Mechanical Ventilation

Educational Reinforcement Material
# Critical Care Fundamentals: Mechanical Ventilation

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Pre-Test Questions

1. Which of the following is not the main goal of mechanical ventilation in the ICU?
   a. Optimize patient comfort
   b. Optimize exchange of carbon dioxide and oxygen
   c. Get them through surgery with less discomfort
   d. Decrease work of breathing

2. What are ways to maximize patient comfort on the ventilator?
   a. Optimize ventilation settings
   b. Sedation
   c. Paralytics
   d. All of the above

3. What is the optimal type of breath?
   a. Spontaneous
   b. Controlled
   c. Assisted
   d. None of the above

4. Will all patients have perfect carbon dioxide and oxygen levels?
   a. Yes
   b. No

5. What should the carbon dioxide goal be with traumatic brain injury?
   a. High to allow increased cerebral blood flow
   b. High to prevent increased cerebral blood flow
   c. Normal to prevent increased cerebral blood flow
   d. Normal to allow increased cerebral blood flow

6. Which of the following is not a toxicity with mechanical intubation?
   a. Hypercarbia
   b. Barotrauma
   c. Volutrauma
   d. Atelactotrauma
   e. Oxygen toxicity

7. What percent of oxygen can lead to oxygen toxicity (even if only a short period of time)?
   a. >50%
   b. >60%
   c. >70%
   d. >80%

8. What is the volume of gas in the lungs at the end of expiration, but prior to inhalation?
   a. Inspiratory Capacity
   b. Expiratory Capacity
   c. Vital Capacity
   d. Tidal Volume
   e. Functional Residual Capacity

9. Is inhalation an active or passive process?
   a. Active
   b. Passive

10. What happens to the intrathoracic pressure/volume when you inhale?
    a. ↑ intra-thoracic pressure: ↑intra-thoracic volume
    b. ↑ intra-thoracic pressure: ↓intra-thoracic volume
    c. ↓ intra-thoracic pressure: ↑intra-thoracic volume
    d. ↓ intra-thoracic pressure: ↓intra-thoracic volume

11. Is exhalation an active or passive process?
    a. Active
    b. Passive

12. What happens to the intrathoracic pressure/volume when you exhale?
    a. ↑ intra-thoracic pressure: ↑intra-thoracic volume
b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume
c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume
d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume

13. When does exhalation become an active process?
   a. With restrictive lung disease
   b. After you run a mile
   c. With obstructive lung disease

14. Mechanical ventilation works by ______?
   a. Positive pressure - pushing air into the lungs
   b. Negative pressure - pulling out the chest wall

15. Which of the following is not a way to improve oxygenation?
   a. FiO₂
   b. PEEP
   c. Inspiratory time
   d. Respiratory rate

16. What is mean airway pressure?
   a. Average pressure that alveoli are exposed to during inspiration
   b. Average pressure that the lungs are exposed to during expiration
   c. Average pressure the lung is exposed to during mechanical ventilation

17. What is the normal I:E ratio?
   a. Inspiration is longer than expiration
   b. Expiration is longer than inspiration
   c. Inspiration and expiration are equal

18. How does increasing the inspiratory time lead to improved oxygenation?
   a. It increases mean airway pressure
   b. It decreases expiration time
   c. It improves PEEP
   d. It increases the tidal volume

19. What is removal of carbon dioxide from the body called?
   a. Hypercarbia
   b. Hypocarbia
   c. Ventilation
   d. Tidal Volume

20. What is the equation for minute ventilation?
   a. Respiratory Rate X PEEP
   b. Respiratory Rate X Tidal Volume
   c. Tidal Volume X Expiratory Time
   d. Expiratory Time X Respiratory Rate

21. What is dead space ventilation?
   a. Carbon dioxide in the unventilated alveoli
   b. Carbon dioxide delivered to the patient if the patient isn’t on 100% oxygen
   c. Carbon dioxide that is unable to diffuse out of the capillaries
   d. Carbon dioxide still in the airway at expiration

22. How does increasing the tidal volume allow more CO₂ removal?
   a. Allows more surface area for the transfer of CO₂
   b. Increases the mean airway pressure
   c. Allows the alveoli to remain open longer for gas exchange
   d. Improves compliance

23. Since tidal volume is limited, what else can we adjust to improve minute ventilation?
   a. Inspiratory time
   b. FiO₂
   c. Respiratory Rate
   d. Expiratory time

24. Why do patients with obstructive lung disease need a shorter respiratory rate?
   a. Gives the patients time to rest
b. Shorter respiratory rate allows a longer expiratory time as they have trouble with air removal
c. Shorter respiratory rate allows for less positive end expiratory pressure
d. Shorter respiratory rate allows for longer inspiratory time to improve oxygenation

25. What is the injury to the alveoli caused by excessive pressure from the ventilator called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

26. What is the injury from over distension of the alveoli from excessive tidal volume called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

27. What is the injury from repetitively opening and closing lung units (a type of sheering stress to the lung) called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

28. What is the lung injury resulting from inflammatory mediators called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

29. What is the lung injury due to oxygen production of free radicals called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

30. What happens with inadequate PEEP?
   a. Alveoli collapse and develop atelectasis
   b. Poor compliance
   c. Inadequate minute ventilation
   d. Higher oxygen requirements leading to oxygen toxicity

31. What happens with adequate PEEP?
   a. Better driving pressure
   b. Less pressure is needed to re-expand the alveoli at the end of expiration
   c. Improved minute ventilation
   d. Lower oxygen requirements thus decreasing risk of barotrauma

32. What is the difference between the plateau pressure (PPlat) and the positive end expiratory pressure (PEEP)?
   a. Driving pressure
   b. Static pressure
   c. Dynamic Pressure
   d. Compliance

33. What happens to blood return with spontaneous breathing?
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return
c. Positive intrathoracic pressure that causes increased resistance and impedes venous return

d. Negative intrathoracic pressure that causes less resistance and assists in venous return

34. What happens to blood return to the right atrium with positive pressure ventilation?
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return

35. How can you help improve venous return in a patient on positive pressure ventilation?
   a. If the patient has decreased intravascular volume, a fluid bolus will help
   b. Higher levels of positive end expiratory pressure (PEEP)
   c. Increase the volume/pressure breath (depends on the mode)
   d. Trial of bronchodilators to decrease afterload

36. What happens to the right ventricle with positive pressure ventilation?
   a. Decreased right ventricular afterload
   b. Increased right ventricular preload
   c. No significant changes to the right ventricle
   d. Increased right ventricular afterload

37. What happens if you intubate a patient with RV failure?
   a. Nothing with rapid sequence intubation technique
   b. Improved pre-load to the RV
   c. RV collapse and cardiac arrest
   d. Increased ejection fraction of the right ventricle

38. What happens to the left ventricle with positive pressure ventilation?
   a. Increased stroke volume and increased cardiac output
   b. Decreased stroke volume and decreased cardiac output
   c. Increased heart rate and increased cardiac output
   d. Decreased heart rate and decreased cardiac output

39. Is positive pressure good or bad with heart failure? Why?
   a. Bad; increases afterload and decreases cardiac output
   b. Good; decreases preload and increases cardiac output
   c. Bad; decreases preload and decreases cardiac output
   d. Good; decreases the LV afterload and allows more cardiac output
   e. Depends on the type an etiology of heart failure
40. Which of the following is not a type of breath that can be delivered by a ventilator?
   a. Controlled
   b. Assisted
   c. Manuel
   d. Spontaneous

41. What are the two types of breath delivery?
   a. FiO₂, PEEP
   b. Volume, pressure
   c. Flow, volume
   d. Respiratory rate and tidal volume

42. What type of breath requires no work by the patient, as the frequency/rate of the breath and the amount of gas delivered is fully dependent on the ventilator?
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

43. Describe the type of breath when the patient starts the process (aka triggers a breath), but the ventilator takes over.
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

44. With what type of breath does the patient do most/all of the work, and the ventilator gives only minimal assistance, if needed?
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

45. What is controlled mandatory ventilation (CMV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

46. What is pressure support?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

47. What is assist controlled ventilation (ACV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

48. What is synchronized intermittent mandatory ventilation (SIMV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

49. In which mode of ventilation is a pre-set amount of gas delivered to the patient?
   a. Volume breath
Critical Care Fundamentals: Mechanical Ventilation

b. Pressure Breath
   c. Both
   d. Neither

50. When giving a volume breath, at what pressure will the gas be delivered?
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

51. When giving a volume breath, what is the relationship between compliance and pressure?
   a. Higher the pressure, higher the compliance needed
   b. Lower the compliance, higher the pressure needed
   c. Lower the pressure, lower the compliance needed
   d. Higher the compliance, higher the pressure needed

52. In which mode of ventilation will a pre-set pressure deliver gas to the patient?
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

53. When giving a pressure breath, how much volume of gas will be delivered to a patient?
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

54. When giving a pressure breath, what is the relationship between compliance and volume?
   a. Lower compliance, the less volume delivered
   b. Lower compliance, the more volume delivered
   c. Higher volume, the higher the compliance needed
   d. Lower volume, the higher the compliance needed

55. Which is a dynamic pressure needed to fully inflate the lungs and overcome the resistive forces and elastic forces of the lungs?
   a. Peak Inspiratory Pressure (PIP)
   b. Positive end expiratory pressure (PEEP)
   c. Plateau pressure (PPlat)
   d. End Expiratory Pressure

56. What is the normal peak inspiratory pressure (PIP)?
   a. Variable depending on body habitus
   b. >20 cm of water pressure
   c. <10 cm of water pressure
   d. <20 cm of water pressure

57. What is a static pressure that the alveoli see?
   a. Positive end expiratory pressure (PEEP)
   b. Driving pressure
   c. Plateau pressure (PPlat)
   d. Peak Inspiratory Pressure (PIP)

58. What is meant by a static pressure vs dynamic pressure?
   a. Dynamic is seen during an inspiratory hold, whereas static is the same as the Peak inspiratory pressure (PIP)
   b. Static has no air movement, dynamic pressure has air movement
   c. Same thing: static pressure is used with volume mode and dynamic pressure with pressure mode
   d. Same thing: static pressure is used with pressure mode and dynamic pressure with volume mode

59. How do you check the plateau pressure (PPlat), on a volume mode?
   a. Inspiratory pause
   b. Expiratory pause
   c. Same as the peak inspiratory pressure (PIP)
d. Ask the respiratory therapist
60. How do you check the plateau pressure (PPlat), on a pressure mode?
   a. Inspiratory pause
   b. Expiratory pause
   c. Same as the peak inspiratory pressure (PIP)
   d. Ask the respiratory therapist
61. What does it mean when there is increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)?
   a. High resistance in the circuit or patient
   b. Poor pulmonary perfusion
   c. Need to change the ventilator mode
   d. Decreased compliance
62. Which is not a cause of increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)?
   a. Pulmonary edema
   b. Bronchospasms
   c. Pneumothorax
   d. Abdominal compartment syndrome
   e. ARDS
63. What does it mean when there is increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)?
   a. High resistance in the circuit or patient
   b. Decreased compliance
   c. Poor pulmonary perfusion
   d. Need to change the ventilator mode
64. Which is not a cause of increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)?
   a. Endotracheal tube occlusion
   b. Mucous plugging
   c. Pulmonary embolism
   d. Bronchospasms
65. Which mode of ventilation allows more control over the minute ventilation?
   a. Volume breath
   b. Pressure breath
66. What happens as compliance decreases in a volume breath?
   a. Less oxygen delivery and hypoxia
   b. Higher peak inspiratory pressures (PIP) leading to barotrauma
   c. Higher FiO₂ and oxygen toxicity
   d. Decrease in the minute ventilation leading to decreased PEEP and atelectasis
67. What is the normal flow pattern of a volume breath?
   a. Constant
   b. Accelerating
   c. Decelerating
   d. Variable
68. What the flow pattern of a pressure delivered breath?
   a. Constant
   b. Accelerating
   c. Decelerating
   d. Variable
69. How is the peak inspiratory pressure (PIP) and the mean airway pressure of a pressure breath in comparison to a volume breath?
   a. ↑ peak airway pressure + ↓ mean airway pressure
   b. ↑ peak airway pressure + ↑ mean airway pressure
   c. ↓ peak airway pressure + ↑ mean airway pressure
   d. ↓ peak airway pressure + ↓ mean airway pressure
70. What is the main disadvantage of a pressure delivered breath?
a. Not as well known to clinicians
b. No control over minute ventilation
c. Constantly pay attention to pressures to make sure adequate tidal volume
d. All of the above
Goals of Mechanical Ventilation

1. Maximize patient ____________ (MV settings, sedation)
2. ________________ work of breathing/ allow spontaneous breathing
   × One of the main reasons for mechanical ventilation is your patient was having excessive work of breathing and they were either in respiratory failure or on the verge of respiratory failure.
   × Optimal type of breath is spontaneous breath
3. Provide ________________ (not perfect) gas exchange (oxygenation and ventilation)
   × Clearly define oxygen saturation goals
   × Clearly define CO₂ goals
     • Example: A patient with a traumatic brain injury would need a normal CO₂ goal because a high CO₂ would increase cerebral blood flow and thereby increase intracranial pressure.
4. Minimize toxicity
   × Barotrauma- overdistension
   × Volutrauma- high volumes
   × Atelectotrauma- opening and closing alveoli
   × O₂ toxicity- >60% (even for short periods of time)
   × Adverse effects on the cardiovascular system
5. This is a supportive therapy to allow time for other interventions to treat the cause of respiratory failure

Basic Review: Respiratory Physiology

Inhalation

_________________________________ (FRC): Volume of gas in the lungs at end expiration, but prior to inhalation; a state of no gas exchange

Natural tendency is for the lungs to want to ________________ due to the natural elastic forces of the lung

Natural tendency of the chest wall to want to ________________
   × Active process by diaphragmatic contraction into the abdomen and the rib cage to move outwards
   × ________________ intra-thoracic volume
   × ________________ intra-thoracic pressure
   × ________________ Pressure gradient between atmosphere and intra-thoracic space

Exhalation

   × ________________ process = Diaphragm relax
   × Lung recoils
   × ________________ intra-thoracic pressure
   × Creates a pressure gradient (alveolar pressure exceeds atmospheric pressure) and gas flow proceeds out of the lungs

Active process: ________________ physiology (example: COPD and asthma) causes it to become active

Positive Pressure Ventilation 0655
Critical Care Fundamentals: Mechanical Ventilation

- Spontaneous breathing occurs via a _____________________ pressure circuit (pulled into the lungs)
- Mechanical ventilation is a complete reversal of normal physiological breathing and occurs via a _____________________ pressure system (pushed into the lungs)
- Air flow into lungs is now the result of a machine (ventilator) pushing or forcing air into the lungs

Oxygenation 0748

Diffusion: oxygen moves down the concentration gradient, down the alveoli and into the capillaries

1. ___________ – first way to improve oxygenation
2. ___________ - second way to improve oxygenation (optimal PEEP)
   a. _____________________: average pressure your lung is being exposed to during mechanical ventilation- both inspiration and expiration
   b. I:E ratio (inspiration to expiration) – lungs stay in expiration twice as long as inspiration
3. ___________ : can increase oxygenation, but is usually used for refractory hypoxemia
   a. Increases the mean airway pressure -> improved oxygenation
   b. Allows air re-distribution from highly compliant alveoli to less compliant alveoli
   c. Maintaining a larger surface area at end inspiration and allowing more time for air to diffuse across the alveoli and into the capillaries

Ventilation = removal of CO₂ from the body

Simple diffusion + Convection- CO₂ builds up in the capillaries

________________________ = Respiratory Rate x Tidal Volume

1. Respiratory Rate
2. Tidal Volume
   × ___________ ventilation-in theory people should breathe in gas that is void of CO₂; however, the CO₂ that remains in the airway mixes w/ the inhaled gas=> increased dead space ventilation with worsening respiratory distress/ decreased ventilation => decreased gradient for CO₂ to diffuse out of the capillaries
   × Inhalation of CO₂ “void” gas allows CO₂ to diffuse out of the capillaries and into the alveoli, which is removed with exhalation; if we breathe in a larger ___________, this will extend the alveoli, which increases the transfer of CO₂ or breath faster by increasing the ___________
   × Tidal volume- limit to how much can deliver, goal ________ ml/kg of predicted body weight
     • If give too much-> volutrauma
3. Expiratory Time
   × Obstructive Lung Disease (e.g. COPD and Asthma)- want to decrease the respiratory rate to allow more time in exhalation because if the expiratory time is too short then the CO₂ is trapped

Complications of Mechanical Ventilation 1352

Ventilator Associated Lung Injury (VILI)

1. _____________ : injury to alveoli, caused by excessive pressure from the ventilator
   × Plateau pressure, aka the pressure that the alveoli see-> this is seen by doing an inspiratory pause
limit the plateau pressure to < ________ mmHg
2. __________________: over distension of the alveoli from excessive tidal volume (Vt)
   × Limit the tidal volumes to ________ ml/ kg of predicted body weight
3. ___________________: damage which may occur when repetitively opening and closing lung units (a type of sheering stress to the lung)
   × Importance of Optimal PEEP
   × End Inspiration: well expanded and optimal to provide adequate gas exchange
   × Expiration with inadequate PEEP: the alveoli collapse and develop atelectasis; a lot more pressure will be needed to expand the alveoli from the collapsed state to the volume at end expiratory-> _________________
   × Expiration with adequate PEEP: less pressure is needed to re-expand the alveoli at end expiration-> have not allowed the alveoli to close and become atelectatic
   × _________________ - difference between the plateau pressure and the PEEP
4. ___________________: lung injury resulting from inflammation mediators (precipitated by VILI) this can be caused by barotrauma, volutrauma, or atelectotrauma
5. ___________________________: lung injury due to O₂ induced production of free radicals
   × Using a goal of <100% saturation allows weaning of FiO₂ and decrease risk of oxygen toxicity; goal of <__________% FiO₂

Hemodynamic Consequences 1850

Cardiac output is determined by a __________________, or high-pressure system leaving the left ventricle and returning to the heart via a low-pressure system via the right atrium

Spontaneous breathing is a negative pressure, which causes a _____________ pressure system in the thorax and _________________ resistance of blood flow to return to the right atrium and assist in allowing adequate venous return and pre-load

Positive pressure ventilation leads to _____________ intrathoracic pressure leads to _____________ right atrial pressures and impede venous return

The decrease in venous return is amplified when a patient has _________________. This can lead to decrease in cardiac output and _________________ = need a fluid bolus to restore intravascular volume and improve preload.

× Right Atrium-
  • Positive pressure is delivered-> increased positive intrathoracic pressure and this pressure is transmitted to the _____________ right atrium -> increase in pressure in the right atrium -> _________________ of venous return and _________________ preload
  • This is less of a problem in patients that are not intravascularly volume depleted

× Right Ventricle-
  • _________________ intrathoracic pressure leads to _________________ right ventricular afterload, which is normally well tolerated, except in patients with ________________ (e.g. long standing pulmonary hypertension or acutely from a massive PE)=> RV collapse and failure with possible cardiac arrest

× Left Ventricle-
  • _________________ intrathoracic pressure leads to a _________________ pressure gradient between the ventricle and the intrathoracic space will ________________ LV afterload => ______________ stroke volume and cardiac output
× Heart failure-
**Critical Care Fundamentals: Mechanical Ventilation**

- beneficial by assisting the LV and allowing more cardiac output

**Modes**

**Terminology**

**Breath Type:** 3 types of breaths that can be delivered

1. controlled
2. assisted
3. spontaneous

**Breath Delivery:** How much volume of gas is delivered to the patient

- __________
- __________

**Mode:** How breath types are combined together; examples: CMV, ACV, IMV, PS

**Mechanical Ventilator Breaths and Pull-ups**

Imagine you have never heard or attempted a pull up for this analogy

1. __________ Breath
   - No work (You just hang on the bar while the trainer pushes you up the bar a few times)
   - Ventilator ________________: the frequency/rate of the breaths and the amount of gas delivered is fully dependent on the ventilator
     - Example: CMV (controlled mandatory ventilation)- ventilator determines the rate and the amount of gas
2. __________ Breath
   - Start Work (You make the effort to start doing the pull-up, but the trainer knows you are not strong enough- they then do everything, one they see your effort)
   - Ventilator ________________: The patient will trigger a breath, and once that is sensed by the ventilator- the ventilator does all the work. The patient can determine the respiratory rate
     - Example: ACV (Assist control ventilation)- combination of a controlled breath and assisted breath
3. __________ Breath (also called spontaneous breath)
   - Able to do some or most of the work (You are now much stronger start the pull up. The trainer will only give you some support to complete the pullup. The weaker you are, the more support the trainer has to give you, and the inverse is true- the stronger you are, the less support the trainer has to give you)
   - Ventilator ________________ (i.e. pressure support). The patient starts the process of taking a breath, and only gets some support from the ventilator. However, most of the work is done by the patient.
     - Example: pressure support will assist or augment their efforts
     - Example: SIMV (synchronized intermittent mandatory ventilation)- Ventilator combines a controlled or assisted breath and combine with a spontaneous breath

**Breath Delivery**

**Volume breath:** a preset amount of __________ is delivered to the patient

- The amount of pressure the ventilator needed to deliver this volume of gas is unknown; this depends on the patient’s ____________
Critical Care Fundamentals: Mechanical Ventilation

- The lower the compliance, or the stiffer the lung, the ______ pressure it will take to deliver the volume
- As the compliance increases, or the lung gets more stretchy, the ______ pressure it will take to deliver the same volume of gas

Pressure breath: a preset __________ will deliver the gas
- The amount of volume that will be delivered to the patient is unknown, as this depends on the patient’s __________
- The lower the compliance means that ______ volume will be delivered to a patient at a given pressure
- To give a larger volume of gas, in a patient with low compliance, a ______ preset pressure would need to be given
- As the compliance increases, or the lung gets more stretchy, the ______ volume will be delivered with the same amount of pressure

Compliance= change in ______ / change in ______
- If you are on a volume mode, pay close attention to the pressure
  o ____ = ↓ compliance
  o ____ = ↑ compliance
- If you are on a pressure mode, pay close attention to the volume
  o ____ = ↑ compliance
  o ____ = ↓ compliance

Peak inspiratory pressure (PIP)
- Normally should be in the teens, < _____ cm of water pressure
- _______ needed to fully inflate the lung and overcome the resistive and elastic forces of the lungs

Plateau Pressure (PPlat):
- pressure that _______ (_________ pause)
- _______ since there is no air movement
- PIP > _______ cm of water pressure, need to check the plateau pressure

Elevated PIP and elevated PPlat= indicate _______ compliance
Lung itself= pulmonary edema, pneumonia, ARDS, or pulmonary contusion
Chest wall/ thorax= pneumothorax, pleural effusion, large circumferential burns w. eschar formations
Abdomen= massive ascites or abdominal compartment syndrome
Elevated PIP and low PPlat= _______________ in the circuit or patient
Examples: patient biting ET tube, kinked ET tube, increased secretions, mucous plugging, COPD or Asthma

Pressure Vs Volume 1236

Advantage of Volume delivered breath
- More control over the ______ = tidal volume X respiratory rate
- More clinicians are familiar with volume breaths
Disadvantage of Volume delivered breath

- As compliance decreases there will be need for higher ____________, which can lead to ___________
- Flow pattern is delivered, constant flow wave form, can lead to patient ____________ and there by increased _________________ = square breath on the ventilation
- Note: we breath by a ____________________ inspiratory wave form

Advantage of Pressure delivered breath

- Uses a ____________________ waveform, which is physiological and can be more comfortable for the patient
- _________________ peak inspiratory pressure compared to a volume breath
- Improves oxygenation due to a higher _________________ compared to volume breath

Disadvantages of Pressure delivered breath

- No direct control over ____________________ ; have to make sure the patient is getting an adequate _________________ for the pressure
- Less familiar to clinicians
- Have to constantly pay attention to the pressures, since _________________ is changing a lot, to get an adequate or appropriate _________________
## Reinforcement Game

Students:

1. Write three things you have learned from the video
2. Turn to your neighbor and discuss these three things
3. Turn in the paper before you leave

Note: help with attendance

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Post Test Questions

1. Which of the following is not the main goal of mechanical ventilation in the ICU?
   a. Optimize patient comfort
   b. Optimize exchange of carbon dioxide and oxygen
   c. Get them through surgery with less discomfort
   d. Decrease work of breathing

2. How is the peak inspiratory pressure (PIP) and the mean airway pressure of a pressure breath in comparison to a volume breath?
   a. ↑ peak airway pressure + ↓ mean airway pressure
   b. ↑ peak airway pressure + ↑ mean airway pressure
   c. ↓ peak airway pressure + ↑ mean airway pressure
   d. ↓ peak airway pressure + ↓ mean airway pressure

3. What is the optimal type of breath?
   a. Spontaneous
   b. Controlled
   c. Assisted
   d. None of the above

4. What happens as compliance decreases in a volume breath?
   a. Less oxygen delivery and hypoxia
   b. Higher peak inspiratory pressures (PIP) leading to barotrauma
   c. Higher FiO₂ and oxygen toxicity
   d. Decrease in the minute ventilation leading to decreased PEEP and atelectasis

5. When giving a pressure breath, what is the relationship between compliance and volume?
   a. Lower compliance, the less volume delivered
   b. Lower compliance, the more volume delivered
   c. Higher volume, the higher the compliance needed
   d. Lower volume, the higher the compliance needed

6. Which of the following is not a way to improve oxygenation?
   a. FiO₂
   b. PEEP
   c. Inspiratory time
   d. Respiratory rate

7. What should the carbon dioxide goal be with traumatic brain injury?
   a. High to allow increased cerebral blood flow
   b. High to prevent increased cerebral blood flow
   c. Normal to prevent increased cerebral blood flow
   d. Normal to allow increased cerebral blood flow

8. Which mode of ventilation allows more control over the minute ventilation?
   a. Volume breath
   b. Pressure breath

9. What is the injury from over distension of the alveoli from excessive tidal volume called?
   a. Barotrauma
   b. Volumotrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

10. What is meant by a static pressure vs dynamic pressure?
    a. Dynamic is seen during an inspiratory hold, whereas static is the same as the Peak inspiratory pressure (PIP)
    b. Static has no air movement, dynamic pressure has air movement
    c. Same thing: static pressure is used with volume mode and dynamic pressure with pressure mode
    d. Same thing: static pressure is used with pressure mode and dynamic pressure with volume mode

11. Is inhalation an active or passive process?
12. Which of the following is not a toxicity with mechanical intubation?
   a. Hypercarbia
   b. Barotrauma
   c. Volutrauma
   d. Atelactotrauma
   e. Oxygen toxicity

13. What happens with inadequate PEEP?
   a. Alveoli collapse and develop atelectasis
   b. Poor compliance
   c. Inadequate minute ventilation

14. When giving a volume breath, what is the relationship between compliance and pressure?
   a. Higher the pressure, higher the compliance needed
   b. Lower the compliance, higher the pressure needed
   c. Lower the pressure, lower the compliance needed
   d. Higher the compliance, higher the pressure needed

15. What percent of oxygen can lead to oxygen toxicity (even if only a short period of time)?
   a. >50%
   b. >60%
   c. >70%
   d. >80%

16. What is the volume of gas in the lungs at the end of expiration, but prior to inhalation?
   a. Inspiratory Capacity
   b. Expiratory Capacity
   c. Vital Capacity
   d. Tidal Volume
   e. Functional Residual Capacity

17. What is the normal peak inspiratory pressure (PIP)?
   a. Variable depending on body habitus
   b. >20 cm of water pressure
   c. <10 cm of water pressure
   d. <20 cm of water pressure

18. What happens to the intrathoracic pressure/volume when you inhale?
   a. ↑ intra-thoracic pressure: ↑ intra-thoracic volume
   b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume
   c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume
   d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume

19. Is exhalation an active or passive process?
   a. Active
   b. Passive

20. What is synchronized intermittent mandatory ventilation (SIMV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

21. Describe the type of breath when the patient starts the process (aka triggers a breath), but the ventilator takes over.
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

22. What is the lung injury due to oxygen production of free radicals called?
   a. Barotrauma
   b. Volumtrauma
c. Atelectotrauma  
d. Biotrauma  
e. Oxygen toxicity

23. What happens to the intrathoracic pressure/volume when you exhale?
   a. ↑ intra-thoracic pressure: ↑ intra-thoracic volume  
   b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume  
   c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume  
   d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume

24. When does exhalation become an active process?
   a. With restrictive lung disease  
   b. After you run a mile  
   c. With obstructive lung disease

25. Mechanical ventilation works by_____?
   a. Positive pressure- pushing air into the lungs  
   b. Negative pressure- pulling out the chest wall

26. What is mean airway pressure?
   a. Average pressure that alveoli are exposed to during inspiration  
   b. Average pressure that the lungs are exposed to during expiration  
   c. Average pressure the lung is exposed to during mechanical ventilation

27. Which is a dynamic pressure needed to fully inflate the lungs and overcome the resistive forces and elastic forces of the lungs?
   a. Peak Inspiratory Pressure (PIP)  
   b. Positive end expiratory pressure (PEEP)  
   c. Plateau pressure (PPlat)  
   d. End Expiratory Pressure

28. What is the equation for minute ventilation?
   a. Respiratory Rate X PEEP  
   b. Respiratory Rate X Tidal Volume  
   c. Tidal Volume X Expiratory Time  
   d. Expiratory Time X Respiratory Rate

29. What is removal of carbon dioxide from the body called?
   a. Hypercarbia  
   b. Hypocarbia  
   c. Ventilation  
   d. Tidal Volume

30. Is positive pressure good or bad with heart failure? Why?
   a. Bad; increases afterload and decreases cardiac output  
   b. Good; decreases preload and increases cardiac output  
   c. Bad; decreases preload and decreases cardiac output  
   d. Good; decreases the LV afterload and allows more cardiac output  
   e. Depends on the type an etiology of heart failure

31. What happens to blood return with spontaneous breathing?
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return  
   b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return  
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return  
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return

32. What is the flow pattern of a pressure delivered breath?
   a. Constant  
   b. Accelerating  
   c. Decelerating  
   d. Variable

33. How does increasing the tidal volume allow more CO2 removal?
   a. Allows more surface area for the transfer of CO2  
   b. Increases the mean airway pressure
c. Allows the alveoli to remain open longer for gas exchange
d. Improves compliance

34. Since tidal volume is limited, what else can we adjust to improve minute ventilation?
   a. Inspiratory time
   b. FiO₂
   c. Respiratory Rate
   d. Expiratory time

35. What is a static pressure that the alveoli see?
   a. Positive end expiratory pressure (PEEP)
   b. Driving pressure
   c. Plateau pressure (PPlat)
   d. Peak Inspiratory Pressure (PIP)

36. Why do patients with obstructive lung disease need a shorter respiratory rate?
   a. Gives the patients time to rest
   b. Shorter respiratory rate allows a longer expiratory time as they have trouble with air removal
   c. Shorter respiratory rate allows for less positive end expiratory pressure
   d. Shorter respiratory rate allows for longer inspiratory time to improve oxygenation

37. What is dead space ventilation?
   a. Carbon dioxide in the unventilated alveoli
   b. Carbon dioxide delivered to the patient if the patient isn’t on 100% oxygen
   c. Carbon dioxide that is unable to diffuse out of the capillaries
   d. Carbon dioxide still in the airway at expiration

38. What happens to blood return to the right atrium with positive pressure ventilation?
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return

39. What is the injury to the alveoli caused by excessive pressure from the ventilator called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
   f. Higher oxygen requirements leading to oxygen toxicity

40. What is the normal I:E ratio?
   a. Inspiration is longer than expiration
   b. Expiration is longer than inspiration
   c. Inspiration and expiration are equal

41. What is injury from repetitively opening and closing lung units (a type of sheering stress to the lung) called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

42. What happens with adequate PEEP?
   a. Better driving pressure
   b. Less pressure is needed to re-expand the alveoli at the end of expiration
   c. Improved minute ventilation
   d. Lower oxygen requirements thus decreasing risk of barotrauma

43. What is the difference between the plateau pressure (PPlat) and the positive end expiratory pressure (PEEP)?
   a. Driving pressure
b. Static pressure
   c. Dynamic Pressure
   d. Compliance

44. How can you help improve venous return in a patient on positive pressure ventilation?
   a. If the patient has decreased intravascular volume, a fluid bolus will help
   b. Higher levels of positive end expiratory pressure (PEEP)
   c. Increase the volume/pressure breath (depends on the mode)
   d. Trial of bronchodilators to decrease afterload

45. What happens to the right ventricle with positive pressure ventilation?
   a. Decreased right ventricular afterload
   b. Increased right ventricular preload
   c. No significant changes to the right ventricle
   d. Increased right ventricular afterload

46. Will all patients have perfect carbon dioxide and oxygen levels?
   a. Yes
   b. No

47. What is the lung injury resulting from inflammatory mediators called?
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

48. What happens if you intubate a patient with RV failure?
   a. Nothing with rapid sequence intubation technique
   b. Improved pre-load to the RV
   c. RV collapse and cardiac arrest
   d. Increased ejection fraction of the right ventricle

49. What happens to the left ventricle with positive pressure ventilation?
   a. Increased stroke volume and increased cardiac output
   b. Decreased stroke volume and decreased cardiac output
   c. Increased heart rate and increased cardiac output
   d. Decreased heart rate and decreased cardiac output

50. Which of the following is not a type of breath that can be delivered by a ventilator?
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

51. What are the two types of breath delivery?
   a. $\text{FiO}_2$, PEEP
   b. Volume, pressure
   c. Flow, volume
   d. Respiratory rate and tidal volume

52. What type of breath requires no work by the patient, as the frequency/rate of the breath and the amount of gas delivered is fully dependent on the ventilator?
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

53. How do you check the plateau pressure (PPlat), on a pressure mode?
   a. Inspiratory pause
   b. Expiratory pause
   c. Same as the peak inspiratory pressure (PIP)
   d. Ask the respiratory therapist

54. With what type of breath does the patient do most/all of the work, and the ventilator gives only minimal assistance, if needed?
   a. Controlled
Critical Care Fundamentals: Mechanical Ventilation

55. What is controlled mandatory ventilation (CMV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

56. What is pressure support?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

57. What is assist controlled ventilation (ACV)?
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

58. In which mode of ventilation is a pre-set amount of gas delivered to the patient?
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

59. When giving a volume breath, at what pressure will the gas be delivered?
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

60. In which mode of ventilation will a pre-set pressure deliver gas to the patient?
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

61. What are ways to maximize patient comfort on the ventilator?
   a. Optimize ventilation settings
   b. Sedation
   c. Paralytics
   d. All of the above

62. When giving a pressure breath, how much volume of gas will be delivered to a patient?
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

63. How do you check the plateau pressure (PPlat), on a volume mode?
   a. Inspiratory pause
   b. Expiratory pause
   c. Same as the peak inspiratory pressure (PIP)
   d. Ask the respiratory therapist

64. What does it mean when there is increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)?
   a. High resistance in the circuit or patient
   b. Poor pulmonary perfusion
   c. Need to change the ventilator mode
   d. Decreased compliance
65. Which is not a cause of increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)?
   a. Pulmonary edema
   b. Bronchospasms
   c. Pneumothorax
   d. Abdominal compartment syndrome
   e. ARDS

66. How does increasing the inspiratory time lead to improved oxygenation?
   a. It increases mean airway pressure
   b. It decreases expiration time
   c. It improves PEEP
   d. It increases the tidal volume

67. What does it mean when there is increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)?
   a. High resistance in the circuit or patient
   b. Decreased compliance
   c. Poor pulmonary perfusion
   d. Need to change the ventilator mode

68. Which is not a cause of increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)?
   a. Endotracheal tube occlusion
   b. Mucous plugging
   c. Pulmonary embolism
   d. Bronchospasms

69. What is the normal flow pattern of a volume breath?
   a. Constant
   b. Accelerating
   c. Decelerating
   d. Variable

70. What is the main disadvantage of a pressure delivered breath?
   a. Not as well known to clinicians
   b. No control over minute ventilation
   c. Constantly pay attention to pressures to make sure adequate tidal volume
   d. All of the above
Pre-Test Questions and Answers

1. Which of the following is not the main goal of mechanical ventilation in the ICU? I-0055
   a. Optimize patient comfort
   b. Optimize exchange of carbon dioxide and oxygen
   c. Get them through surgery with less discomfort
   d. Decrease work of breathing

2. What are ways to maximize patient comfort on the ventilator? I-0110
   a. Optimize ventilation settings
   b. Sedation
   c. Paralytics
   d. All of the above

3. What is the optimal type of breath? I-0134
   a. Spontaneous
   b. Controlled
   c. Assisted
   d. None of the above

4. Will all patients have perfect carbon dioxide and oxygen levels? I-0230
   a. Yes
   b. No

5. What should the carbon dioxide goal be with traumatic brain injury? I--0253
   a. High to allow increased cerebral blood flow
   b. High to prevent increased cerebral blood flow
   c. Normal to prevent increased cerebral blood flow
   d. Normal to allow increased cerebral blood flow

6. Which of the following is not a toxicity with mechanical intubation? I-0330
   a. Hypercarbia
   b. Barotrauma
   c. Volutrauma
   d. Atelactotrauma
   e. Oxygen toxicity

7. What percent of oxygen can lead to oxygen toxicity (even if only a short period of time)? I-0330
   a. >50%
   b. >60%
   c. >70%
   d. >80%

8. What is the volume of gas in the lungs at the end of expiration, but prior to inhalation? I-0515
   a. Inspiratory Capacity
   b. Expiratory Capacity
   c. Vital Capacity
   d. Tidal Volume
   e. Functional Residual Capacity

9. Is inhalation an active or passive process? I-0515
   a. Active
   b. Passive

10. What happens to the intrathoracic pressure/volume when you inhale? I-0545
    a. ↑ intra-thoracic pressure: ↑ intra-thoracic volume
    b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume
    c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume
    d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume

11. Is exhalation an active or passive process? I-0620
    a. Active
    b. Passive

12. What happens to the intrathoracic pressure/volume when you exhale? I-0620
    a. ↑ intra-thoracic pressure: ↑ intra-thoracic volume
    b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume
c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume
d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume

13. When does exhalation become an active process? I-0620
   a. With restrictive lung disease
   b. After you run a mile
   c. With obstructive lung disease

14. Mechanical ventilation works by ______ ? I-0655
   a. Positive pressure- pushing air into the lungs
   b. Negative pressure- pulling out the chest wall

15. Which of the following is not a way to improve oxygenation? I-0748
   a. FiO₂
   b. PEEP
   c. Inspiratory time
   d. Respiratory rate

16. What is mean airway pressure? I-0826
   a. Average pressure that alveoli are exposed to during inspiration
   b. Average pressure that the lungs are exposed to during expiration
   c. Average pressure the lung is exposed to during mechanical ventilation

17. What is the normal I:E ratio? I-0844
   a. Inspiration is longer than expiration
   b. Expiration is longer than inspiration
   c. Inspiration and expiration are equal

18. How does increasing the inspiratory time lead to improved oxygenation? I-0910
   a. It increases mean airway pressure
   b. It decreases expiration time
   c. It improves PEEP
   d. It increases the tidal volume

19. What is removal of carbon dioxide from the body called? I-1002
   a. Hypercarbia
   b. Hypocarbia
   c. Ventilation
   d. Tidal Volume

20. What is the equation for minute ventilation? I-1040
   a. Respiratory Rate X PEEP
   b. Respiratory Rate X Tidal Volume
   c. Tidal Volume X Expiratory Time
   d. Expiratory Time X Respiratory Rate

21. What is dead space ventilation? I-1058
   a. Carbon dioxide in the unventilated alveoli
   b. Carbon dioxide delivered to the patient if the patient isn’t on 100% oxygen
   c. Carbon dioxide that is unable to diffuse out of the capillaries
   d. Carbon dioxide still in the airway at expiration

22. How does increasing the tidal volume allow more CO2 removal? I-1138
   a. Allows more surface area for the transfer of CO2
   b. Increases the mean airway pressure
   c. Allows the alveoli to remain open longer for gas exchange
   d. Improves compliance

23. Since tidal volume is limited, what else can we adjust to improve minute ventilation? I-1138
   a. Inspiratory time
   b. FiO₂
   c. Respiratory Rate
   d. Expiratory time

24. Why do patients with obstructive lung disease need a shorter respiratory rate? I-1245
   a. Gives the patients time to rest
   b. Shorter respiratory rate allows a longer expiratory time as they have trouble with air removal

26
c. Shorter respiratory rate allows for less positive end expiratory pressure
d. Shorter respiratory rate allows for longer inspiratory time to improve oxygenation
25. What is the injury to the alveoli caused by excessive pressure from the ventilator called? I-1406
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
26. What is the injury from over distension of the alveoli from excessive tidal volume called? I-1413
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
27. What is the injury from repetitively opening and closing lung units (a type of sheering stress to the lung) called? I-1416
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
28. What is the lung injury resulting from inflammatory mediators called? I-1438
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
29. What is the lung injury due to oxygen production of free radicals called? I-1509
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
30. What happens with inadequate PEEP? I-1729
    a. Alveoli collapse and develop atelectasis
    b. Poor compliance
    c. Inadequate minute ventilation
    d. Higher oxygen requirements leading to oxygen toxicity
31. What happens with adequate PEEP? I-1803
    a. Better driving pressure
    b. Less pressure is needed to re-expand the alveoli at the end of expiration
    c. Improved minute ventilation
    d. Lower oxygen requirements thus decreasing risk of barotrauma
32. What is the difference between the plateau pressure (Pplat) and the positive end expiratory pressure (PEEP)? I-1825
    a. Driving pressure
    b. Static pressure
    c. Dynamic Pressure
    d. Compliance
33. What happens to blood return with spontaneous breathing? I-1911
    a. Positive intrathoracic pressure that causes less resistance and assists in venous return
    b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return
    c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
    d. Negative intrathoracic pressure that causes less resistance and assists in venous return
34. What happens to blood return to the right atrium with positive pressure ventilation? I-1932, 2010
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes in adequate venous return
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return
35. How can you help improve venous return in a patient on positive pressure ventilation? I-1944
   a. If the patient has decreased intravascular volume, a fluid bolus will help
   b. Higher levels of positive end expiratory pressure (PEEP)
   c. Increase the volume/pressure breath (depends on the mode)
   d. Trial of bronchodilators to decrease afterload
36. What happens to the right ventricle with positive pressure ventilation? I-2048
   a. Decreased right ventricular afterload
   b. Increased right ventricular preload
   c. No significant changes to the right ventricle
   d. Increased right ventricular afterload
37. What happens if you intubate a patient with RV failure? I-2048
   a. Nothing with rapid sequence intubation technique
   b. Improved pre-load to the RV
   c. RV collapse and cardiac arrest
   d. Increased ejection fraction of the right ventricle
38. What happens to the left ventricle with positive pressure ventilation? I-2128
   a. Increased stroke volume and increased cardiac output
   b. Decreased stroke volume and decreased cardiac output
   c. Increased heart rate and increased cardiac output
   d. Decreased heart rate and decreased cardiac output
39. Is positive pressure good or bad with heart failure? Why? I-2150
   a. Bad; increases afterload and decreases cardiac output
   b. Good; decreases preload and increases cardiac output
   c. Bad; decreases preload and decreases cardiac output
   d. Good; decreases the LV afterload and allows more cardiac output
   e. Depends on the type an etiology of heart failure
40. Which of the following is not a type of breath that can be delivered by a ventilator? II-0216
   a. Controlled
   b. Assisted
   c. Manuel
   d. Spontaneous
41. What are the two types of breath delivery? II-0228
   a. FiO₂, PEEP
   b. Volume, pressure
   c. Flow, volume
   d. Respiratory rate and tidal volume
42. What type of breath requires no work by the patient, as the frequency/rate of the breath and the amount of gas delivered is fully dependent on the ventilator? II-0318
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported
43. Describe the type of breath when the patient starts the process (aka triggers a breath), but the ventilator takes over. II-0401
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported
44. With what type of breath does the patient do most/all of the work, and the ventilator gives only minimal assistance, if needed? II-0405
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported
45. What is controlled mandatory ventilation (CMV)? II-0551
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath
46. What is pressure support? II-0535
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath
47. What is assist controlled ventilation (ACV)? II-0600
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath
48. What is synchronized intermittent mandatory ventilation (SIMV)? II-0608
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath
49. In which mode of ventilation is a pre-set amount of gas delivered to the patient? II-0632
   a. Volume breath
Critical Care Fundamentals: Mechanical Ventilation

50. When giving a volume breath, at what pressure will the gas be delivered? Il-0650
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

51. When giving a volume breath, what is the relationship between compliance and pressure? Il-7010, 0721, 0820
   a. Higher the pressure, higher the compliance needed
   b. Lower the compliance, higher the pressure needed
   c. Lower the pressure, lower the compliance needed
   d. Higher the compliance, higher the pressure needed

52. In which mode of ventilation will a pre-set pressure deliver gas to the patient? Il-0730
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

53. When giving a pressure breath, how much volume of gas will be delivered to a patient? Il-0747
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

54. When giving a pressure breath, what is the relationship between compliance and volume? Il-0748, 0802, 0810, 0850
   a. Lower compliance, the less volume delivered
   b. Lower compliance, the more volume delivered
   c. Higher volume, the higher the compliance needed
   d. Lower volume, the higher the compliance needed

55. Which is a dynamic pressure needed to fully inflate the lungs and overcome the resistive forces and elastic forces of the lungs? Il-0925, 1045
   a. Peak Inspiratory Pressure (PIP)
   b. Positive end expiratory pressure (PEEP)
   c. Plateau pressure (PPlat)
   d. End Expiratory Pressure

56. What is the normal peak inspiratory pressure (PIP)? Il-1014
   a. Variable depending on body habitus
   b. >20 cm of water pressure
   c. <10 cm of water pressure
   d. <20 cm of water pressure

57. What is a static pressure that the alveoli see? Il-1026
   a. Positive end expiratory pressure (PEEP)
   b. Driving pressure
   c. Plateau pressure (PPlat)
   d. Peak Inspiratory Pressure (PIP)

58. What is meant by a static pressure vs dynamic pressure? Il-1026, 1045
   a. Dynamic is seen during an inspiratory hold, whereas static is the same as the Peak inspiratory pressure (PIP)
   b. Static has no air movement, dynamic pressure has air movement
   c. Same thing: static pressure is used with volume mode and dynamic pressure with pressure mode
   d. Same thing: static pressure is used with pressure mode and dynamic pressure with volume mode

59. How do you check the plateau pressure (PPlat), on a volume mode? Il-1026
   a. Inspiratory pause
b. Expiratory pause  
c. Same as the peak inspiratory pressure (PIP)  
d. Ask the respiratory therapist

60. How do you check the plateau pressure (PPlat), on a pressure mode? II-1026  
a. Inspiratory pause  
b. Expiratory pause  
c. Same as the peak inspiratory pressure (PIP)  
d. Ask the respiratory therapist

61. What does it mean when there is increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)? II-1106  
a. High resistance in the circuit or patient  
b. Poor pulmonary perfusion  
c. Need to change the ventilator mode  
d. Decreased compliance

62. Which is not a cause of increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)? II-1106  
a. Pulmonary edema  
b. Bronchospasms  
c. Pneumothorax  
d. Abdominal compartment syndrome  
e. ARDS

63. What does it mean when there is increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)? II-1145  
a. High resistance in the circuit or patient  
b. Decreased compliance  
c. Poor pulmonary perfusion  
d. Need to change the ventilator mode

64. Which is not a cause of increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)? II-1145  
a. Endotracheal tube occlusion  
b. Mucous plugging  
c. Pulmonary embolism  
d. Bronchospasms

65. Which mode of ventilation allows more control over the minute ventilation? II-1257  
a. Volume breath  
b. Pressure breath

66. What happens as compliance decreases in a volume breath? II-1343  
a. Less oxygen delivery and hypoxia  
b. Higher peak inspiratory pressures (PIP) leading to barotrauma  
c. Higher FiO₂ and oxygen toxicity  
d. Decrease in the minute ventilation leading to decreased PEEP and atelectasis

67. What is the normal flow pattern of a volume breath? II-1433  
a. Constant  
b. Accelerating  
c. Decelerating  
d. Variable

68. What the flow pattern of a pressure delivered breath? II-1456  
a. Constant  
b. Accelerating  
c. Decelerating  
d. Variable

69. How is the peak inspiratory pressure (PIP) and the mean airway pressure of a pressure breath in comparison to a volume breath? II-1456  
a. ↑ peak airway pressure + ↓ mean airway pressure  
b. ↑ peak airway pressure + ↑ mean airway pressure  
c. ↓ peak airway pressure + ↑ mean airway pressure
Critical Care Fundamentals: Mechanical Ventilation

70. What is the main disadvantage of a pressure delivered breath? IL-1533
   a. Not as well known to clinicians
   b. No control over minute ventilation
   c. Constantly pay attention to pressures to make sure adequate tidal volume
   d. All of the above
Post Test Questions and Answers

1. Which of the following is not the main goal of mechanical ventilation in the ICU? I-0055
   a. Optimize patient comfort
   b. Optimize exchange of carbon dioxide and oxygen
   c. Get them through surgery with less discomfort
   d. Decrease work of breathing

2. How is the peak inspiratory pressure (PIP) and the mean airway pressure of a pressure breath in comparison to a volume breath? II-1456
   a. ↑ peak airway pressure + ↓ mean airway pressure
   b. ↑ peak airway pressure + ↑ mean airway pressure
   c. ↓ peak airway pressure + ↑ mean airway pressure
   d. ↓ peak airway pressure + ↓ mean airway pressure

3. What is the optimal type of breath? I-0134
   a. Spontaneous
   b. Controlled
   c. Assisted
   d. None of the above

4. What happens as compliance decreases in a volume breath? II-1343
   a. Less oxygen delivery and hypoxia
   b. Higher peak inspiratory pressures (PIP) leading to barotrauma
   c. Higher FiO₂ and oxygen toxicity
   d. Decrease in the minute ventilation leading to decreased PEEP and atelectasis

5. When giving a pressure breath, what is the relationship between compliance and volume? II-0748, 0802, 0810, 0850
   a. Lower compliance, the less volume delivered
   b. Lower compliance, the more volume delivered
   c. Higher volume, the higher the compliance needed
   d. Lower volume, the higher the compliance needed

6. Which of the following is not a way to improve oxygenation? I-0748
   a. FiO₂
   b. PEEP
   c. Inspiratory time
   d. Respiratory rate

7. What should the carbon dioxide goal be with traumatic brain injury? I--0253
   a. High to allow increased cerebral blood flow
   b. High to prevent increased cerebral blood flow
   c. Normal to prevent increased cerebral blood flow
   d. Normal to allow increased cerebral blood flow

8. Which mode of ventilation allows more control over the minute ventilation? II-1257
   a. Volume breath
   b. Pressure breath

9. What is the injury from over distension of the alveoli from excessive tidal volume called? I-1413
   a. Barotrauma
   b. Volutrauma
   c. Atelectrauma
   d. Biotrauma
   e. Oxygen toxicity

10. What is meant by a static pressure vs dynamic pressure? II-1026, 1045
    a. Dynamic is seen during an inspiratory hold, whereas static is the same as the Peak inspiratory pressure (PIP)
    b. Static has no air movement, dynamic pressure has air movement
    c. Same thing: static pressure is used with volume mode and dynamic pressure with pressure mode
d. Same thing: static pressure is used with pressure mode and dynamic pressure with volume mode
11. Is inhalation an active or passive process? I-0515
   a. Active
   b. Passive
12. Which of the following is not a toxicity with mechanical intubation? I-0330
   a. Hypercarbia
   b. Barotrauma
   c. Volutrauma
   d. Atelactotrauma
   e. Oxygen toxicity
13. What happens with inadequate PEEP? I-1729
   a. Alveoli collapse and develop atelectasis
   b. Poor compliance
   c. Inadequate minute ventilation
14. When giving a volume breath, what is the relationship between compliance and pressure? II-7010, 0721, 0820
   a. Higher the pressure, higher the compliance needed
   b. Lower the compliance, higher the pressure needed
   c. Lower the pressure, lower the compliance needed
   d. Higher the compliance, higher the pressure needed
15. What percent of oxygen can lead to oxygen toxicity (even if only a short period of time)? I-0330
   a. >50 %
   b. >60%
   c. >70%
   d. >80%
16. What is the volume of gas in the lungs at the end of expiration, but prior to inhalation? I-0515
   a. Inspiratory Capacity
   b. Expiratory Capacity
   c. Vital Capacity
   d. Tidal Volume
   e. Functional Residual Capacity
17. What is the normal peak inspiratory pressure (PIP)? II-1014
   a. Variable depending on body habitus
   b. >20 cm of water pressure
   c. <10 cm of water pressure
   d. <20 cm of water pressure
18. What happens to the intrathoracic pressure/ volume when you inhale? I-0545
   a. ↑ intra-thoracic pressure: ↑ intra-thoracic volume
   b. ↑ intra-thoracic pressure: ↓ intra-thoracic volume
   c. ↓ intra-thoracic pressure: ↑ intra-thoracic volume
   d. ↓ intra-thoracic pressure: ↓ intra-thoracic volume
19. Is exhalation an active or passive process? I-0620
   a. Active
   b. Passive
20. What is synchronized intermittent mandatory ventilation (SIMV)? II-0608
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath
21. Describe the type of breath when the patient starts the process (aka triggers a breath), but the ventilator takes over. II-0401
   a. Controlled
   b. Assisted
   c. Manuel
22. What is the lung injury due to oxygen production of free radicals called? I-1509
   a. Barotrauma
   b. Volutrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
23. What happens to the intrathoracic pressure/volume when you exhale? I-0620
   a. ↑ intra-thoracic pressure; ↑ intra-thoracic volume
   b. ↑ intra-thoracic pressure; ↓ intra-thoracic volume
   c. ↓ intra-thoracic pressure; ↑ intra-thoracic volume
   d. ↓ intra-thoracic pressure; ↓ intra-thoracic volume
24. When does exhalation become an active process? I-0620
   a. With restrictive lung disease
   b. After you run a mile
   c. With obstructive lung disease
25. Mechanical ventilation works by? I-0655
   a. Positive pressure- pushing air into the lungs
   b. Negative pressure- pulling out the chest wall
26. What is mean airway pressure? I-0826
   a. Average pressure that alveoli are exposed to during inspiration
   b. Average pressure that the lungs are exposed to during expiration
27. Which is a dynamic pressure needed to fully inflate the lungs and overcome the resistive forces and elastic forces of the lungs? II-0925, 1045
   a. Peak Inspiratory Pressure (PIP)
   b. Positive end expiratory pressure (PEEP)
   c. Plateau pressure (Pplat)
   d. End Expiratory Pressure
28. What is the equation for minute ventilation? I-1040
   a. Respiratory Rate X PEEP
   b. Respiratory Rate X Tidal Volume
   c. Tidal Volume X Expiratory Time
   d. Expiratory Time X Respiratory Rate
29. What is removal of carbon dioxide from the body called? I-1002
   a. Hypercarbia
   b. Hypocarbia
   c. Ventilation
   d. Tidal Volume
30. Is positive pressure good or bad with heart failure? Why? I-2150
   a. Bad; increases afterload and decreases cardiac output
   b. Good; decreases preload and increases cardiac output
   c. Bad; decreases preload and decreases cardiac output
   d. Good; decreases the LV afterload and allows more cardiac output
   e. Depends on the type an etiology of heart failure
31. What happens to blood return with spontaneous breathing? I-1911
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes adequate venous return
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return
32. What is the flow pattern of a pressure delivered breath? II-1456
   a. Constant
   b. Accelerating
   c. Decelerating
33. How does increasing the tidal volume allow more CO2 removal? I-1138
   a. Allows more surface area for the transfer of CO2
   b. Increases the mean airway pressure
   c. Allows the alveoli to remain open longer for gas exchange
   d. Improves compliance

34. Since tidal volume is limited, what else can we adjust to improve minute ventilation? I-1138
   a. Inspiratory time
   b. FiO2
   c. Respiratory Rate
   d. Expiratory time

35. What is a static pressure that the alveoli see? II-1026
   a. Positive end expiratory pressure (PEEP)
   b. Driving pressure
   c. Plateau pressure (PPlat)
   d. Peak Inspiratory Pressure (PIP)

36. Why do patients with obstructive lung disease need a shorter respiratory rate? I-1245
   a. Gives the patients time to rest
   b. Shorter respiratory rate allows a longer expiratory time as they have trouble with air removal
   c. Shorter respiratory rate allows for less positive end expiratory pressure
   d. Shorter respiratory rate allows for longer inspiratory time to improve oxygenation

37. What is dead space ventilation? I-1058
   a. Carbon dioxide in the unventilated alveoli
   b. Carbon dioxide delivered to the patient if the patient isn’t on 100% oxygen
   c. Carbon dioxide that is unable to diffuse out of the capillaries
   d. Carbon dioxide still in the airway at expiration

38. What happens to blood return to the right atrium with positive pressure ventilation? I-1932, 2010
   a. Positive intrathoracic pressure that causes less resistance and assists in venous return
   b. Negative intrathoracic pressure that causes increased resistance and impedes adequate venous return
   c. Positive intrathoracic pressure that causes increased resistance and impedes venous return
   d. Negative intrathoracic pressure that causes less resistance and assists in venous return

39. What is the injury to the alveoli caused by excessive pressure from the ventilator called? I-1406
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

40. What is the normal I:E ratio? I-0844
   a. Inspiration is longer than expiration
   b. Expiration is longer than inspiration
   c. Inspiration and expiration are equal

41. What is the injury from repetitively opening and closing lung units (a type of sheering stress to the lung) called? I-1416
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity
   f. Higher oxygen requirements leading to oxygen toxicity

42. What happens with adequate PEEP? I-1803
   a. Better driving pressure
   b. Less pressure is needed to re-expand the alveoli at the end of expiration
   c. Improved minute ventilation
d. Lower oxygen requirements thus decreasing risk of barotrauma

43. What is the difference between the plateau pressure (PPlat) and the positive end expiratory pressure (PEEP)? I-1825
   a. Driving pressure
   b. Static pressure
   c. Dynamic Pressure
   d. Compliance

44. How can you help improve venous return in a patient on positive pressure ventilation? I-1944
   a. If the patient has decreased intravascular volume, a fluid bolus will help
   b. Higher levels of positive end expiratory pressure (PEEP)
   c. Increase the volume/pressure breath (depends on the mode)
   d. Trial of bronchodilators to decrease afterload

45. What happens to the right ventricle with positive pressure ventilation? I-2048
   a. Decreased right ventricular afterload
   b. Increased right ventricular preload
   c. No significant changes to the right ventricle
   d. Increased right ventricular afterload

46. Will all patients have perfect carbon dioxide and oxygen levels? I-0230
   a. Yes
   b. No

47. What is the lung injury resulting from inflammatory mediators called? I-1438
   a. Barotrauma
   b. Volumtrauma
   c. Atelectotrauma
   d. Biotrauma
   e. Oxygen toxicity

48. What happens if you intubate a patient with RV failure? I-2048
   a. Nothing with rapid sequence intubation technique
   b. Improved pre-load to the RV
   c. RV collapse and cardiac arrest
   d. Increased ejection fraction of the right ventricle

49. What happens to the left ventricle with positive pressure ventilation? I-2128
   a. Increased stroke volume and increased cardiac output
   b. Decreased stroke volume and decreased cardiac output
   c. Increased heart rate and increased cardiac output
   d. Decreased heart rate and decreased cardiac output

50. Which of the following is not a type of breath that can be delivered by a ventilator? II-0216
   a. Controlled
   b. Assisted
   c. Manuel
   d. Spontaneous

51. What are the two types of breath delivery? II-0228
   a. FiO₂, PEEP
   b. Volume, pressure
   c. Flow, volume
   d. Respiratory rate and tidal volume

52. What type of breath requires no work by the patient, as the frequency/rate of the breath and the amount of gas delivered is fully dependent on the ventilator? II-0318
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

53. How do you check the plateau pressure (PPlat), on a pressure mode? II-1026
   a. Inspiratory pause
   b. Expiratory pause
   c. Same as the peak inspiratory pressure (PIP)
d. Ask the respiratory therapist

54. With what type of breath does the patient do most/all of the work, and the ventilator gives only minimal assistance, if needed? II-0405
   a. Controlled
   b. Assisted
   c. Manuel
   d. Supported

55. What is controlled mandatory ventilation (CMV)? II-0551
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

56. What is pressure support? II-0535
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

57. What is assist controlled ventilation (ACV)? II-0600
   a. A combination of a controlled/assisted breathing with a spontaneous breath
   b. A way for the ventilator to assist/ augment the efforts of the patient
   c. A controlled form of ventilation where the ventilator controls the rate and the amount of gas
   d. A combination of controlled and assisted breath

58. In which mode of ventilation is a pre-set amount of gas delivered to the patient? II-0632
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

59. When giving a volume breath, at what pressure will the gas be delivered? II-0650
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

60. In which mode of ventilation will a pre-set pressure deliver gas to the patient? II-0730
   a. Volume breath
   b. Pressure Breath
   c. Both
   d. Neither

61. What are ways to maximize patient comfort on the ventilator? I-0110
   a. Optimize ventilation settings
   b. Sedation
   c. Paralytics
   d. All of the above

62. When giving a pressure breath, how much volume of gas will be delivered to a patient? II-0747
   a. Depends on compliance
   b. 6-8 ml / kg of ideal body weight
   c. Depends on the respiratory rate
   d. Depends on the flow and inspiratory time

63. How do you check the plateau pressure (PPlat), on a volume mode? II-1026
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   d. Ask the respiratory therapist
64. What does it mean when there is increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)? II-1106
   a. High resistance in the circuit or patient
   b. Poor pulmonary perfusion
   c. Need to change the ventilator mode
   d. Decreased compliance

65. Which is not a cause of increased peak inspiratory pressure (PIP) and increased plateau pressure (PPlat)? II-1106
   a. Pulmonary edema
   b. Bronchospasms
   c. Pneumothorax
   d. Abdominal compartment syndrome
   e. ARDS

66. How does increasing the inspiratory time lead to improved oxygenation? I-0910
   a. It increases mean airway pressure
   b. It decreases expiration time
   c. It improves PEEP
   d. It increases the tidal volume

67. What does it mean when there is increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)? II-1145
   a. High resistance in the circuit or patient
   b. Decreased compliance
   c. Poor pulmonary perfusion
   d. Need to change the ventilator mode

68. Which is not a cause of increased peak inspiratory pressure (PIP) and low plateau pressure (PPlat)? II-1145
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   d. All of the above