Pilbeam's Mechanical Ventilation 8th edition Cairo Test Bank

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Test Bank - Chapter 01

Q1: The body's mechanism for conducting air in and out of the lungs is known as which of the following?

A. External respiration
B. Internal respiration
C. Spontaneous ventilation (Correct)
D. Mechanical ventilation

Rationale: The conduction of air in and out of the body is known as ventilation. Since the question asks for the body's mechanism, this would be spontaneous ventilation. External respiration involves the exchange of oxygen (O2) and carbon dioxide (CO2) between the alveoli and the pulmonary capillaries. Internal respiration occurs at the cellular level and involves movement of oxygen from the systemic blood into the cells.

Q2: Which of the following are involved in external respiration?

A. Red blood cells and body cells
B. Scalenes and trapezius muscles
C. Alveoli and pulmonary capillaries (Correct)
D. External oblique and transverse abdominal muscles

Rationale: External respiration involves the exchange of oxygen and carbon dioxide (CO2) between the alveoli and the pulmonary capillaries. Internal respiration occurs at the cellular level and involves movement of oxygen from the systemic blood into the cells. Scalene and trapezius muscles are accessory muscles of inspiration. External oblique and transverse abdominal muscles are accessory muscles of expiration.

Q3: The graph that shows intrapleural pressure changes during normal spontaneous breathing is depicted by which of the following?

A. [Image omitted]
B. [Image omitted] (Correct)
C. [Image omitted]
D. [Image omitted]

Rationale: During spontaneous breathing, the intrapleural pressure drops from about -5 cm H2O at end-expiration to about -10 cm H2O at end-inspiration. The graph depicted for answer B shows that change from -5 cm H2O to -10 cm H2O.

Q4: What is the approximant alveolar pressure (PA) during spontaneous inspiration?

A. -1 cm H2O (Correct)
B. +1 cm H2O
C. 0 cm H2O

D. 5 cm H2O

Rationale: -1 cm H2O is the lowest alveolar pressure will become during normal spontaneous ventilation. During the exhalation of a normal spontaneous breath the alveolar pressure will become +1 cm H2O.

Q5: The pressure required to maintain alveolar inflation is known as which of the following?

A. Transairway pressure (PTA)
B. Transthoracic pressure (PTT)
C. Transrespiratory pressure (PTR)
D. Transpulmonary pressure (PL) (Correct)

Rationale: The definition of transpulmonary pressure (PL) is the pressure required to maintain alveolar inflation. Transairway pressure (PTA) is the pressure gradient required to produce airflow in the conducting tubes. Transrespiratory pressure (PTR) is the pressure to inflate the lungs and airways during positive-pressure ventilation. Transthoracic pressure (PTT) represents the pressure required to expand or contract the lungs and the chest wall at the same time.

Q6: Calculate the pressure needed to overcome airway resistance during positive-pressure ventilation when the proximal airway pressure (Pawo) is 35 cm H2O and the alveolar pressure (PA) is 5 cm H2O.

A. 7 cm H2O
B. 30 cm H2O (Correct)
C. 40 cm H2O
D. 175 cm H2O

Rationale: The transairway pressure (PTA) is used to calculate the pressure required to overcome airway resistance during mechanical ventilation. This formula is PTA = Pawo - PA.

Q7: The term used to describe the tendency of a structure to return to its original form after being stretched or acted on by an outside force is which of the following?

A. Elastance (Correct)
B. Compliance
C. Viscous resistance
D. Distending pressure

Rationale: The elastance of a structure is the tendency of that structure to return to its original shape after being stretched. The more elastance a structure has, the more difficult it is to stretch. The compliance of a structure is the ease with which the structure distends or stretches. Compliance is the opposite of elastance. Viscous resistance is the opposition to movement offered by adjacent structures such as the lungs and their adjacent organs. Distending pressure is pressure required to maintain inflation, for example, alveolar distending pressure.

Q8: Calculate the pressure required to achieve a tidal volume of 400 mL for an intubated patient with a respiratory system compliance of 15 mL/cm H2O.

A. 6 cm H2O

B. 26.7 cm H2O (Correct)

C. 37.5 cm H2O

D. 41.5 cm H2O

Rationale: $\Delta C = \Delta V/\Delta P$ then $\Delta P = \Delta V/\Delta C$

Q9: Which of the following conditions causes pulmonary compliance to increase?

A. Asthma

B. Kyphoscoliosis

C. Emphysema (Correct)

D. Acute respiratory distress syndrome (ARDS)

Rationale: Emphysema causes an increase in pulmonary compliance, whereas ARDS and kyphoscoliosis cause decreases in pulmonary compliance. Asthma attacks cause increase in airway resistance.

Q10: Calculate the effective static compliance (Cs) given the following information about a patient receiving mechanical ventilation: peak inspiratory pressure (PIP) is 56 cm H2O, plateau pressure (Pplat) is 40 cm H2O, exhaled tidal volume (VT) is 650 mL, and positive end expiratory pressure (PEEP) is 10 cm H2O.

A. 14.1 mL/cm H2O

B. 16.3 mL/cm H2O

C. 21.7 mL/cm H2O (Correct)

D. 40.6 mL/cm H2O

Rationale: The formula for calculating effective static compliance is Cs = VT/(Pplat - EEP).

Q11: Based upon the following patient information, calculate the patient's static lung compliance: exhaled tidal volume (VT) is 675 mL, peak inspiratory pressure (PIP) is 28 cm H2O, plateau pressure (Pplat) is 8 cm H2O, and PEEP is set at 5 cm H2O.

A. 0.02 L/cm H2O

B. 0.03 L/cm H2O

C. 0.22 L/cm H2O (Correct)

D. 0.34 L/cm H2O

Rationale: The formula for calculating effective static compliance is Cs = VT/(Pplat - EEP).

Q12: A patient receiving mechanical ventilation has an exhaled tidal volume (VT) of 500 mL and a positive end expiratory pressure setting (PEEP) of 5 cm H2O. Patient-ventilator system checks reveal the following data: TimePIP (cm H2O)Pplat (cm H2O)060027150800291510003613 The respiratory therapist should recommend which of the following for this patient? 1. Tracheobronchial suctioning 2. Increase in the set tidal volume 3. Beta adrenergic bronchodilator therapy 4. Increase positive end expiratory pressure

A. 1 and 3 only (Correct)

B. 2 and 4 only

C. 1, 2, and 3 only

D. 2, 3, and 4 only

Rationale: Calculate the transairway pressure (PTA) by subtracting the plateau pressure from the peak inspiratory pressure. Analyzing the PTA will show any changes in the pressure needed to overcome airway resistance. Analyzing the Pplateau will demonstrate any changes in compliance. The Pplateau remained the same for the first two checks and then actually dropped at the 1000-hour check. Analyzing the PTA, however, shows a slight increase between 0600 and 0800 (from 12 to 14 cm H2O) and then a sharp increase to 23 cm H2O at 1000. Increases in PTA signify increases in airway resistance. Airway resistance may be caused by secretion buildup, bronchospasm, mucosal edema, and mucosal inflammation. Tracheobronchial suctioning will remove any secretion buildup, and a beta adrenergic bronchodilator will reverse bronchospasm. Increasing the tidal volume will add to the airway resistance according to Poiseuille's law. Increasing the PEEP will not address the root of this patient's problem; the patient's compliance is normal.

Q13: The values below pertain to a patient who is being mechanically ventilated with a measured exhaled tidal volume (VT) of 700 mL. TimePeak Inspiratory Pressure (cm H2O)Plateau Pressure (cm H2O)0800353010003934110045391130504 4 Analysis of this data points to which of the following conclusions?

A. Airway resistance is increasing.

B. Airway resistance is decreasing.

C. Lung compliance is increasing.

D. Lung compliance is decreasing. (Correct)

Rationale: To evaluate this information the transairway pressure (PTA) is calculated for the different times: 0800 PTA = 5 cm H2O, 1000 PTA = 5 cm H2O, 1100 PTA = 6 cm H2O, and 1130 PTA = 6 cm H2O. This data shows that there is no significant increase or decrease in this patient's airway resistance. Analysis of the patient's plateau pressure (Pplat) reveals an increase of 15 cm H2O over the three and a half hour time period. This is directly related to a decrease in lung compliance. Calculation of the lung compliance (CS = VT/(Pplat – EEP) at each time interval reveals a steady decrease from 20 mL/cm H2O to 14 mL/cm H2O.

Q14: The respiratory therapist should expect which of the following findings while ventilating a patient with acute respiratory distress syndrome (ARDS)?

A. An elevated plateau pressure (Pplat) (Correct)

B. A decreased elastic resistance

C. A low peak inspiratory pressure (PIP)

D. A large transairway pressure (PTA) gradient

Rationale: ARDS is a pathological condition that is associated with a reduction in lung compliance. The formula for static compliance (CS) utilizes the measured plateau pressure (Pplat) in its denominator (CS = VT /(Pplat - EEP). Therefore, with a consistent exhaled tidal volume (VT), an elevated Pplat will decrease CS.

Q15: The formula used for the calculation of static compliance (CS) is which of the following?

A. (Peak inspiratory pressure (PIP) - EEP)/tidal volume (VT)
B. (Plateau pressure (Pplat) - EEP)/tidal volume (VT)
C. Tidal volume/(plateau pressure - EEP) (Correct)
D. Tidal volume/(peak pressure (PIP) - plateau pressure (Pplat))

Rationale: CS = VT/(Pplat - EEP)

Q16: Plateau pressure (Pplat) is measured during which phase of the ventilatory cycle?

A. Inspiration
B. End-inspiration (Correct)
C. Expiration
D. End-expiration

Rationale: The calculation of compliance requires the measurement of the plateau pressure. This pressure measurement is made during no-flow conditions. The airway pressure (Pawo) is measured at end-inspiration. The inspiratory pressure is taken when the pressure reaches its maximum during a delivered mechanical breath. The pressure that occurs during expiration is a dynamic measurement and drops during expiration. The pressure reading at end-expiration is the baseline pressure; this reading is either at zero (atmospheric pressure) or at above atmospheric pressure (PEEP).

Q17: The condition that is associated with an increase in airway resistance is which of the following?

A. Pulmonary edema
B. Bronchospasm (Correct)
C. Fibrosis
D. Ascites

Rationale: Airway resistance is determined by the gas viscosity, gas density, tubing length, airway diameter, and the flow rate of the gas through the tubing. The two factors that are most often subject to change are the airway diameter and the flow rate of the gas. The flow rate of the gas during mechanical ventilation is controlled. Pulmonary edema is fluid accumulating in the alveoli and will cause a drop in the patient's lung compliance. Bronchospasm causes a narrowing of the airways and will, therefore, increase the airway resistance. Fibrosis causes an inability of the lungs to stretch, decreasing the patient's lung compliance. Ascites causes fluid buildup in the peritoneal cavity and increases tissue resistance, not airway resistance.

Q18: An increase in peak inspiratory pressure (PIP) without an increase in plateau pressure (Pplat) is associated with which of the following?

A. Increase in static compliance (CS)
B. Decrease in static compliance (CS)
C. Increase in airway resistance (Correct)

D. Decrease in airway resistance

Rationale: The PIP represents the amount of pressure needed to overcome both elastance and airway resistance. The Pplat is the amount of pressure required to overcome elastance alone. Since the Pplat has remained constant in this situation, the static compliance is unchanged. The difference between the PIP and the Pplat is the transairway pressure (PTA) and represents the pressure required to overcome the airway resistance. If PTA increases, the airway resistance is also increasing, when the gas flow rate remains the same.

Q19: The patient-ventilator data over the past few hours demonstrates an increased peak inspiratory pressure (PIP) with a constant transairway pressure (PTA). The respiratory therapist should conclude which of the following?

A. Static compliance (CS) has increased.
B. Static compliance (CS) has decreased. (Correct)
C. Airway resistance (Raw) has increased.
D. Airway resistance (Raw) has decreased.

Rationale: The PIP represents the amount of pressure needed to overcome both elastance and airway resistance. The Pplat is the amount of pressure required to overcome elastance alone, and is the pressure used to calculate the static compliance. Since PTA has stayed the same, it can be concluded that Raw has remained the same. Therefore, the reason the PIP has increased is because of an increase in the Pplat. This correlates to a decrease in CS.

Q20: Calculate airway resistance (Raw) for a ventilator patient, in cm H2O/L/sec, when the peak inspiratory pressure (PIP) is 50 cm H2O, the plateau pressure (Pplat) is 15 cm H2O, and the set flow rate is 60 L/min.

A. 0.58 Raw
B. 1.2 Raw
C. 35 Raw (Correct)
D. 50 Raw

Rationale: Raw = PTA/flow; or Raw = (PIP - Pplat)/flow

Q21: Calculate airway resistance (Raw) for a ventilator patient, in cm H2O/L/sec, with the following information: Peak inspiratory pressure (PIP) is 20 cm H2O, plateau pressure (Pplat) is 15 cm H2O, PEEP is 5 cm H2O, and set flow rate is 50 L/min.

A. 5 Raw
B. 6 Raw (Correct)
C. 10 Raw
D. 15 Raw

Rationale: Raw = (PIP - Pplat)/flow and flow is in L/sec.

Q22: Calculate the static compliance (CS), in mL/cm H2O, when PIP is 47 cm H2O, plateau pressure (Pplat) is 27 cm H2O, baseline pressure is 10 cm H2O, and exhaled tidal volume (VT) is

725 mL.

A. 43 CS (Correct)
B. 36 CS
C. 20 CS
D. 0.065 CS

Rationale: CS = VT/(Pplat - EEP)

Q23: Calculate the inspiratory time necessary to ensure 98% of the volume is delivered to a patient with a Cs = 40 mL/cm H2O and the Raw = 1 cm H2O/(L/sec).

A. 0.04 second
B. 0.16 second (Correct)
C. 1.6 second
D. 4.0 seconds

Rationale: Time constant = C (L/cm H2O) × R (cm H2O/(L/sec)). 98% of the volume will be delivered in 4 time constants. Therefore, multiply 4 times the time constant.

Q24: How many time constants are necessary for 95% of the tidal volume (VT) to be delivered from a mechanical ventilator?

A. 1
B. 2
C. 3 (Correct)
D. 4

Rationale: One time constant allows 63% of the volume to be inhaled; 2 time constants allow about 86% of the volume to be inhaled; 3 time constants allow about 95% to be inhaled; 4 time constants allow about 98% to be inhaled; and 5 time constants allow 100% to be inhaled.

Q25: Compute the inspiratory time necessary to ensure 100% of the volume is delivered to an intubated patient with a Cs = 60 mL/cm H2O and the Raw = 6 cm H2O/(L/sec).

A. 0.36 second
B. 0.5 second
C. 1.4 second
D. 1.8 second (Correct)

Rationale: Time constant (TC) = C (L/cm H2O) × R (cm H2O/(L/sec)). 100% of the volume will be delivered in 5 time constants. Therefore, multiply 5 times the time constant.

Q26: Evaluate the combinations of compliance and resistance and select the combination that will cause the lungs to fill fastest.

A. Cs = 0.1 L/cm H2O Raw = 1 cm H2O/(L/sec)
B. Cs = 0.1 L/cm H2O Raw = 10 cm H2O/(L/sec)

C. Cs = 0.03 L/cm H2O Raw = 1 cm H2O/(L/sec) (Correct)

D. Cs = 0.03 L/cm H2O Raw = 10 cm H2O/(L/sec)

Rationale: Use the time constant formula, TC = C × R, to determine the time constant for each choice. The time constant for answer A is 0.1 sec. The time constant for answer B is 1 sec. The time constant for answer C is 0.03 sec, and the time constant for answer D is 0.3 sec. The product of multiplying the time constant by 5 is the inspiratory time needed to deliver 100% of the volume.

Q27: The statement that describes the alveolus shown in Figure 1-1 is which of the following? [Image omitted] 1. Requires more time to fill than a normal alveolus. 2. Fills more quickly than a normal alveolus. 3. Requires more volume to fill than a normal alveolus. 4. More pressure is needed to achieve a normal volume.

A. 1 and 3 only

B. 2 and 4 only (Correct)

C. 2 and 3 only

D. 1, 3, and 4 only

Rationale: The figure shows a low-compliant unit, which has a short time constant. This means it takes less time to fill and empty and will require more pressure to achieve a normal volume. Lung units that require more time to fill are high-resistance units. Lung units that require more volume to fill than normal are high-compliance units.

Q28: Calculate the static compliance (CS), in mL/cm H2O, when PIP is 26 cm H2O, plateau pressure (Pplat) is 19 cm H2O, baseline pressure is 5 cm H2O, and exhaled tidal volume (VT) is 425 mL.

A. 16

B. 20

C. 22

D. 30 (Correct)

Rationale: CS = VT/(Pplat - EEP)

Q29: What type of ventilator increases transpulmonary pressure (PL) by mimicking the normal mechanism for inspiration?

A. Positive-pressure ventilation (PPV)

B. Negative-pressure ventilation (NPV)

C. High frequency oscillatory ventilation (HFOV)

D. High frequency positive-pressure ventilation (HFPPV) (Correct)

Rationale: Negative-pressure ventilation (NPV) attempts to mimic the function of the respiratory muscles to allow breathing through normal physiological mechanisms. Positive-pressure ventilation (PPV) pushes air into the lungs by increasing the alveolar pressure. High frequency oscillatory ventilation (HFOV) delivers very small volumes at very high rates in a "to-and-fro" motion by pushing the gas in and pulling it out during exhalation. High frequency positive-pressure ventilation (HFPPV) pushes in small volumes at high respiratory rates.

Q30: Air accidentally trapped in the lungs due to mechanical ventilation is known as which of the following?

A. Plateau pressure (Pplat)
B. Functional residual capacity (FRC)
C. Extrinsic positive end expiratory pressure (extrinsic PEEP)
D. Intrinsic positive end expiratory pressure (intrinsic PEEP) (Correct)

Rationale: The definition of intrinsic PEEP is air that is accidentally trapped in the lung. Another name for this is auto-PEEP. Extrinsic PEEP is the positive baseline pressure that is set by the operator. Functional residual capacity (FRC) is the sum of a patient's residual volume and expiratory reserve volume and is the amount of gas that normally remains in the lung after a quiet exhalation. The plateau pressure is the pressure measured in the lungs at no flow during an inspiratory hold maneuver.

Q31: The transairway pressure (PTA) shown in this figure is which of the following? [Image omitted]

A. 5 cm H2O
B. 10 cm H2O (Correct)
C. 20 cm H2O
D. 30 cm H2O

Rationale: PTA = PIP - Pplat, where the PIP is 30 cm H2O and the Pplat is 20 cm H2O. The PEEP is 5 cm H2O.

Q32: Use this figure to compute the static compliance (CS) for an intubated patient with an exhaled tidal volume (VT) of 500 mL. [Image omitted]

A. 14 mL/cm H2O
B. 20 mL/cm H2O
C. 33 mL/cm H2O
D. 50 mL/cm H2O (Correct)

Rationale: Cs = Pplat - EEP; the Pplat in the figure is 20 cm H2O and the PEEP is 10 cm H2O.

Q33: Evaluate the combinations of compliance and resistance and select the combination that will cause the lungs to empty slowest.

A. CS = 0.05 L/cm H2O Raw = 2 cm H2O/(L/sec)
B. CS = 0.05 L/cm H2O Raw = 6 cm H2O/(L/sec) (Correct)
C. CS = 0.03 L/cm H2O Raw = 5 cm H2O/(L/sec)
D. CS = 0.03 L/cm H2O Raw = 8 cm H2O/(L/sec)

Rationale: Use the time constant formula, TC = C × R, to determine the time constant for each choice. The combination with the longest time constant will empty the slowest. The time constant for A is 0.1 second, B is 0.3 second, C is 0.15 second, and D is 0.24 second. To find out how many

seconds for emptying, multiply the time constant by 5.

Q34: Use this figure to compute the static compliance for an intubated patient with an inspiratory flow rate set at 70 L/min. [Image omitted]

A. 0.2 cm H2O/(L/sec)
B. 11.7 cm H2O/(L/sec) (Correct)
C. 16.7 cm H2O/(L/sec)
D. 20 cm H2O/(L/sec)

Rationale: Use the graph to determine the PIP (34 cm H2O) and the Pplat (20 cm H2O). Convert the flow into L/sec (70 L/min/60 = 1.2 L/sec). Then, Raw = (PIP - Pplat)/flow.

Q35: The ventilator that functions most physiologically uses which of the following?

A. Open loop
B. Double circuit
C. Positive pressure
D. Negative pressure (Correct)

Rationale: Air is caused to flow into the lungs with a negative pressure ventilator because the ventilator generates a negative pressure at the body surface that is transmitted to the pleural space and then to the alveoli. The transpulmonary pressure becomes greater because the pleural pressure drops. This closely resembles how a normal spontaneous breath occurs.

Q36: 1 mm Hg =

A. 7.5 mm H2O
B. 1.30 atm
C. 1.36 cm H2O (Correct)
D. 1034 cm H2O

Rationale: 1 mm Hg = 1.36 cm H2O 1 kPa = 7.5 mm Hg 1 Torr = 1 mm Hg 1 atm = 760 mm Hg = 1034 cm H2O

Q37: Which of the following statements best defines elastance?

A. Ability of a structure to stretch.
B. Ability of a structure to return to its natural shape after stretching. (Correct)
C. Ability of a structure to stretch and remain in that position.
D. Ability of a structure to fill and empty during static conditions.

Rationale: The opposite of compliance, elastance is the tendency of a structure to return to its original form after being stretched or acted on by an outside force.

Q38: The term used to describe the opposition to movement offered by adjacent structures such as the lungs and their adjacent organs is which of the following?

A. Elastance

B. Compliance

C. Viscous resistance (Correct)

D. Distending pressure

Rationale: The elastance of a structure is the tendency of that structure to return to its original shape after being stretched. The more elastance a structure has, the more difficult it is to stretch. The compliance of a structure is the ease with which the structure distends or stretches. Compliance is the opposite of elastance. Viscous resistance is the opposition to movement offered by adjacent structures such as the lungs and their adjacent organs. Distending pressure is pressure required to maintain inflation, for example, alveolar distending pressure.

Q39: Using a sensor, where do current ICU mechanical ventilators measure airway pressure (PAW)?

A. At the patient's airway opening

B. By placing a specially designed balloon in the esophagus

C. Proximal to the expiratory valve (Correct)

D. Airway pressure cannot be measured

Rationale: During mechanical ventilation, proximal airway pressure is not typically measured at the airway opening due to accumulation of secretions and technical errors can alter sensor measurements. Current generation ICU mechanical ventilators measure airway pressure (Paw) using a sensor positioned proximal to the expiratory valve, which is closed during the inspiration.