

COMPREHENSIVE REVIEW TEST 2: RESPIRATORY EMERGENCIES AND MECHANICAL VENTILATION

1. A 62-year-old man with COPD presents with severe dyspnea. ABG shows pH 7.28, PaCO₂ 68 mmHg, PaO₂ 52 mmHg on room air. What type of respiratory failure is this?

- A. Type I hypoxemic respiratory failure
- B. Type II hypercapnic respiratory failure
- C. Type III perioperative respiratory failure
- D. Type IV shock-related respiratory failure

2. What is the primary mechanism of hypoxemia in ARDS?

- A. Hypoventilation
- B. Diffusion impairment
- C. Intrapulmonary shunt
- D. Decreased inspired oxygen concentration

3. According to the Berlin Definition, what PaO₂/FiO₂ ratio defines severe ARDS?

- A. 200-300 mmHg
- B. 100-200 mmHg
- C. Less than 100 mmHg
- D. Less than 150 mmHg

4. A patient on mechanical ventilation has peak pressure 38 cmH₂O and plateau pressure 18 cmH₂O. What does this pressure pattern indicate?

- A. Decreased lung compliance
- B. Increased airway resistance
- C. Auto-PEEP
- D. Pneumothorax

5. What is the target plateau pressure to prevent ventilator-induced lung injury?

- A. Less than 20 cmH₂O
- B. Less than 30 cmH₂O
- C. Less than 40 cmH₂O
- D. Less than 50 cmH₂O

6. A patient with ARDS is on FiO₂ 100% and PEEP 16 cmH₂O with SpO₂ 86%. What intervention is most likely to improve oxygenation?

- A. Increase tidal volume to 10 mL/kg
- B. Increase respiratory rate to 30
- C. Prone positioning
- D. Decrease PEEP to reduce barotrauma

7. What is the recommended tidal volume for lung-protective ventilation in ARDS?

- A. 4-6 mL/kg ideal body weight
- B. 6-8 mL/kg ideal body weight
- C. 8-10 mL/kg ideal body weight
- D. 10-12 mL/kg actual body weight

8. A patient with severe asthma is intubated and becomes hypotensive with bilateral diminished breath sounds. What is the most likely cause?

- A. Tension pneumothorax
- B. Cardiogenic shock
- C. Auto-PEEP and dynamic hyperinflation
- D. Anaphylaxis to medications

9. In volume-controlled ventilation, what happens when lung compliance decreases?

- A. Tidal volume decreases
- B. Peak airway pressure increases
- C. Respiratory rate increases automatically
- D. PEEP automatically adjusts

10. A patient is on BiPAP with IPAP 14 cmH₂O and EPAP 6 cmH₂O. What is the effective pressure support?

- A. 14 cmH₂O
- B. 6 cmH₂O
- C. 8 cmH₂O
- D. 20 cmH₂O

11. Which condition is an absolute contraindication to non-invasive positive pressure ventilation?

- A. COPD exacerbation
- B. Cardiogenic pulmonary edema
- C. Respiratory arrest

D. Hypercapnic respiratory failure

12. A mechanically ventilated patient develops sudden high peak pressures with absent breath sounds on the right. What is the most likely diagnosis?

A. Right mainstem intubation

B. Right pneumothorax

C. Mucus plugging

D. Bronchospasm

13. What is the primary purpose of PEEP in mechanical ventilation?

A. Increase tidal volume delivery

B. Prevent alveolar collapse and improve oxygenation

C. Decrease respiratory rate

D. Reduce work of breathing

14. During a spontaneous breathing trial, what RSBI value suggests readiness for extubation?

A. Greater than 150 breaths/min/L

B. Greater than 105 breaths/min/L

C. Less than 105 breaths/min/L

D. Less than 50 breaths/min/L

15. A patient with pneumonia has SpO₂ 82% on room air. ABG shows pH 7.50, PaCO₂ 26 mmHg, PaO₂ 54 mmHg. What is the acid-base disturbance?

A. Respiratory acidosis

B. Respiratory alkalosis

- C. Metabolic acidosis
- D. Metabolic alkalosis

16. What is the recommended initial FiO₂ when initiating mechanical ventilation?

- A. 21%
- B. 40%
- C. 100%
- D. Match pre-intubation oxygen level

17. A patient with ARDS has PaO₂ 55 mmHg on FiO₂ 100% and PEEP 20 cmH₂O. What is the P/F ratio?

- A. 55
- B. 100
- C. 275
- D. 550

18. Which pulmonary function finding is diagnostic of obstructive lung disease?

- A. FEV₁/FVC ratio greater than 0.80
- B. FEV₁/FVC ratio less than 0.70
- C. Decreased total lung capacity
- D. Decreased residual volume

19. A patient with COPD exacerbation is started on BiPAP. After 2 hours, pH improves from 7.25 to 7.32 and PaCO₂ drops from 75 to 58 mmHg. What is the appropriate action?

- A. Intubate for worsening respiratory failure
- B. Continue BiPAP as patient is improving

- C. Switch to high-flow nasal cannula
- D. Discontinue BiPAP and observe

20. What ventilator waveform finding indicates the presence of auto-PEEP?

- A. Expiratory flow returns to zero before next breath
- B. Expiratory flow does not return to zero before next breath
- C. Square wave inspiratory pattern
- D. Decelerating inspiratory flow pattern

21. A patient requires FiO₂ 80% to maintain adequate oxygenation. Which oxygen delivery device is most appropriate?

- A. Nasal cannula at 6 L/min
- B. Simple face mask at 10 L/min
- C. Venturi mask at 50%
- D. Non-rebreather mask at 15 L/min

22. What is the mechanism of action of surfactant in the lungs?

- A. Increases surface tension
- B. Decreases surface tension to prevent alveolar collapse
- C. Promotes mucus clearance
- D. Enhances gas diffusion

23. A patient on mechanical ventilation has auto-PEEP of 10 cmH₂O. What ventilator adjustment would help reduce this?

- A. Increase respiratory rate

- B. Increase tidal volume
- C. Decrease inspiratory flow rate
- D. Increase expiratory time

24. What is the driving pressure formula in mechanical ventilation?

- A. Peak pressure minus PEEP
- B. Plateau pressure minus PEEP
- C. Peak pressure minus plateau pressure
- D. Mean airway pressure minus PEEP

25. A patient with status asthmaticus has pH 7.15, PaCO₂ 80 mmHg, and is becoming obtunded. What is the most appropriate intervention?

- A. Increase bronchodilator frequency
- B. Start BiPAP
- C. Endotracheal intubation
- D. Administer sodium bicarbonate

26. Which mode of ventilation delivers a set pressure for a set inspiratory time?

- A. Volume-controlled ventilation
- B. Pressure-controlled ventilation
- C. Pressure support ventilation
- D. CPAP

27. A patient on volume-controlled ventilation has decreased exhaled tidal volume compared to set tidal volume. What is the most likely cause?

- A. Decreased lung compliance
- B. Circuit leak or cuff leak
- C. Increased airway resistance
- D. Auto-PEEP

28. What parameter is used to assess adequacy of ventilation?

- A. PaO₂
- B. PaCO₂
- C. SpO₂
- D. FiO₂

29. A 70-year-old patient with pneumonia develops hypoxemic respiratory failure. SpO₂ is 84% on 15 L non-rebreather. He is alert and cooperative. What is the most appropriate next step?

- A. Immediate intubation
- B. Trial of high-flow nasal cannula
- C. Continue non-rebreather and observe
- D. Comfort measures only

30. What is the significance of the rapid shallow breathing index (RSBI)?

- A. Predicts likelihood of developing ARDS
- B. Predicts readiness for extubation
- C. Determines optimal PEEP level
- D. Assesses bronchospasm severity

31. Which laboratory finding supports acute respiratory acidosis?

- A. pH 7.48, PaCO₂ 30 mmHg, HCO₃ 22 mEq/L
- B. pH 7.25, PaCO₂ 62 mmHg, HCO₃ 26 mEq/L
- C. pH 7.30, PaCO₂ 38 mmHg, HCO₃ 18 mEq/L
- D. pH 7.52, PaCO₂ 44 mmHg, HCO₃ 34 mEq/L

32. A patient with myasthenia gravis has progressive dyspnea with NIF of -18 cmH₂O and vital capacity 12 mL/kg. What is the appropriate action?

- A. Continue observation
- B. Start BiPAP
- C. Prepare for intubation
- D. Increase pyridostigmine dose

33. What is the effect of permissive hypercapnia in ARDS management?

- A. Harmful and should be avoided
- B. Allows lung-protective ventilation with lower tidal volumes
- C. Improves oxygenation directly
- D. Increases cardiac output

34. A mechanically ventilated patient develops fever, purulent secretions, and new infiltrate after 72 hours. What is the most likely diagnosis?

- A. Atelectasis
- B. Ventilator-associated pneumonia
- C. Pulmonary edema
- D. Pulmonary embolism

35. Which intervention is most effective for preventing ventilator-associated pneumonia?

- A. Routine endotracheal tube changes
- B. Head of bed elevation to 30-45 degrees
- C. Prophylactic antibiotics
- D. Daily chest X-rays

36. A patient with asthma has ABG showing pH 7.54, PaCO₂ 26 mmHg, PaO₂ 72 mmHg. What does this indicate about asthma severity?

- A. Severe attack requiring intubation
- B. Mild to moderate with hyperventilation
- C. Respiratory failure with CO₂ retention
- D. Normal finding in asthma

37. What is the most common complication of endotracheal intubation?

- A. Esophageal intubation
- B. Right mainstem bronchus intubation
- C. Vocal cord injury
- D. Tracheal stenosis

38. During pressure-controlled ventilation, lung compliance suddenly improves. What happens to tidal volume?

- A. Tidal volume decreases
- B. Tidal volume increases
- C. Tidal volume remains unchanged
- D. Respiratory rate increases

39. A patient with severe COPD has chronic ABG: pH 7.37, PaCO₂ 56 mmHg, HCO₃ 31 mEq/L. What does this represent?

- A. Acute respiratory acidosis
- B. Chronic compensated respiratory acidosis
- C. Metabolic alkalosis
- D. Normal ABG

40. What is the gold standard for confirming endotracheal tube placement?

- A. Chest X-ray
- B. Auscultation of bilateral breath sounds
- C. End-tidal CO₂ detection
- D. Visualization of tube passing through cords

41. A patient with severe ARDS is on optimal settings. What is the recommended duration for prone positioning per session?

- A. 4-6 hours
- B. 8-12 hours
- C. At least 16 hours
- D. 30-60 minutes

42. What is the normal A-a gradient for a young healthy adult on room air?

- A. Less than 15 mmHg
- B. 15-30 mmHg
- C. 30-45 mmHg
- D. Greater than 45 mmHg

43. A patient has PaO₂ 58 mmHg on FiO₂ 50%. Increasing FiO₂ to 100% raises PaO₂ to only 65 mmHg. What does this suggest?

- A. V/Q mismatch
- B. Hypoventilation
- C. Large intrapulmonary shunt
- D. Equipment malfunction

44. What is the effect of PEEP on preload?

- A. Increases preload
- B. Decreases preload
- C. No effect on preload
- D. Variable effect unrelated to pressure

45. A patient develops stridor and respiratory distress immediately after extubation. What is the most likely cause?

- A. Aspiration pneumonia
- B. Laryngeal edema
- C. Pneumothorax
- D. Pulmonary embolism

46. What is the primary benefit of pressure support ventilation during weaning?

- A. Guarantees minimum minute ventilation
- B. Overcomes ETT resistance and reduces work of breathing
- C. Provides full ventilatory support

D. Prevents atelectasis

47. A patient with cardiogenic pulmonary edema is placed on BiPAP. What is the expected hemodynamic effect?

- A. Increased preload and afterload
- B. Decreased preload and decreased afterload
- C. Increased preload and decreased afterload
- D. No hemodynamic effect

48. What percentage of inspired oxygen does a nasal cannula at 4 L/min approximately deliver?

- A. 24%
- B. 36%
- C. 50%
- D. 60%

49. A patient is being weaned from mechanical ventilation. Which finding indicates weaning failure?

- A. Respiratory rate of 18
- B. SpO₂ of 96%
- C. Paradoxical abdominal movement
- D. Stable blood pressure

50. What is the oxygen-hemoglobin dissociation curve shift that occurs with acidosis?

- A. Left shift increasing oxygen affinity
- B. Right shift decreasing oxygen affinity
- C. No change in the curve

D. Flattening of the curve

51. Which finding on chest X-ray is most consistent with ARDS?

A. Unilateral infiltrate

B. Bilateral diffuse opacities

C. Hyperinflation with flat diaphragms

D. Enlarged cardiac silhouette

52. A patient on AC ventilation has set rate of 12 but is triggering at 24 breaths/min. What is the delivered respiratory rate?

A. 12 breaths/min

B. 24 breaths/min

C. 18 breaths/min

D. 36 breaths/min

53. What is the recommended cuff pressure for an endotracheal tube?

A. 10-15 cmH₂O

B. 20-30 cmH₂O

C. 35-45 cmH₂O

D. 50-60 cmH₂O

54. A patient with COPD is on supplemental oxygen. Target SpO₂ should be:

A. 98-100%

B. 94-98%

C. 88-92%

D. 85-88%

55. What is the deadspace to tidal volume ratio (V_d/V_t) in a healthy adult?

A. 0.1-0.2

B. 0.3-0.4

C. 0.5-0.6

D. 0.7-0.8

56. A patient has plateau pressure 30 cmH₂O and PEEP 12 cmH₂O. What is the driving pressure?

A. 30 cmH₂O

B. 18 cmH₂O

C. 12 cmH₂O

D. 42 cmH₂O

57. Which respiratory failure pattern is characteristic of drug overdose?

A. Hypoxemia with elevated A-a gradient

B. Hypercapnia with normal A-a gradient

C. Isolated hypoxemia responsive to oxygen

D. Mixed respiratory and metabolic acidosis

58. What is the mechanism of oxygen toxicity in prolonged high F_iO_2 ?

A. Direct thermal injury

B. Free radical formation and oxidative stress

C. Surfactant overproduction

D. Bronchospasm

59. A patient with bilateral pulmonary infiltrates has BNP of 1400 pg/mL. What does this suggest?

- A. Confirms ARDS diagnosis
- B. Suggests cardiogenic component
- C. Excludes heart failure
- D. Indicates pulmonary embolism

60. A patient with severe ARDS has P/F ratio of 55 despite optimal conventional therapy. What rescue intervention should be considered?

- A. Increase tidal volume to 10 mL/kg
- B. Venovenous ECMO
- C. Decrease PEEP to 5 cmH₂O
- D. High-frequency jet ventilation only

Answer Key with Explanations

1. B - Type II (hypercapnic) respiratory failure is defined by elevated PaCO₂ >45 mmHg with respiratory acidosis. This patient has PaCO₂ 68 mmHg with pH 7.28, indicating ventilatory failure typical of COPD exacerbation where the patient cannot eliminate CO₂ adequately.
2. C - ARDS causes alveolar flooding with protein-rich edema, creating lung units that are perfused but not ventilated (shunt). Shunt physiology is characterized by hypoxemia that responds poorly to supplemental oxygen because blood bypasses functional alveoli entirely.
3. C - Berlin Definition classifies ARDS severity by P/F ratio with PEEP ≥5 cmH₂O: Mild (200-300), Moderate (100-200), Severe (<100). Severe ARDS has the highest mortality and may require rescue therapies like prone positioning or ECMO.
4. B - Large gap between peak and plateau pressure (>10 cmH₂O) indicates increased airway resistance. Peak pressure reflects both resistance and compliance, while plateau pressure reflects compliance only. Common causes include bronchospasm, secretions, or kinked ETT.
5. B - Plateau pressure should be maintained <30 cmH₂O to prevent alveolar overdistension and ventilator-induced lung injury. This is a cornerstone of lung-protective ventilation and is associated with improved survival in ARDS.
6. C - Prone positioning redistributes perfusion to better-ventilated dorsal lung regions, improving V/Q matching. The PROSEVA trial demonstrated mortality benefit in severe ARDS with prone positioning for ≥16 hours daily. It should be considered when P/F <150 despite optimized settings.
7. A - ARDSNet protocol recommends 4-6 mL/kg ideal body weight for lung-protective ventilation. Low tidal volumes reduce volutrauma and cyclic stretch injury. IBW is calculated from height, not actual weight, to avoid excessive volumes in obese patients.
8. C - Severe asthma causes air trapping and dynamic hyperinflation leading to auto-PEEP (intrinsic PEEP). This increases intrathoracic pressure, impedes venous return, and causes hypotension. Treatment includes disconnecting briefly to allow exhalation and reducing respiratory rate.

9. B - In volume-controlled ventilation, the ventilator delivers a set tidal volume regardless of lung mechanics. When compliance decreases (stiffer lungs), higher pressure is required to deliver the same volume, so peak airway pressure increases.

10. C - Pressure support in BiPAP equals IPAP minus EPAP. With IPAP 14 and EPAP 6, the pressure support is $14 - 6 = 8$ cmH₂O. EPAP provides the PEEP equivalent while the difference (pressure support) augments inspiratory effort.

11. C - Respiratory arrest is an absolute contraindication to NIV because the patient cannot protect their airway or initiate breaths. Other absolute contraindications include inability to protect airway, hemodynamic instability, and inability to fit mask properly.

12. B - Sudden high peak pressure with absent unilateral breath sounds suggests pneumothorax. Positive pressure ventilation can rapidly convert simple pneumothorax to tension. This is an emergency requiring immediate needle decompression followed by chest tube placement.

13. B - PEEP maintains positive pressure at end-expiration, preventing alveolar collapse (atelectasis), recruiting collapsed alveoli, and improving oxygenation by increasing functional residual capacity. It reduces intrapulmonary shunt by keeping alveoli open throughout the respiratory cycle.

14. C - RSBI (respiratory rate/tidal volume in liters) <105 predicts successful extubation with good sensitivity. Values >105 indicate rapid shallow breathing pattern suggesting respiratory muscle fatigue and higher risk of extubation failure.

15. B - Low PaCO₂ (26 mmHg) with elevated pH (7.50) indicates respiratory alkalosis. The patient is hyperventilating in response to hypoxemia, blowing off CO₂. This is a compensatory response commonly seen in pneumonia and other hypoxemic conditions.

16. C - Start with FiO₂ 100% upon intubation to ensure adequate oxygenation during the critical transition period. Then rapidly titrate down to the lowest FiO₂ maintaining SpO₂ $>92\%$ (or 88-92% in COPD) to minimize oxygen toxicity risk.

17. A - P/F ratio = PaO₂/FiO₂ = $55/1.0 = 55$. This indicates severe ARDS (<100) and qualifies for rescue therapies. The P/F ratio is calculated using FiO₂ as a decimal, so 100% oxygen = 1.0.

18. B - FEV1/FVC ratio <0.70 defines obstructive lung disease (COPD, asthma). Airflow limitation reduces FEV1 proportionally more than FVC. Restrictive diseases show reduced TLC with preserved or elevated FEV1/FVC ratio because both values decrease proportionally.

19. B - The ABG shows clear improvement: pH increased from 7.25 to 7.32, and PaCO₂ decreased from 75 to 58 mmHg. This indicates NIV is effectively augmenting ventilation. Continue current therapy and monitor closely; intubation is not indicated when patient is improving.

20. B - Auto-PEEP occurs when exhalation is incomplete before the next breath begins. On the flow-time waveform, expiratory flow fails to return to zero (baseline) before inspiration starts, indicating trapped gas and intrinsic PEEP.

21. D - Non-rebreather mask with reservoir at 15 L/min can deliver FiO₂ up to 80-90%. Nasal cannula delivers maximum ~44% at 6 L/min, simple mask up to 50%, and Venturi masks provide precise but lower concentrations. For high FiO₂ needs, non-rebreather or high-flow nasal cannula is required.

22. B - Surfactant decreases surface tension at the air-liquid interface in alveoli, preventing collapse at end-expiration according to LaPlace's law. Surfactant deficiency (as in ARDS or neonatal RDS) leads to atelectasis, decreased compliance, and impaired gas exchange.

23. D - Auto-PEEP results from incomplete exhalation. Increasing expiratory time allows more complete lung emptying. This can be achieved by decreasing respiratory rate, increasing inspiratory flow rate (shortening inspiratory time), or decreasing I:E ratio.

24. B - Driving pressure = Plateau pressure minus PEEP. It represents the pressure actually distending the alveoli during inspiration. Driving pressure <15 cmH₂O is associated with improved outcomes in ARDS and may be more important than absolute plateau pressure.

25. C - Severe respiratory acidosis (pH 7.15, PaCO₂ 80) with altered mental status indicates impending respiratory arrest requiring immediate intubation. The patient is fatiguing and cannot maintain adequate ventilation. BiPAP may be attempted in less severe cases but obtundation indicates need for definitive airway.

26. B - Pressure-controlled ventilation delivers a set inspiratory pressure for a set inspiratory time. Tidal volume varies based on lung compliance and resistance. This differs from pressure support ventilation, which is flow-cycled (ends when flow drops to a threshold).

27. B - In volume-controlled ventilation, the set volume should be delivered unless there's a leak. Discrepancy between set inspiratory and measured exhaled volume indicates a leak in the circuit, ETT cuff, or around the tube. Check cuff pressure and circuit connections.

28. B - PaCO₂ directly reflects alveolar ventilation adequacy. Elevated PaCO₂ indicates hypoventilation; low PaCO₂ indicates hyperventilation. PaO₂ and SpO₂ assess oxygenation, which is related but distinct from ventilation.

29. B - For hypoxemic respiratory failure in an alert, cooperative patient, a trial of high-flow nasal cannula (HFNC) is appropriate before intubation. HFNC provides high FiO₂, some PEEP effect, and may prevent intubation. Reserve immediate intubation for obtunded patients or those failing HFNC.

30. B - RSBI (respiratory rate divided by tidal volume in liters) predicts extubation readiness. It quantifies the rapid shallow breathing pattern that indicates respiratory muscle fatigue. RSBI <105 suggests adequate reserve for successful extubation.

31. B - Acute respiratory acidosis shows low pH with elevated PaCO₂ and normal or minimally elevated HCO₃ (no time for metabolic compensation). Option B shows pH 7.25, PaCO₂ 62, HCO₃ 26, indicating acute CO₂ retention with minimal renal compensation.

32. C - In neuromuscular disease, vital capacity <15-20 mL/kg or NIF weaker than -20 to -25 cmH₂O indicates impending respiratory failure requiring intubation. This patient has VC 12 mL/kg and NIF -18 cmH₂O, both below critical thresholds. Waiting risks respiratory arrest.

33. B - Permissive hypercapnia accepts elevated PaCO₂ (typically allowing pH >7.20) to maintain lung-protective low tidal volumes. This strategy reduces ventilator-induced lung injury and improves outcomes in ARDS. Contraindicated in elevated ICP and severe acidosis.

34. B - Fever, purulent secretions, and new infiltrate after >48 hours of mechanical ventilation define ventilator-associated pneumonia (VAP). Treatment requires broad-spectrum antibiotics covering hospital-acquired pathogens including Pseudomonas, MRSA, and gram-negatives.

35. B - Head of bed elevation to 30-45 degrees reduces aspiration of gastric and oropharyngeal secretions, a major VAP risk factor. This is a cornerstone of VAP prevention bundles along with oral care, sedation interruption, and daily SBT assessment.

36. B - Low PaCO₂ with respiratory alkalosis in asthma indicates hyperventilation, typical of mild-moderate exacerbations where the patient can compensate. A "normal" or rising PaCO₂ in acute asthma is ominous, suggesting fatigue and impending respiratory failure.

37. B - Right mainstem bronchus intubation is the most common intubation complication because the right bronchus has a more vertical angle and larger diameter. Signs include absent left breath sounds and left lung atelectasis. Confirm ETT position 2-4 cm above carina on chest X-ray.

38. B - In pressure-controlled ventilation, the ventilator delivers a set pressure. If compliance improves (lungs become easier to inflate), the same pressure delivers a larger tidal volume. This is opposite of volume-controlled modes where pressure changes with compliance.

39. B - Chronic compensated respiratory acidosis shows elevated PaCO₂ with metabolic compensation (elevated HCO₃) bringing pH toward normal. The kidneys retain bicarbonate over days to weeks. This represents the patient's baseline in chronic COPD, not an acute change.

40. C - End-tidal CO₂ detection (capnography or colorimetric detector) is the gold standard for confirming tracheal placement. Persistent ETCO₂ waveform confirms ventilation of lungs, not stomach. Chest X-ray confirms appropriate depth but doesn't distinguish tracheal from esophageal placement as quickly.

41. C - PROSEVA trial demonstrated mortality benefit with prone positioning for at least 16 consecutive hours daily in severe ARDS (P/F <150). Shorter durations have not shown the same survival benefit. Prone positioning improves V/Q matching and reduces VILI.

42. A - Normal A-a gradient is approximately $2.5 + (0.21 \times \text{age})$ mmHg, typically <15 mmHg in young adults. Elevated A-a gradient indicates V/Q mismatch, shunt, or diffusion impairment as the cause of hypoxemia rather than hypoventilation.

43. C - Poor response to increased FiO₂ (only 7 mmHg improvement despite doubling FiO₂) indicates shunt physiology. Blood passing through non-ventilated lung units doesn't contact alveolar oxygen regardless of FiO₂. V/Q mismatch typically shows better response to supplemental oxygen.

44. B - PEEP increases intrathoracic pressure, which impedes venous return to the right heart, thereby decreasing preload. This can cause hypotension, especially in hypovolemic patients or those with RV dysfunction. Consider fluid status when increasing PEEP.

45. B - Post-extubation stridor indicates upper airway obstruction, most commonly from laryngeal edema. Risk factors include prolonged intubation, large ETT, traumatic intubation, and female sex. Treatment includes nebulized racemic epinephrine and IV corticosteroids.

46. B - Pressure support augments patient-initiated breaths, helping overcome the resistance imposed by the endotracheal tube and ventilator circuit. This reduces inspiratory work of breathing and supports gradual weaning. Typical PS of 5-8 cmH₂O compensates for ETT resistance.

47. B - Positive pressure ventilation decreases preload by reducing venous return and decreases LV afterload by reducing transmural pressure (the pressure difference across the LV wall). Both effects are beneficial in cardiogenic pulmonary edema by unloading the failing heart.

48. B - Nasal cannula delivers approximately 24% FiO₂ at 1 L/min, increasing by about 4% per liter. At 4 L/min: $24 + (3 \times 4) = 36\%$. Actual FiO₂ varies with patient's respiratory pattern, minute ventilation, and mouth breathing.

49. C - Paradoxical (asynchronous) abdominal movement indicates diaphragmatic fatigue and impending respiratory failure. Normal breathing shows abdomen moving outward with inspiration. Paradoxical movement (abdomen moving inward) suggests accessory muscle use and diaphragm fatigue.

50. B - Acidosis causes a right shift of the oxyhemoglobin dissociation curve (Bohr effect), decreasing hemoglobin oxygen affinity and facilitating oxygen release to tissues. Other right-shift factors include hyperthermia, hypercapnia, and increased 2,3-DPG.

51. B - ARDS characteristically shows bilateral diffuse opacities on chest imaging not fully explained by effusions, collapse, or nodules. These represent diffuse alveolar damage with edema and inflammation. Unilateral infiltrate suggests pneumonia; hyperinflation suggests COPD.

52. B - In Assist-Control mode, every patient-triggered breath receives full ventilator support. If the patient triggers faster than the set rate, all triggered breaths are fully supported. The delivered rate equals the patient's actual triggered rate of 24 breaths/min.

53. B - ETT cuff pressure should be 20-30 cmH₂O. This is high enough to prevent aspiration and air leaks but low enough to prevent tracheal mucosal ischemia and subsequent stenosis. Pressures >30 cmH₂O exceed capillary perfusion pressure causing mucosal injury.

54. C - In COPD, target SpO₂ 88-92% to avoid suppressing hypoxic respiratory drive while adequately treating hypoxemia. Some COPD patients depend on hypoxic drive; excessive oxygen can cause hypoventilation and CO₂ retention (oxygen-induced hypercapnia).

55. B - Normal V_d/V_t is approximately 0.3-0.4 (30-40% of each breath ventilates deadspace). Elevated V_d/V_t (>0.5) indicates increased deadspace ventilation seen in pulmonary embolism, ARDS, and other conditions with V/Q mismatch. It's a poor prognostic indicator.

56. B - Driving pressure = Plateau pressure minus PEEP = 30 - 12 = 18 cmH₂O. Driving pressure represents the cyclic stretch applied to alveoli. Values <15 cmH₂O are associated with better outcomes in ARDS and should be targeted when possible.

57. B - Pure hypoventilation (drug overdose, neuromuscular disease) causes hypercapnia with normal A-a gradient because the lungs are intrinsically normal, only ventilation is inadequate. Hypoxemia in hypoventilation responds well to supplemental oxygen since there's no V/Q mismatch or shunt.

58. B - Prolonged exposure to high FiO₂ (>60% for >24-48 hours) generates reactive oxygen species (free radicals) causing oxidative damage to alveolar epithelium and endothelium. This can worsen lung injury and contribute to ARDS. Minimize FiO₂ to lowest level maintaining adequate oxygenation.

59. B - Elevated BNP (>400-500 pg/mL) suggests cardiac contribution to pulmonary edema. This doesn't exclude ARDS but indicates possible cardiogenic component requiring echocardiography. ARDS and cardiogenic edema can coexist; treatment should address both etiologies.

60. B - Venovenous ECMO should be considered for severe refractory ARDS (P/F <80) despite optimal conventional therapy including prone positioning. VV-ECMO provides gas exchange support while allowing "lung rest" with minimal ventilator settings, permitting lung recovery.