventilation-perfusion matching. Unfortunately, both failed to increase the FiO₂. There are a variety of other maneuvers such as increasing the expiratory time (which essentially results in increasing the PEEP) which was also unsuccessful.

Although initial trials were unimpressive, more recent trials suggest a possible mortality benefit with ECMO (1,2). ECMO is done in specialized centers that have experience with this therapy. Given that this patient was young and functional a trial of ECMO seemed reasonable.

The patient was begun on venous to venous ECMO where venous blood is taken from a vein, oxygenated and returned to the venous system. This resulted in an improvement in the pO₂ but also resulted in a depressed cardiac output and hypotension. The patient suffered a cardiac arrest but recovered spontaneous circulation. The ECMO was switched to venous-arterial (VA) ECMO where blood was removed from the femoral vein, oxygenated and returned to the arterial circulation through a catheter placed in the descending aorta through the femoral artery.

The patient developed an unusual appearance where the lower extremities were pink but the upper extremities and head were cyanotic.

What should be **done next**?

1. Administer esmolol
2. Consider moving the arterial catheter to another artery
3. Increase the flow rate from the ECMO
4. 1 and 3
5. All of the above

Correct!
5. All of the above

The patient has developed ECMO "harlequin" syndrome. This results from inadequate mixing of blood in the aorta where the relatively deoxygenated blood from the left heart is not adequately mixed with the oxygenated blood from ECMO (Figure 2).

Figure 2. Schematic showing inadequate mixing of deoxygenated and oxygenated blood resulting in cyanosis in the upper extremities and head.

The deoxygenated blood is directed more towards the upper body while the oxygenated blood is directed more towards the lower extremities. Increasing the mixing or another mode of ECMO are strategies to deliver more oxygenated blood to the head and upper extremities. The flow rate of the ECMO was increased along with administration of esmolol to decrease the flow rate out of the left ventricle to allow more adequate mixing. If these had failed, moving the arterial line from the ECMO could be considered. Switching to another mode of ECMO such as venous-arterial-venous (VAV) where oxygenated blood is returned to both the arterial and venous circulation is another consideration.

The patient eventually improved after two days on ECMO and eventually was extubated and transferred to the floor.

References

1. Zapol WM, Snider MT, Hill JD, et al. Extracorporeal membrane oxygenation in severe acute respiratory failure. A randomized prospective study. JAMA. 1979;242(20):2193-6. [\[CrossRef\]](#) [\[PubMed\]](#)
2. Peek GJ, Mugford M, Tiruvoipati R, et al. Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial. Lancet. 2009;374(9698):1351-63. [\[CrossRef\]](#) [\[PubMed\]](#)
3. Moisan M, Lafargue M, Calderon J, Osés P, Ouattara A. Pulmonary alveolar proteinosis requiring "hybrid" extracorporeal life support, and complicated by acute necrotizing pneumonia. Ann Fr Anesth Reanim. 2013;32(4):e71-5. [\[CrossRef\]](#) [\[PubMed\]](#)