Answers

Mechanical Ventilation

Part 1

1) B: Pressure controlled mode

Despite what the name pressure regulated volume controlled or other names in different ventilators (VC+, auto flow, APV, etc) implies that the mode is a volume controlled. This mode is an adaptive pressure controlled mode that has the ability to increase or decrease the driving pressure step wise to target a set tidal volume. This mode is also erroneously sometime called dual control. Dual control is where the ventilator can combine a pressure and volume controlled mode within the same breath or in between breaths.

2) D: Volume controlled mode, intermittent mandatory ventilation

Indeed, ASV is not a single mode per se, it is an algorithm that can combine continuous mandatory pressure controlled mode if the patient is passive with no effort, intermittent mandatory pressure controlled breath if patient has some effort but less than the targeted respiratory rate, and can be totally spontaneous pressure support mode in patients whose respiratory rae is higher than the targeted rate.

3) C: Patient must be chemically paralyzed

Prone position has been shown to improve mortality for moderate to severe ARDS especially if applied early within 48-72 hours and for prolonged time 18-20 hours per day. There are many ways how prone ventilation can improve oxygenation. Among those are the improved ventilation-perfusion matching, more homogenous lung ventilation through changes of pleural pressures, more ventilation to dorsal dependent lung regions through relief of the lung from the weight of the heart and abdominal organs, increased secretion drainage, along with improved right heart hemodynamics. Patients do not have to be chemically paralyzed to be in the prone position. One of the fears of prone position is complications like endotracheal tube dislodgement, skin tears, etc. however most studies have not shown much differences in those complications compared to the supine position.

4) D: Volume controlled ventilation

If you notice the flow curve (pink) you will notice that it is in the square (continuous) flow which are used exclusively in the volume controlled mode. The pressure-time curve (yellow) looks square instead of the expected triangular shape, but this is because the peak inspiratory pressure is very high and reached the maximum dialed pressure limit. Also, to be noted there is an inspiratory pause and that is why the airway pressure drops to a plateau level.

5) A: High resistance

Calculated resistance = Peak inspiratory pressure – Plateau pressure (cmH2O) / Flow (liter per second

(PIP – Pplat /Flow). Flow 60 lit/min = 1 lit/sec

55-15 / 1

40 cmH2O/L/Sec

Compliance: Tidal volume / Pplat – total PEEP

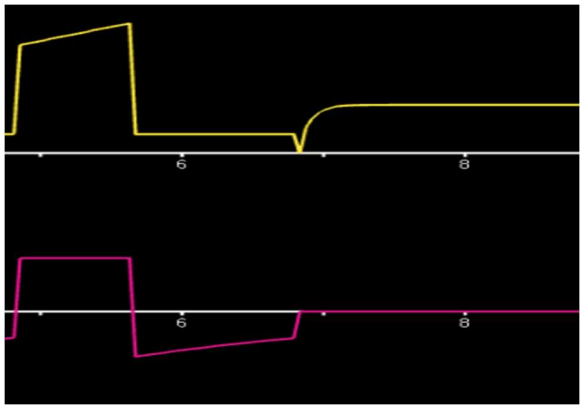
600 / (15-5)

60 ml/cmH2O

6) C: Auto-PEEP

If you notice the flow-time curve (pink), the expiratory flow does not return to zero before the next breath start, this indicate the presence of air trapping or auto-PEEP. To calculate the amount of auto-PEEP, an expiratory pause maneuver needs to be applied for the expiratory pressure to equilibrate.

In the figure below, the PEEP is set at 5 cmH2O, after the expiratory maneuver, the pressure arises to 10 cmH20. Total PEEP is 10, and auto-PEEP = 5 cmH2O



7) C: Decrease flow rate

Reducing the minute ventilation by reducing the tidal volume, respiratory rate will help improve auto-PEEP. Reducing airway resistance with bronchodilator effects would help too. Reducing the inspiratory time and prolonging expiratory time would help, but this would be accomplished by increasing the inspiratory flow not reducing it. Additionally matching the auto-PEEP by applying PEEP at 75-80% of auto-PEEP might help too.

8) B: Get re-intubated if extubated

This patient will likely fail extubation. His heart rate increased by almost 20% indicating increase muscle need of oxygen and load on the heart, additionally his airway occlusion pressure at 100 msec (P0.1) is -8 which indicates increase muscle work (usually -1 to -5 has shown correlation with extubation success). If you notice the flow-time curve in pink showing high convexity instead of the descending flow curve used in pressure support again indicating high muscle work to breathe.

9) E: Improved mortality

The decelerating inspiratory flow curve has many advantages over the continuous square flow used commonly in volume controlled ventilation. The changing flow in pressure control is more comfortable as patient is not locked in one certain level, and changes per respiratory mechanics thus reducing asynchronies. Higher mean airway pressure with less peak inspiratory pressure also is an advantage of decelerating flow wave forms. However all those advantages did not translate to improved mortality with the pressure controlled mode compared to the volume controlled mode.

10) C: T low should be adjusted to avoid auto-PEEP

APRV is considered a pressure controlled intermittent mandatory ventilation and patients can breath at any point of the respiratory cycle. T Low is intentionally set very short to intentionally create auto-PEEP to prevent lung collapse at the end of the release period. This mode has many advantages over conventional ventilation including, improved oxygenation, comfort, improved hemodynamics, along with newer studies showing improved mortality.