

Mechanical Ventilation Case Questions

Case 1

A 55 year-old man with a history of COPD presents to the emergency room with a two day history of worsening shortness of breath which came on following a recent viral infection. In the emergency room, his oxygen saturation is 88% on room air. He is working hard to breathe and is only speaking in short sentences. On exam, he has diffuse wheezes and a prolonged expiratory phase. His chest x-ray reveals changes consistent with COPD but no new focal infiltrates. An arterial blood gas (ABG) is done and shows pH 7.17, PCO_2 55, PO_2 62, HCO_3^- 25.

What are the indications for starting a patient on mechanical ventilation?

What do you think about the possibility of using non-invasive positive pressure ventilation (bi-level positive airway pressure) in this patient?

What is the difference between bi-level positive airway pressure (BiPAP) and continuous positive airway pressure (CPAP)? What are the indications for using these different modes of non-invasive mechanical ventilation?

Case 2

A 45 year-old, 6-foot tall man presented to the emergency room with a two day history of fever and cough productive of brown sputum. He was hemodynamically stable at the time with a blood pressure of 130/87. His chest x-ray showed a right middle lobe infiltrate and his room air ABG showed: pH 7.32, PCO_2 32, PO_2 78, HCO_3^- 18. He was started on antibiotics and admitted to the floor. Four hours later, the nurse calls because she is concerned that he is doing worse. On your arrival in the room, his blood pressure is 85/60, his pulse is 120 and his oxygen saturation, which had been 97% on 2L oxygen by nasal cannula is now 78% on a non-rebreather mask. The patient is obviously laboring to breathe with use of accessory muscles and is less responsive than he was on admission. He is diaphoretic and cannot talk in full sentences. On lung exam, he has crackles throughout the bilateral lung fields. You obtain a chest x-ray which shows increasing bilateral, diffuse lung opacities. An ABG is done while he is on the non-rebreather mask and shows: pH 7.17, PCO_2 45, PO_2 58, HCO_3^- 14.

What should you do now? Is there a role for CPAP or bi-level positive airway pressure in managing his hypoxemia?

A decision is made to intubate the patient and initiate mechanical ventilation for worsening respiratory failure. The intubation proceeds without difficulty. The tube position is confirmed and the anesthesiologist leaves the room. The respiratory therapist has secured the breathing tube. She turns to you and asks what settings you would like to use for the ventilator?

What information do you need to provide to the respiratory therapist?

The respiratory therapist suggests you use the volume targeted assist Control (AC) mode of mechanical ventilation. How does this work? How does it differ from Synchronized Intermittent Mandatory Ventilation (SIMV) or Pressure Control (PC)? Which mode is better for your patient?

Suppose you put the patient on a volume-targeted Assist Control mode of mechanical ventilation. How do you choose the tidal volume?

What respiratory rate should you choose for the patient?

What should the $F_{I}O_2$ and PEEP be set at?

Case 3

A patient is admitted to the ICU with severe necrotizing pancreatitis. A few hours after admission, he developed increasing oxygen requirements and was intubated for hypoxemic respiratory failure. Initially, his oxygen saturations improved to the mid-90% range on an $F_{I}O_2$ of 0.5, but in the past 2 hours, the nurse has had to increase the $F_{I}O_2$ back to 0.7 and his SaO_2 is still in the lower 90% range. The patient remains on a PEEP of 5 cm H_2O . The nurse drew an ABG which shows pH 7.35, pCO_2 38, PO_2 60, HCO_3^- 22 on an $F_{I}O_2$ of 0.8. The patient's repeat chest x-ray is shown below. An echocardiogram performed earlier in the day revealed normal left ventricular function.



How do you explain his worsening oxygenation status?

What can you do to improve his oxygenation?

What other changes should you consider making in the ventilator settings?

If his oxygen saturation fails to improve despite being on high levels of support (eg. $F_{I}O_2$ of 1.0 and 20 cm H_2O of PEEP), what other options do you have for improving his oxygenation?

Case 4

A 63 year-old woman was intubated four days ago for respiratory failure secondary to sepsis from a presumed pneumonia. She is on appropriate antibiotics, is now off pressors, and her WBC count has declined to the normal range. During your pre-rounding, you note that her $F_{I}O_2$ is down to 0.4 and she is on a PEEP of 5 cm H_2O . On these settings, the ABG shows pH 7.36, pCO_2 46, PO_2 75, HCO_3^- 26. She has a weak cough and continues with copious secretions, requiring suctioning every 30 to 60 minutes.

At what point do you start considering whether your patient is ready to come off the ventilator?

How do you determine if the patient is capable of being separated from the ventilator?

Suppose your patient demonstrates that she can be separated from the ventilator. Should she be extubated?

Case 5

A 65 year-old man was admitted to the ICU with pneumonia and was intubated when he developed progressive hypoxemia. He has been on the ventilator for 5 days and has generally been tolerating this therapy well. The nurse calls you because he has all of a sudden become severely agitated and appears to be fighting the ventilator. She asks if she can increase the infusion rates on his midazolam and fentanyl drips for sedation.

What should you do next?

Case 6

A 65 year-old woman is intubated emergently for a severe COPD exacerbation. She underwent a rapid sequence intubation using succinylcholine for paralysis and etomidate for sedation. Shortly after intubation, she becomes hypotensive with her blood pressure dropping from 145/85 prior to intubation to 95/60 post-intubation. On exam, she has a very prolonged expiratory phase and diffuse wheezing.

What is the differential diagnosis for this patient's hypotension?

What can you do to sort through this differential and identify the etiology of the problem?

How should you manage the most likely source of the problem?

Case 7

You are called to the bedside of a patient because the nurse is concerned that the ventilator's pressure alarm is now going off. He was admitted for a COPD exacerbation and was intubated earlier in the day when he failed a trial of non-invasive ventilation. Earlier in the evening, the peak pressure was 45 cm H₂O while the static pressure was 25 cm H₂O. At the time she calls you, the peak pressure has risen to 60 cm H₂O and the static pressure is now 40 mm Hg. His heart rate has increased from 90 beats/minute to 110 beats/minute while his blood pressure has fallen from 110/85 to 90/70. The physical exam is noteworthy for diminished breath sounds on the left side of the chest.

What do static pressures represent on the ventilator?

What do peak pressures represent on the ventilator?

Where do you think the problem lies with this particular patient?

What management steps should you institute at this point?

Case 8

At 11:00PM, you are called to the bedside of a 55 year-old man who was intubated one day prior for airway protection during a large upper gastrointestinal hemorrhage due to esophageal varices. He has self-extubated and is lying with the endotracheal tube in his hand. At the time this happened, he had been on an FIO₂ of 0.4 and a PEEP of 5 cm H₂O. His P_aO₂ earlier in the day was 100 mm

Hg. The team had been planning to do a spontaneous breathing trial in the morning. At present, his oxygen saturation is 94% on 6L oxygen by nasal cannula. The nurse wants to know if you want to re-intubate him.

What should you do?

You decide not to reintubate the patient because his clinical status appears stable. Four hours later, you are called back to the bedside because the patient is laboring to breathe and his oxygen saturation has fallen into the upper 80% range on a venturi mask set with an $F_{I}O_2$ of 0.5. You obtain an ABG and it shows pH 7.30, PCO_2 47, PO_2 60 and bicarbonate 25.

Should you reintubate the patient or can you give him a trial of non-invasive ventilation?

Case 9

A 30 year-old woman has been intubated for 2 days following a motor vehicle accident. On morning rounds, she passed her spontaneous breathing trial and a decision was made to extubate her. The respiratory therapist removes the endotracheal tube and shortly afterwards, she is noted to have stridor. You are called to the room and find her struggling to breathe. She has audible stridor and suprasternal retractions on exam. Her oxygen saturation on 4L oxygen by nasal cannula is 94%.

What is the differential diagnosis for her problem?

How should you manage the patient? Does she need to be reintubated?

In cases where you suspect prior to extubation that a patient may have laryngeal edema and post-extubation stridor, what can you do to minimize the risk of this problem?

Case 10

A 57 year-old woman was intubated two weeks ago for respiratory failure resulting from ARDS due to urosepsis. About 5 days ago, her oxygen requirements declined such that she is now on an $F_{I}O_2$ of 0.4 with a PEEP of 5 cm H_2O . She has been doing poorly, however, on her spontaneous breathing trials and has not been able to be separated from the ventilator. On her latest spontaneous breathing trial this morning, her tidal volumes were between 125 and 150 ml and her respiratory rates rose to 35 after only 10 minutes of spontaneous breathing.

What items should you consider on the differential diagnosis for a patient who cannot be liberated from the mechanical ventilator?

What diagnostic steps can you consider to help you sort through this differential?

What can you do to help her get off the ventilator?

At what point do you consider placing a tracheostomy tube in this patient?