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Respiratory System

The following chapter will focus on the respiratory system. Pertinent questions, answers, and rationale will be reviewed. Answers for this chapter can be found beginning on page 101.

Key Words: Lungs; airway; ventilator; oxygen; pulmonary.

1. Which of the following is true regarding endotracheal intubation in infants and children?
 - a. The presence of a Murphy eye side hole provides absolute protection against obstruction of the endotracheal tube.
 - b. Tube obstruction in infants is as high as 30%.
 - c. Incidence of obstruction with small tubes is similar to the incidence with large tubes.
 - d. The endotracheal tube insertion guide is the channel on the straight blade.
 - e. Age is a more reliable determinant of endotracheal tube size than height.
2. The incidence of subglottic stenosis following intubation in children is approximately:
 - a. 5%.
 - b. 10%.
 - c. 15%.
 - d. 20%.
3. Predisposing risk factors for tracheal injury and subglottic stenosis following tracheal intubation include:
 - a. General medical condition of the patient.
 - b. Seizures.
 - c. Head position.
 - d. Endotracheal tube material.
 - e. All of the above.
4. Which of the following is true of postextubation croup?
 - a. Occurs in 50% of children.
 - b. Begins within 18 hours, peaks at 48 hours, and resolves by 5 days.
 - c. Less prevalent in patients with frequent coughing.
 - d. More prevalent in children 1–4 years of age who have undergone neck surgery.
 - e. All of the above.
5. Postextubation croup is most closely associated with which of the following?
 - a. Failure to lubricate the endotracheal tube prior to insertion.
 - b. Failure to use analgesic sprays.
 - c. Excess humidification.
 - d. History of upper respiratory infection prior to intubation.
 - e. Surgery within the neck area.
6. Which of the following is true of tracheostomy?
 - a. The highest complication rate occurs in infants.
 - b. A mortality rate of up to 3% has been reported.
 - c. Complications are higher with emergency tracheostomy compared with tracheostomy following endotracheal intubation.
 - d. Airway secretions are increased 24–48 hours following tracheostomy.
 - e. All of the above.
7. Acute postoperative complications of tracheostomy include:
 - a. Subcutaneous emphysema.
 - b. Pneumothorax.
 - c. Pneumomediastinum.
 - d. Increased airway secretions.
 - e. All of the above.
8. Immediate postoperative care of a child with a new tracheostomy includes:
 - a. Evaluation of a chest radiograph for tube position.
 - b. Evaluation for subcutaneous emphysema.
 - c. Monitoring for bleeding.
 - d. More frequent suctioning.
 - e. All of the above.

9. Which of the following is true pertaining to tracheostomy tubes?
 - a. Must measure 0.5 mm smaller in size than the previously used endotracheal tube.
 - b. Initial tracheostomy change may be done by the bedside nurse.
 - c. Cuffed tracheostomy tubes are not suitable for infants because of the small diameter of the airway.
 - d. All of the above.
10. A 9-year-old boy with a tracheostomy in place for 8 years is emergently transferred to the pediatric intensive care unit (ICU) because copious amounts of fresh blood had been noted coming out of the tracheostomy tube. Regarding the diagnosis and immediate intervention:
 - a. A cuffed tracheostomy tube must be passed and the cuff inflated immediately.
 - b. Erosion of the thyroid vein is the most likely diagnosis.
 - c. The patient should be intubated orally and the tracheostomy tube removed.
 - d. Tracheal granuloma is the most likely diagnosis.
 - e. All of the above.
11. A 3-year-old with a tracheostomy for two and a half years is being decannulated. Immediately following decannulation, he develops stridor and respiratory distress. Possible etiologies include all of the following except:
 - a. Tracheal stenosis or granulation tissue.
 - b. An obstructing flap of the posterior tracheal wall.
 - c. Fusion of vocal cords.
 - d. Temporary laryngeal abductor failure.
12. Which of the following is true regarding use of tracheostomy for a prolonged period of time?
 - a. The tracheostomy tube is placed above the narrowest portion of the airway in children.
 - b. The tracheostomy stoma frequently needs suture closure.
 - c. In infants, the tracheostomy tube is plugged prior to decannulation.
 - d. Bronchoscopy is often indicated prior to decannulation.
13. Select whether the following statements are true or false regarding a child with globe injury.
____ a. Apply the same principles of treatment for closed head injury.
____ b. Avoid succinyl choline because it increase intraocular pressure.
14. Contraindications to nasotracheal intubation include which of the following?
 - a. A platelet count of 18,000/mm³.
 - b. A prothrombin time of 18 seconds.
 - c. Fracture of the cribriform plate of the ethmoid bone.
 - d. All of the above.
15. Which of the following medication combinations is most appropriate for intubating a 5-year-old with a closed head injury who has a capillary refill of 5 seconds, and fractured right femur because of a crushing injury he sustained 5 hours ago?
 - a. Succinylcholine, thiopental, and lidocaine.
 - b. Ketamine, succinyl choline, and lidocaine.
 - c. Vecuronium, lidocaine, and low-dose thiopental.
 - d. Pancuronium, thiopental, and lidocaine.
16. A 2-year-old male with a history of vomiting and diarrhea for 2 days is admitted to the pediatric ICU from the emergency department. He appears very lethargic; pulse 195/min; blood pressure (BP) 60/palpable; and capillary refill is 6 seconds. In preparing for tracheal intubation, which of the following combinations of drugs is best?
 - a. Ketamine, vecuronium.
 - b. Thiopental, vecuronium.
 - c. Thiopental, pancuronium, and lidocaine.
 - d. Thiopental, succinyl choline.
17. The relationship between helium and the effect on airway resistance is best described by which of the following?
 - a. Helium–oxygen mixtures (HeliOx) have much lower viscosity than oxygen–nitrogen mixtures.
 - b. Use of oxyhood is highly recommended in children with croup.
 - c. To minimize airway resistance, helium must be mixed with carbon dioxide.
 - d. When HeliOx is administered through the ventilator direct volume measurements are necessary.
18. Acute pulmonary edema has been described in children with the relief of airway obstruction with which of the following?
 - a. Epiglottitis.
 - b. Laryngotracheobronchitis.
 - c. Laryngospasm.
 - d. Obstructed endotracheal tube.
 - e. All of the above.

19. Bronchopulmonary dysplasia occurs in association with which of the following conditions in the neonate?
 - a. Pulmonary hypoplasia.
 - b. Hyaline membrane disease.
 - c. Diaphragmatic hernia.
 - d. Tracheoesophageal fistula.
 - e. All of the above.
20. Risk factors for development of bronchopulmonary dysplasia (BPD) include:
 - a. Male sex.
 - b. White race.
 - c. Birth weight less than 750 g.
 - d. All of the above.
21. Factors that promote formation of pulmonary edema include all of the following except:
 - a. More negative pleural pressure.
 - b. Higher pulmonary blood flow.
 - c. Lower plasma protein.
 - d. More positive pleural pressure.
22. Infections likely to predispose the preterm infant to BPD include:
 - a. Group B streptococcal infection.
 - b. Ureaplasma urealyticum.
 - c. Respiratory syncytial virus infection soon after birth.
 - d. Cytomegalovirus infection.
 - e. All of the above.
23. Pulmonary interstitial emphysema promotes which of the following?
 - a. Pulmonary edema.
 - b. Hyperinflation.
 - c. Higher airway resistance.
 - d. Pneumoperitoneum, pneumopericardium, and subcutaneous emphysema.
 - e. All of the above.
24. The primary event in the development of pulmonary interstitial emphysema is:
 - a. Subcutaneous emphysema.
 - b. Increased airway resistance.
 - c. Impaired lymphatic drainage.
 - d. Epithelial necrosis.
25. Physiological changes unique to preterm infants with BPD that places them at higher risk for respiratory failure is least likely to include which of the following?
 - a. Low intercostal muscle activity during rapid eye movement sleep.
 - b. Disuse atrophy following prolonged mechanical ventilation.
 - c. A blunted arousal response to hypoxia.
 - d. Absence of the peripheral chemoreceptor response.
26. In infants with BPD, progressive pulmonary hypertension can lead to all of the following except:
 - a. Systemic to pulmonary anastomoses with intrapulmonary shunting.
 - b. Increased right ventricular preload.
 - c. Restriction of right coronary blood flow to diastole.
 - d. Subendocardial ischemia.
 - e. Restriction of blood flow through the right coronary artery to systole.
27. Which of the following is the most essential drug for infants with BPD?
 - a. Oxygen.
 - b. Morphine.
 - c. Acetylcholine.
 - d. Caffeine.
28. Side effects of aerosolized β_2 -agonist include all of the following except:
 - a. Tachycardia.
 - b. Hypokalemia.
 - c. Impaired mucociliary clearance.
 - d. Tremor.
 - e. Arrhythmia.
29. Which of the following statements is least accurate regarding use of bronchodilators and anti-inflammatory medications in infants with BPD?
 - a. Methylxanthines increase chemoreceptor sensitivity to CO_2 .
 - b. Cromolyn Na^+ , like methylxanthine, has anti-inflammatory effects.
 - c. Combination of ipratropium bromide and β_2 -agonist appears to have an antagonistic effect.
 - d. Improved mucociliary function is a recognized effect of β_2 -agonists.

30. Side effects of methylxanthines include all of the following except:
- Hyperglycemia.
 - Hypokalemia.
 - Hypothermia.
 - Agitation and seizures.
31. Which one of the following is the least likely effect of diuretics when used in patients with BPD?
- Improved pulmonary mechanics.
 - Improved survival.
 - Decreased pulmonary vascular resistance.
 - Improved lymphatic drainage from lungs.
32. Which of the following is true regarding use of furosemide in BPD?
- Chloride depletion induced by furosemide has been associated with poor outcome.
 - The hypokalemic metabolic alkalosis induced by furosemide can decrease minute ventilation leading to elevation of PCO_2 .
 - Furosemide is associated with renal calcification.
 - All of the above.
33. Advantages of tracheostomy for infants with bronchopulmonary dysplasia include:
- A stable, chronic access to airway.
 - A decrease in work of breathing
 - More freedom of mobility and physical therapy.
 - Pleasant oral stimulation, such as nipple.
 - All of the above.
34. Factors that contribute to decreased respiratory muscle capacity include:
- Respiratory acidosis.
 - Hyperinflation.
 - Disuse atrophy.
 - All of the above.
35. In infants with BPD, factors that may adversely lead to elevation of CO_2 include all of the following except:
- Agitation with patient ventilator asynchrony.
 - Fever.
 - Hyperalimentation with 68% carbohydrate.
 - Tracheostomy.
36. Increased dead space contributes significantly to work of breathing. In a setting of increased dead space, a small increase in CO_2 production may require significant increases in minute ventilation for adequate CO_2 elimination. The ratio of dead space to tidal volume can be improved by:
- Allowing patient's spontaneous respiratory rate to have a higher contribution to the total ventilatory support.
 - Use of pulmonary vasodilators.
 - Tracheostomy.
 - A and C only.
 - A, B, and C.
37. In infancy, congenital anomalies are the most common cause of death. The second most common cause of death in infancy is the result of disorders in:
- The cardiovascular system.
 - The respiratory system.
 - The central nervous system.
 - The gastrointestinal system.
 - The cardiovascular system.
38. Whenever lung disease leads to respiratory failure, the most common mechanism responsible for abnormal gas exchange is:
- Ventilation-perfusion mismatch.
 - Diffusion defect.
 - Alveolar hypoventilation.
 - Shunt.
39. A newborn diagnosed with a left-sided diaphragmatic hernia at the 22nd week of gestation underwent complete repair on the first day of life. He is on mechanical ventilation and recovering from surgery. In the ensuing several months, it is expected that:
- Progressive branching of airways will occur.
 - Progressive regression of airways will occur.
 - Airway branching will occur albeit very slowly over the next few years.
 - Postnatal branching of airways will not occur and left lung hypoplasia is irreversible.
 - The airway branching will continue in the left lung, but growth of the distal airway will lag behind the proximal airway in the first 5 years of life.
40. Developmental changes in lungs that predispose the infant to respiratory failure include all of the following except:
- Bronchial cartilage is incomplete and continues to increase in number for several months.
 - Growth of the distal airway lags behind growth of the proximal airway in the first 5 years of life.
 - The smaller alveolar size and number predisposes the infant to airway collapse.
 - Absence of pores of Kohn.
 - The presence of canals of Lambert.

41. Match the following with their correct associated description:

a. Pores of Kohn.	c. Both.
b. Canals of Lambert.	d. Neither.

_____ Appear in the second year of life.
 _____ Do not appear until the frontal sinuses start forming.

42. A 4-year-old (20 kg) child is breathing at a rate of 20 breaths per minute. The concentration of CO₂ in the alveolar gas is estimated to be 40 torr, whereas the concentration of CO₂ in the exhaled gas is estimated to be 30 torr. Assuming that the spontaneous tidal volume is 5 mL/kg, the total volume of the anatomic dead space is:
- a. 100 mL. d. 400 mL.
 b. 200 mL. e. 500 mL.
 c. 300 mL.

43. A 3-month-old with bronchiolitis is on mechanical ventilation for respiratory failure. The arterial PCO₂ is 55 mmHg, whereas the end tidal CO₂ on capnography that is attached to the end of the endotracheal tube is 35 mmHg. The infant is being ventilated with a tidal volume of approx 50 mL at a rate of 35 breaths per minute. The physiological dead space in this patient is:
- a. 235 mL. d. 725 mL.
 b. 345 mL. e. 125 mL.
 c. 636 mL.

44. The physiological dead space in this infant is:
- a. Normal.
 b. Slightly increased.
 c. Slightly decreased.
 d. Cannot be determined from this data.

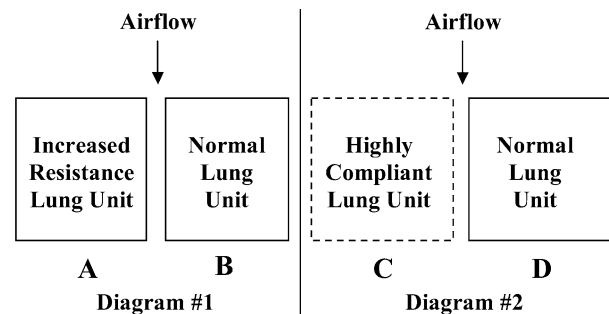
45. Infants have a very compliant chest wall and a reduced elastic recoil. Both of these factors lead to higher intrapleural pressure with subsequent collapse of airways and alveoli in dependent lung regions. However, functional residual capacity is maintained by:
- a. Expiratory braking.
 b. Grunting constantly.
 c. Increasing closing capacity.
 d. Increasing closing volume.

46. Regarding expiratory braking in infants, all of the following are true except:
- a. It is decreased during active sleep in premature infants.

- b. It is increased during active sleep in premature infants.
 c. Absence of expiratory braking in premature infants during active sleep exacerbates loss of O₂ stores during apnea.
 d. Abolished by anesthesia.

47. Regarding respiratory physiology, which one of the following statements is least accurate?
- a. With laminar flow, resistance to flow is proportional to viscosity.
 b. With turbulent flow, resistance to flow is proportional to density.
 c. Specific compliance is the same for adults and children, but specific conductance is higher in children.
 d. Peripheral airway resistance in children less than 5 years old is fourfold higher than in older children or adults.

48. The diagrams below schematically represent two compartment lung units. If inflation were interrupted prematurely in these examples:

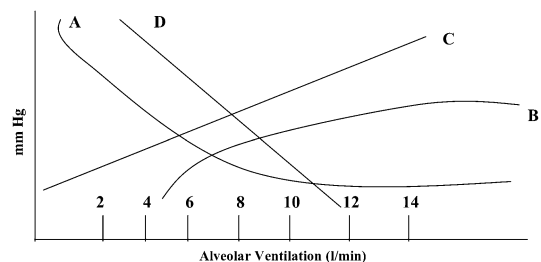


- a. Units A and C will have higher volumes of gas.
 b. Units D and B will contain higher volumes of gas.
 c. Units A and C are considered fast units.
 d. The pressure within C will be higher than in D.
49. Regarding developmental changes of pulmonary blood flow and lung development, all of the following are true except:
- a. Pulmonary blood flow plays a significant role in the growth of lungs.
 b. Diaphragmatic hernias adversely affect airway and alveolar development, but not pulmonary vascular development.
 c. In the newborn, muscular arteries end at the level of terminal bronchioles.
 d. The onset of congestive heart failure from left to right shunt occurs earlier in the premature than the full-term infant.

50. With regard to pulmonary circulation in infants and children, which one of the following statements is least accurate?
- The hypoxic pulmonary vasoconstriction response is more dramatic in infants than in the older child.
 - During hypoxic pulmonary vasoconstriction, driving pressure increases much more than flow in the whole lung.
 - Regional hypoxic pulmonary vasoconstriction increases pulmonary vascular resistance dramatically.
 - Newborns who live at high altitudes have persistent right ventricular hypertrophy.
51. Examples of “shunt” include which of the following?
- Cyanotic congenital heart disease.
 - Bronchial circulation.
 - Thebesian circulation.
 - Blood flow through completely atelectatic lung segments.
 - All of the above.
52. The alveolar air equation, $PaO_2 = PIO_2 - PaCO_2/R$, does not make which one of the following assumptions?
- There is no inert gas exchange.
 - There is no difference in inspired and expired gas volume.
 - Normally, more O_2 is consumed than CO_2 is produced.
 - Normally, the amount of O_2 consumed and CO_2 produced are the same.
53. Regarding the oxygen cascade and oxygen transport, all of the following statements are true except:
- If the percentage of shunt (QS/QT) is close to zero, the response to increasing FiO_2 is linear.
 - An increase in FiO_2 will have a negligible effect on PaO_2 with a QS/QT of 50%.
 - If cardiac output falls while O_2 consumption (VO_2) remains constant, then mixed venous content must fall.
 - If VO_2 rises for a constant cardiac output, mixed venous O_2 content will increase.
54. The normal newborn exhibits a lower PaO_2 than an adult. The mechanism that contributes least to this phenomenon is:
- A right-to-left shunt through the foramen ovale.
 - A right-to-left shunt through the patent ductus arteriosus.
 - Shunting caused by atelectatic areas of the lungs.
 - Low ventilation/perfusion (V/Q) segments.
55. The alveolar capillary membrane is the physical barrier that separates alveolar gas from pulmonary capillary blood and thus acts as a gaseous diffusion barrier and a fluid transfer barrier. All of the following statements describing this barrier are true except:
- Diffusion block is rarely, if ever, the sole cause of significant hypoxemia.
 - Diffusion is measured by diffusing capacity.
 - In practice, diffusing capacity is measured by using the diffusing capacity for carbon monoxide instead of oxygen.
 - Transfer factor refers to diffusing capacity in relation to alveolar ventilation.
 - Transfer factor increases with age.
56. The type of hemoglobin (Hb) and the position of the O_2 -Hb dissociation curve play a significant role in O_2 delivery (DO_2) to tissues. All of the following statements are true regarding this topic except:
- 2,3-Diphosphoglycerate (DPG) lowers the affinity of Hb for O_2 by binding to the β -chain of Hb.
 - The interaction of 2,3-DPG and the γ -chain does not lower O_2 -Hb affinity as much as the interaction of DPG with the β -chain.
 - Hb-S has a lower P_{50} than Hb-A.
 - The iron in Hb-F is more resistant to oxidation than the iron in Hb-A.
57. Newborns are particularly susceptible to methemoglobinemia following exposure to nitrates because:
- Of their smaller size.
 - Iron in Hb-F is less readily oxidized.
 - Of exposure to city water at such an early age.
 - Of the relative deficiency in the enzyme methemoglobin reductase.
58. Regarding DO_2 to and VO_2 by tissues, which of the following least accurately describes these two processes?
- A normal DO_2 with a resultant normal mixed venous O_2 content does not guarantee adequate tissue oxygenation.
 - In the newborn, if environmental temperature drops from $33^\circ C$ to $31^\circ C$, O_2 consumption doubles.

- c. The normal O_2 extraction is 0.25.
 - d. Resting VO_2 in a 1-week-old is approximately half of that for an adult based on kilograms of body weight.
 - e. Electron transfer requires a minimum of 1 mmHg of O_2 for the mitochondria to properly utilize O_2 .
59. Mixed venous PO_2 is least dependent on which of the following factors?
- a. DO_2 .
 - b. Circulatory distribution.
 - c. Inferior vena cava pressure.
 - d. P_{50} .
 - e. VO_2 .
60. Which of the following options is not true with regard to neural and humoral control of respirations?
- a. Carotid bodies respond to falling PaO_2 in an exponential fashion.
 - b. Peripheral chemoreceptors respond to falling SAO_2 in an exponential fashion.
 - c. Central chemoreceptors respond to increasing $PaCO_2$ in a linear fashion.
 - d. Hypoxia increases the slope of the minute ventilation curve in response to increasing CO_2 .
61. There are a number of pulmonary receptors that modulate breathing. All of the following statements pertaining to this are true except:
- a. Chemical or mechanical stimulation of the oropharynx leads to apnea and bradycardia.
 - b. Stimulation of laryngeal receptors produces cough and wheezing in experimental animals.
 - c. Excess interstitial fluid results in bradycardia, hypotension, and even apnea via stimulation of juxtacapillary receptors.
 - d. Laryngeal and bronchial receptors respond to CO_2 in an exponential fashion.
62. The resting $PaCO_2$ in the neonate is 33–34 torr as opposed to 40 torr in the older child or adult. Which one of the following statements least accurately explains the reason for this phenomenon?
- a. The O_2 demand for the young infant is double of that for the adult based on a kilogram per kilogram of body weight basis.
 - b. Lower CO_2 is the result of higher minute ventilation required to meet the increased O_2 demand.
 - c. The CO_2 response curve is shifted to the left.
 - d. The CO_2 response curve is shifted to the right.
63. Chemical and neural control of respirations in the preterm infant differ from that of the full-term infant. All of the following statements are true except:
- a. In preterm infants with periodic breathing, the CO_2 response curve is shifted to the right.
 - b. The $PaCO_2$ is closer to 40 torr as in adults.
 - c. The CO_2 response is flatter than in the term infant.
 - d. Premature infants do not have carotid bodies.
64. In children, the reason for the progressive reduction in total respiratory system compliance from birth until middle childhood is:
- a. Individual variations of the operator performing the test.
 - b. A progressive reduction in lung compliance with age.
 - c. A progressive increase in airway resistance with age.
 - d. A progressive reduction in chest wall compliance with age.
 - e. None of the above.
65. The majority of tidal breathing in the infant takes place in the range of closing capacity. Which of the following statements pertaining to this phenomenon is true?
- a. This increases the risk of atelectasis.
 - b. This is because of the very low elastic recoil pressure of the newborn chest wall.
 - c. Closing capacity refers to the volume of the lung below the functional residual capacity at which the alveoli and airways in the dependent regions of the lung close.
 - d. All of the above.
66. The highly compliant chest wall of the infant:
- a. Means that the infant must generate more pressure and perform more work to move the same tidal volume.
 - b. Is clinically manifested as retractions.
 - c. Is responsible for respiratory muscle fatigue and ultimate apnea, with any respiratory distress.
 - d. All of the above.

67. When infants are confronted with the need to increase work of breathing because of underlying pulmonary disease, a certain percentage of them will fatigue and ultimately develop apnea. Which of the following is a contributing factor?
- Functional residual capacity is much greater than closing capacity in infants.
 - The small tidal volume in infants.
 - The highly compliant chest wall.
 - The CO_2 response curve of infants is shifted to the right.
68. Infants and newborns are more susceptible to diaphragmatic muscle fatigue because:
- Closing volume is lower than in adults.
 - Of smaller residual volume.
 - Of abundant sarcoplasmic reticulum in the muscle fibers of the diaphragm.
 - Of the long contraction–relaxation time of diaphragmatic muscle fibers.
69. In the face of prolonged respiratory distress, some infants develop fatigue and apnea. The reasons for this phenomenon include all of the following except:
- These infants are unable to recruit intercostal muscle activity.
 - Rapid chest wall distortion with respiratory distress prematurely terminates inspiration.
 - The young infant cannot compensate for this respiratory load during active sleep.
 - The short contraction–relaxation time of the respiratory muscles.
70. Which of the following statements inaccurately describes apnea in infants and children?
- Premature infants less than 60 weeks conception are at risk of life-threatening apnea following general anesthesia.
 - Aminophylline helps apnea by significantly altering the pH and PaCO_2 around the respiratory center.
 - The association between apnea and gastroesophageal reflux is well accepted.
 - Children with obstructive sleep apnea because of adenotonsillar hypertrophy, may have deranged central control of respiration postoperatively as a result of increased opioid activity in the cerebrospinal fluid.
71. Cervical spine injury below C5 in an infant will not result in:
- Ineffective cough.
 - Chest wall retraction with each contraction of the diaphragm.
 - Mucus plugging.
 - Respiratory failure.
 - Decreased work of breathing.
72. Unilateral phrenic nerve paralysis is clinically more significant in infants and young children compared with adults because of all of the following except:
- Hemidiaphragmatic paralysis in this age group is equivalent to massive flail chest in an adult.
 - The excessively compliant chest wall of the young child.
 - The poor ability of intercostal muscles to stabilize the chest wall in the young infant.
 - Less compliant chest wall of the young child.
 - With inspiration, the ipsilateral intercostal muscles and the paralyzed diaphragm are sucked in.
73. Airway resistance would appear to be the most direct measurement of airway obstruction. It is not used as frequently as tests of forced expiration in children because:
- It requires use of plethysmography.
 - It is not as accurate as forced expiratory volume in 1 second.
 - Physiologically important changes in pulmonary airways can be obscured by less important changes in the upper airway which may be responsible for 50% of airway resistance.
 - None of the above.
74. Match the statements to the curves in the figure below.



- Alveolar PO_2
 — Arterial PCO_2

75. Which of the following does not increase the likelihood of having West “Zone 1” in the lungs?
- Mechanical positive pressure ventilation with hyperinflation.
 - A pulmonary artery occlusion pressure of 22 mmHg.
 - Pulmonary embolism.
 - A capillary refill of 6 seconds in the lower extremity.

76. Regarding West “Zone 4” of the lung, which of the following is true?
- Blood flow in this zone is regulated by the gradient between pulmonary artery pressure and pulmonary venous pressure.
 - Blood flow in this zone is regulated by the gradient between pulmonary artery pressure and alveolar pressure.
 - Transduction of fluid across the capillary barrier exceeds the rate of lymphatic drainage from the lungs.
 - Zone 4 blood flow exceeds Zone 3 blood flow.

77. In the pulmonary circulation, active vasoconstriction occurs when:
- Cardiac output decreases and pulmonary artery pressure increases or remains constant.
 - Cardiac output increases and pulmonary artery pressure is constant.
 - Cardiac output decreases and pulmonary artery pressure decreases.
 - All of the above.

78. Match the statements with their correct associated outcome.

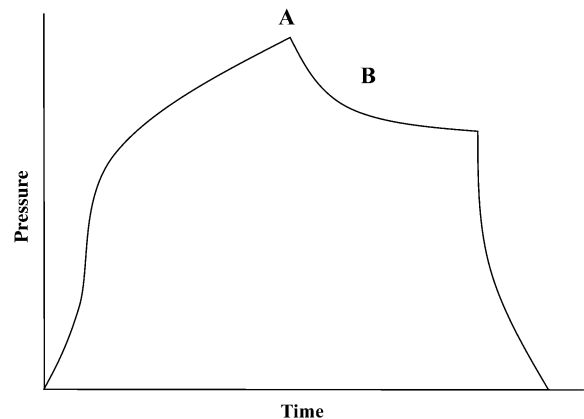
- Generalized hypoxic pulmonary vasoconstriction.
- Regional hypoxic pulmonary vasoconstriction.
- Both.
- Neither.

- ___ Result(s) in elevation of pulmonary artery pressure.
- ___ Protective mechanism(s) for the host.

79. Compliance is the relationship between changes in volume (ΔV) for a given change in the distending pressure (ΔP). Regarding this relationship, all of the following statements are true except:

- Compliance of the lungs is determined by DV and the difference between alveolar pressure and pleural pressure.
- Compliance of the chest wall is determined by ΔV and the difference between alveolar pressure and ambient pressure.
- Compliance of the total respiratory system is determined by ΔV and the difference between alveolar pressure and the ambient pressure.
- Chest wall compliance is the ΔV divided by the difference between pleural pressure and the ambient pressure.

80. Conditions associated with decreased total respiratory system compliance as a result of increased elastic recoil of the lungs include all of the following except:
- Adult respiratory distress syndrome (ARDS).
 - Pneumocystis carinii pneumonia.
 - Pulmonary edema caused by severe mitral stenosis with circulatory failure.
 - Near-drowning.
 - Bronchiolitis.



81. The above diagram relates the transthoracic pressure to time during a positive pressure inspiration. Which one of the following statements pertaining to Fig. 3 is least accurate?
- The decrease in pressure from A to B is because of the redistribution of gas into more compliant alveoli.
 - This diagram indicates that dynamic compliance is greater than static compliance.
 - The diagram indicates that static compliance is greater than dynamic compliance.
 - A and C are true statements.

82. Conditions associated with decreased total respiratory system compliance include all of the following except:
- Thermal injury of the lower respiratory tract.
 - Erect posture.
 - Atelectasis.
 - Abdominal distention.
 - High peak end-expiratory pressure (PEEP).
83. All of the following statements about airway resistance in children are true except:
- Airway resistance accounts for less than 50% of total nonelastic resistance.
 - With laminar flow, the pressure drop down the airway is proportional to the flow rate.
 - With turbulent flow, the pressure drop down the airway is proportional to the square of the flow rate.
 - Peripheral airways account for 50% of total airway resistance in children younger than 5 years.
 - Airway resistance increases with increased flow and decreased functional residual capacity.
84. The time constant (t) describes the time required for the lung compartments to achieve a change in volume following the application or withdrawal of a constant distending pressure and is the product of compliance and resistance. Regarding this concept, which of the following statements is most accurate?
- t is expressed in terms of flow in liters per second.
 - When a constant pressure is applied to the mouth, the component overcoming air flow resistance is maximal at first and declines exponentially.
 - When a constant pressure is applied to the mouth the pressure required to overcome compliance is maximal initially and decreases exponentially.
 - Mathematically, 63% of lung inflation or deflation occurs within $3t$.
85. An 8-year-old male with posttraumatic ARDS is being ventilated with a pressure limited “mode” of ventilation with an inspiratory time of 1 second, synchronized intermittent mandatory ventilation of 20 bpm, peak inspiratory pressure (PIP) of 30 cm H₂O, and PEEP of 8 cm H₂O. The chest radiograph has shown significant improvement over the past 24 hours, and FiO₂ has been decreased from 0.7 to 0.55. Failure to decrease the inspiratory time may result in all of the following except:
- Decreased venous return.
 - Decreased physiological dead space.
 - Auto PEEP.
 - Pneumomediastinum.
86. Closing capacity is the sum of residual volume and closing volume. An increase in closing capacity leads to a situation where lung volume is reduced so far below functional residual capacity that small alveoli and airways in the dependent regions of the lungs are closed. Which of the following conditions is least likely to lead to elevation of closing capacity?
- Infancy.
 - Bronchiolitis.
 - Cystic fibrosis.
 - Asthma.
 - Pulmonary edema
87. In conditions associated with increased closing capacity, the most appropriate therapeutic intervention includes:
- Increase residual volume.
 - Control pulmonary secretions and use of bronchodilators.
 - Use of continuous positive airway pressure (CPAP).
 - Use of PEEP when on mechanical ventilation.
88. The V/Q ratio remains stable as one moves from the base of the lung up to the third rib, but then as one moves toward the apex, the V/Q ratio changes exponentially because:
- Blood flow falls more rapidly than ventilation with distance up the lung.
 - Ventilation increases more rapidly down the lungs than perfusion.
 - Both ventilation and perfusion increase exponentially down the lungs.
 - Ventilation decreases linearly but perfusion exponentially down the lungs.
89. Which of the following statements is most accurate regarding the compliance and resistance of the ventilatory circuits and their interaction with the patient?
- If the compliance of the ventilator circuit and the patient are equal, adequate delivery of tidal volume to the patient is assured.
 - Large circuit compliance leads to delay in the delivery of an assisted breath.
 - Use of rigid short tubing aggravates loss of tidal volume.

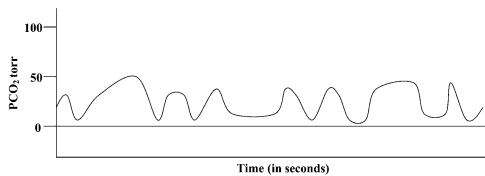
- d. Distribution of volume delivered by a positive pressure ventilator between the ventilator circuit and the patient is determined entirely by the patient's respiratory compliance and resistance.
90. Modifications of ventilator circuiting for pediatric mechanical ventilators, in order to substantially reduce the ventilator system compliance, include all of the following except:
- Small diameter circuit tubing.
 - Rigid tubing with inspiratory circuit as short as possible.
 - Decreasing humidifier size.
 - Positioning of exhalation valve away from the airway opening.
 - Maintaining humidifier fluid level.
91. The most common clinical application of hyperbaric oxygen therapy is:
- Carbon monoxide poisoning.
 - Decompression sickness.
 - Gas embolism.
 - Radiation necrosis.
 - Crush injury.
92. Use of hyperbaric O₂ therapy for CO poisoning is probably the most common application of this technology. All of the following statements regarding this application are true except:
- The beneficial effect of hyperbaric O₂ therapy is directly related to the associated increase in PaO₂.
 - The half-life of CO as measured by carboxyhemoglobin (HbCO) is decreased to 53 minutes at 3 atmospheric pressure (atm).
 - Hyperbaric O₂ therapy helps reverse binding of carbon monoxide to cytochrome α_3 .
 - Hyperbaric O₂ therapy is indicated in patients who suffer unconsciousness or display signs of central nervous system depression.
93. The least likely complication of hyperbaric oxygen therapy is:
- Tympanic membrane perforation.
 - Pneumomediastinum.
 - Fire and ignition accidents.
 - Significant central nervous system toxicity at 2.5 atm pressure.
94. Helium is a low-density gas that, when used in combination with oxygen, has proven particularly useful. All of the following statements are true except:
- The use of HeliOx is less dense than air.
 - HeliOx may improve gas exchange and decrease peak inspiratory pressure in asthmatics requiring ventilatory support.
 - In children with large airway obstruction HeliOx improves alveolar oxygen component.
 - HeliOx decreases work of breathing.
 - HeliOx can not be used in patients whose airway has been instrumented.
95. A 6-kg infant with pneumonia is being ventilated with conventional mechanical ventilation at a rate of 35 bpm on an FiO₂ of 0.6. The PIP is 32 cm H₂O and PEEP is 6 cm H₂O. The inspiratory time is set at 0.5 seconds and the flow of gas through the ventilator circuit is set at 8 L/minute. The approximate tidal volume is:
- 11 mL/kg.
 - 5 mL/kg.
 - 7 mL/kg.
 - 9 mL/kg.
 - None of the above.
96. Most of gas exchange during mechanical ventilation with a normal inspiration:exhalation ratio occurs during:
- Inspiration.
 - The inspiratory plateau.
 - Exhalation.
 - Gas exchange is uniform throughout the respiratory cycle.
97. Time-limited, constant-flow ventilators are one category of ventilators that are sometimes used in the pediatric ICU. True statements pertaining to this category of ventilators include all of the following except:
- Use is restricted to the asynchronous mode.
 - Tidal volume can only be estimated.
 - Inspiratory flow limits of these ventilators do not provide adequate flow for patients weighing in excess of 15 kg.
 - The peak inspiratory pressure relief valve is housed in the inspiratory circuit in these ventilators.
98. In the assist-control mode of mechanical ventilation:
- A preset tidal volume is delivered in response to every patient-initiated effort.
 - The patient must perform inspiratory work to open the inspiratory valve and initiate each tidal volume.

- c. Ventilator trigger sensitivity and peak inspiratory flow are controlled by the operator.
 - d. Ventilator peak inspiratory flow and trigger sensitivity affect work of breathing.
 - e. All of the above.
99. Intermittent mandatory ventilation allows spontaneous breathing between positive pressure breaths with a preset tidal volume and frequency. Which one of the following statements least accurately describes intermittent mandatory ventilation?
- a. To minimize work of breathing, the inspiratory gas flow in continuous flow circuit should not exceed the patient's own peak inspiratory flow rate.
 - b. A flow-by system avoids problems associated with continuous flow and demand flow systems in terms of work of breathing.
 - c. Intermittent mandatory ventilation is likely to be associated with more stable hemodynamics compared with continuous mandatory ventilation.
 - d. Intermittent mandatory ventilation is more likely to be associated with improved V/Q matching compared with continuous mandatory ventilation.
 - e. The need for frequent administration of sedatives and/or muscle relaxants seems to be decreased by using intermittent mandatory ventilation compared with continuous mandatory ventilation.
100. In describing pressure support ventilation, which one of the following options is least accurate?
- a. The ventilator retains control of the cycle length, as well as the depth and flow characteristics.
 - b. It has been shown to abolish diaphragmatic muscle fatigue in patients who fail conventional weaning attempts.
 - c. Pressure support ventilation helps compensate for work of breathing owing to the inspiratory demand valve and endotracheal tube impedance.
 - d. Patient effort, length of pressure support, and the respiratory system impedance determine the tidal volume.
101. Inverse-ratio ventilation is performed using:
- a. Pressure-limited breaths with decelerating inspiratory flow rates and adjustment of inspiratory time to the desired level.
 - b. Volume-limited breaths with low inspiratory flow rates to achieve the desired inspiratory time.
 - c. Volume-limited breaths with normal inspiratory flow rate and prolonged inspiratory pause to maintain a prolonged inspiratory phase.
 - d. All of the above.
102. During pressure-control, inverse-ratio ventilation, tidal volume is a function of:
- a. Respiratory system compliance and resistance.
 - b. The preset pressure limit.
 - c. The ratio of inspiratory time to total duty cycle.
 - d. Frequency.
 - e. All of the above.
103. Positive pressure ventilatory support in the setting of respiratory failure is aimed at elevating the functional residual capacity or mean lung volume through the application of CPAP or PEEP. Appropriate statements pertaining to this application include all of the following except:
- a. Application of appropriate levels of PEEP/CPAP can decrease work of breathing.
 - b. High levels of PEEP have the potential to increase work of breathing.
 - c. The decrease in DO_2 associated with high levels of PEEP is often resistant to fluid resuscitation and inotropic support.
 - d. In the absence of pulmonary artery catheter, PEEP should be gradually increased to maintain an A-a gradient less than 250 torr with adequate perfusion.
 - e. As a general rule, a pulmonary artery catheter is recommended to monitor cardiac output when PEEP of greater than 15 cm is used.
104. When deciding to discharge a patient who is ventilator-dependent, the least important factor to consider is:
- a. Presence of an established tracheostomy with healed stoma.
 - b. PaO_2 greater than 60 torr with FiO_2 less than 0.3 and PaCO_2 less than 50 torr using home ventilatory settings.
 - c. No need for PEEP.
 - d. The underlying disease.
 - e. Stable ventilatory settings for 1 month.
105. Adverse hemodynamic effects of PEEP are related to:
- a. Decreased venous return.
 - b. Ventricular interdependence.
 - c. Increased residual volume.

- d. Reflex neurohormonal factors leading to ventricular dysfunction.
e. All of the above.
106. Barotrauma is a recognized complication of mechanical ventilatory support and has a number of clinical manifestations. Which of the following is always considered clinically significant?
a. Pulmonary interstitial emphysema.
b. Pneumomediastinum.
c. Subcutaneous emphysema.
d. Pneumoperitoneum.
e. None of the above.
107. Tension pneumothorax is a life-threatening complication of trauma or positive pressure ventilation that requires immediate intervention. All of the following statements are true except:
a. Tension pneumothorax occurs when a communication exists between the pleural space and either the alveoli or the atmosphere, so that air enters the pleural space during inspiration, but is unable to exit during exhalation.
b. Tension pneumothorax occurs when intrapleural pressure continues to remain subatmospheric.
c. Obstruction of venous return occurs.
d. Treatment is by closed chest thoracotomy tube.
108. Features of veno-venous extracorporeal life support include all of the following except:
a. It depends on patient's native heart for DO_2 to tissue.
b. Usually requires lower extracorporeal flow.
c. It reduces the risk of embolization with an intact heart.
d. It maintains well-oxygenated pulmonary blood flow.
e. It requires the right ventricle to work unremittingly in the face of pulmonary hypertension.
109. Match the statements with their correct associated descriptions.
- | |
|---|
| a. Veno-arterial extracorporeal life support. |
| b. Veno-venous extracorporeal life support. |
| c. Both. |
| d. Neither. |
- _____ Maintain(s) pulmonary blood flow with oxygenated blood.
_____ Assist(s) systemic circulation.
_____ Decrease(s) pulmonary artery pressure.
110. Which of the following equations best describes the O_2 saturation that is obtained using the pulse oximetry?
a. $= HbO_2 / HbO_2 + Hb + HbCO + Hb\text{ met.}$
b. $= HbO_2 / Hb.$
c. $= HbO_2 / HbO_2 + Hb.$
d. $= HbO_2 + Hb / HbO_2.$
111. You have made a diagnosis of nitrite poisoning and decide to administer methylene blue intravenously at a dose of 1 mg/kg over few minutes. As the nurse is injecting the methylene blue, you notice that the saturation on pulse oximetry decreases precipitously from 99 to 85%. The most likely explanation and the appropriate course of action is:
a. Shock with hypotension; stop the medication.
b. Formation of HbCO.
c. Methylene blue is misinterpreted by the pulse oximeter as reduced Hb resulting in a low saturation; this should resolve in 2 minutes without any intervention.
d. None of the above.
112. Match the correct hemoglobin to the statement below.
- | |
|-------------------|
| a. HbCO. |
| b. Hb. |
| c. Oxyhemoglobin. |
- _____ A high level of this compound leads to a low fractional saturation but relatively high functional saturation.
113. Which of the following is least likely to interfere with an accurate reading of saturation on pulse oximetry?
a. High levels of HbCO.
b. High levels of met Hb.
c. An external light source such as a surgical lamp, bilirubin lamps, or fluorescent lights.
d. Hyperbilirubinemia.
e. Shock with low perfusion states.
114. Which of the following clinical conditions is not associated with a low mixed venous oxygen saturation?
a. Low Hb.
b. Low arterial oxygen saturation.
c. Low cardiac output.
d. Increased DO_2 .
e. Increased VO_2 .

115. Which of the following clinical conditions is not associated with a high mixed venous oxygen saturation?
- Increased DO_2 .
 - Decreased O_2 extraction by the tissue.
 - Severe mitral regurgitation.
 - A wedged pulmonary artery catheter.
 - Increased VO_2 .

116. The figure below represents the capnogram obtained from a patient on SIMV mode of mechanical ventilation and a ventilator with a demand valve mechanism. The best course of action would be:



- Substitute the neuromuscular blockade agent used with a nondepolarizing agent.
 - Calm the patient and reassure him.
 - Add a bronchodilator and intravenous corticosteroid.
 - Add 20 cm water of pressure support.
 - None of the above, as this represents a normal variation of capnography.
117. Which one of the clinical conditions listed below is not expected to be associated with a sudden decline in end tidal carbon dioxide?
- Cardiac standstill.
 - Air embolism.
 - Obstruction of the endotracheal tube.
 - Leakage in the circuit or discontinuation of the ventilator suddenly.
 - Hypoventilation.
118. You are preparing to draw an arterial blood gas sample from a patient in the pediatric ICU. In discussing with your medical students, the technical errors associated with this process, which one of the following statements would you not make?
- A gas bubble in the syringe will falsely elevate $PaCO_2$.
 - The major blood gas error associated with excess heparin in the sample is a drop in $PaCO_2$.
 - When a sample that is obtained from a patient breathing room air is interfaced with a bubble, the PaO_2 obtained will be close to 150 torr.

- In a patient on high FiO_2 with normal lungs, the presence of an air bubble in the syringe may spuriously lower PaO_2 .

119. Alterations in blood gas values occur if the sample is not immediately analyzed leading to spurious results; generally, this effect is most noticeable in patients with:
- Hyponatremia and hypercalcemia.
 - Leukopenia.
 - Neutropenia.
 - Leukocytosis and reticulocytopenia.
 - Reticulocytosis with high band forms.
120. Which one of the following drugs leads to a high anion gap metabolic acidosis?
- Acetazolamide.
 - Aldactone.
 - Arginine HCl.
 - Aspirin.
 - Cholestyramine and sulfamylon.
121. Which of the following is not a characteristic feature of posterior choanal atresia?
- Clinical symptoms have been noted to persist after surgical correction in some infants.
 - Most cases are unilateral.
 - Has a familiar occurrence.
 - Other associated anomalies are extremely uncommon.
122. Nasal encephalocele is a recognized cause of nasal obstruction in children. Which one of the following statements does not accurately describe this condition?
- Usually communicates with the subarachnoid space.
 - May be seen as a nasofrontal or a nasoethmoidal mass.
 - The mass is soft, compressible and may be pulsatile, but biopsy is contraindicated.
 - Nasal obstruction does not occur when the mass is located at the base of skull.
123. Nasopharyngeal angiofibromas
- May extend to the nasal passages and cause obstruction.
 - Tend to cause symptoms typically at puberty.
 - Rhinorrhea and epistaxis are common symptoms.
 - Treatment is radiation therapy or surgery.
 - All of the above.

124. Match the correct associations.

a. Infant	c. Both
b. Adult	d. Neither

- _____ Vocal cords are concave and at an angle to the trachea.
- _____ The main bronchi branch from the trachea at equal angles.
- _____ The glottis is located at C6.
- _____ The tracheal length from glottis to bifurcation is 11 cm.

125. Which of the following statements regarding the pediatric airway is true?

- The lateral diameter of the newborn glottis is 10 mm.
- At birth, the trachea is approx 10–12 cm in length.
- At 4–6 months, the epiglottis loses contact with the soft palate and becomes more erect.
- The glottis assumes the adult location at the level of the sixth cervical vertebra by 6 years of age.

126. During spontaneous respirations, the major contribution to total respiratory resistance is by:

- Nasal airway and mouth.
- Glottis.
- Trachea.
- Bronchi.

127. A child with an airway that has a diameter of 8 mm develops a respiratory infection with airway inflammation and circumferential edema, which leads to a 1-mm uniform reduction in the size of the airway; this will decrease the cross-sectional area of the airway by:

- 34%.
- 44%.
- 56%.
- 64%.
- 74%.

128. Laryngospasm is induced by reflexes in the nose, oropharynx, epiglottis, and vocal cords and may be seen in response to mucous, saliva, emesis, or blood. It necessitates immediate interventions, which may include:

- Positive pressure ventilation by a mask.
- Removal of the offending agent.
- Elevation of the mandible.
- Use of a muscle relaxant.
- All of the above.

129. In children younger than two and a half years with chronic stridor, the most common etiology is:

- Infection of the larynx and surrounding structures.
- Congenital anomalies of the larynx.
- Foreign body aspiration.
- Trauma.

130. Laryngomalacia is characterized by all of the following except:

- It is the most common congenital laryngeal anomaly.
- Aryepiglottic folds fall into the glottis on inspiration.
- Voice is hoarse leading to abnormal cry.
- Resolves by 18–24 months.
- Tracheostomy may be required if the problem interferes with feeding and growth.

131. All of the following congenital abnormalities lead to abnormal cry and hoarseness of voice except:

- Laryngocele.
- Laryngeal web.
- Laryngomalacia.
- Laryngeal cyst.
- Laryngotracheoesophageal cleft.

132. Match the correct associations.

a. Laryngomalacia	c. Both
b. Airway hemangioma	d. Neither

- _____ Symptoms usually occur before six months of age.
- _____ Treatment is conservative, since most cases resolve by two years of age.

133. Syndromes associated with difficult airway management due to micrognathia is/are:

- Hallermann-Streiff Syndrome (Oculomandibulodyscephaly).
- Mobius Syndrome.
- Noonan's Syndrome.
- DiGeorge Syndrome.
- All of the above.

134. Postoperative complications associated with cleft lip/palate repair include:

- Edema leading to nasopharyngeal obstruction.
- Nasopharyngeal blockage from secretions.
- Laryngospasm from excessive secretion and bloody drainage.
- All of the above.

135. Macroglossia with a short neck combines to produce a difficult airway in which of the following clinical disorders?
- Hurler's Syndrome.
 - Scheie's Syndrome.
 - Both.
 - Neither.
136. A difficult airway owing to a short and rigid neck is seen in:
- Hurler's and Marqio's mucopolysaccharidoses.
 - Klippel-Feil Syndrome.
 - Myositis ossificans.
 - Ankylosing spondylitis.
 - All of the above.
137. A two and a half-year-old white male who has a 2-day history of an upper respiratory tract infection and fever is now having mild stridor and dysphagia. His immunizations are up to date. You suspect retropharyngeal abscess. Which one of the following statements is incorrect regarding this patient?
- Age of the patient is somewhat atypical.
 - Inspiratory radiograph films are more informative than expiratory films.
 - A chest radiograph should be obtained to evaluate mediastinal extension.
 - The retropharyngeal space extends from the base of the skull to the level of the second thoracic vertebra
 - The usual organisms are staphylococci, group A streptococci, and anaerobes.
138. A 3-year-old is admitted to the pediatric ICU with a diagnosis of bacterial tracheitis. All of the following statements are true except:
- Diagnosis is confirmed by thick purulent secretions suctioned from the trachea or the presence of a pseudomembrane, or ulcerations intratracheally.
 - Intermittent tracheal suctioning should be avoided.
 - Intubation may be required in cases of severe airway obstruction.
 - Repeated bronchoscopy aids secretion removal and assessment of disease progression.
 - Extubation criteria include lack of fever, presence of air leak around the tube, signs of healing at bronchoscopy, and a decreased need for suctioning.
139. A two and a half-year-old with viral croup required intubation for increasing CO₂ and acidemia 3 days ago. Extubation is recommended when:
- An air leak around the tube can be heard with coughing.
 - An air leak around the tube can be heard with a positive pressure insufflation of less than 40 cm H₂O.
 - The amount of endotracheal secretions has diminished.
 - All of the above.
140. With regard to orofacial trauma caused by external forces, all of the following statements are true except:
- Nasotracheal intubation should be avoided with midfacial fractures.
 - Provided the cervical spine is stable, hemorrhage at the base of the tongue should be managed by having the patient in the prone, or lateral position with the head down to allow drainage of blood.
 - A skateboard-associated injury to the neck usually involves an area of soft tissue and an underlying skeletal injury.
 - The amount of subcutaneous emphysema of the neck correlates with the severity of airway injury.
141. In children with acquired subglottic stenosis, the most common etiology is:
- Endotracheal intubation.
 - External neck trauma.
 - Burns.
 - High tracheostomy sites.
 - Tumors.
142. Among the risk factors for the development of subglottic stenosis is the duration of mechanical ventilation. The acceptable time for the duration of intubation is:
- 2 days.
 - 4 days.
 - 7 days.
 - 10 days.
 - None of the above.
143. With regard to thermal and chemical injuries to the head and neck region, all of the following statements are true except:
- If there are flame burns of the face or singed facial hairs, the temperature is high enough to result in a respiratory burn.
 - Thermal injury usually affects the nasopharynx and larynx.

- c. A child with a history of caustic ingestion requires examination of the larynx.
- d. HeliOx has not been shown to be effective in the management of postextubation stridor in burn victims.
144. Papillomas are the most common airway tumors in children with symptoms usually appearing before 7 years of age. True statements about papillomas include all of the following except:
- Most commonly located on vocal cords.
 - Initial symptoms involve a change in voice such as stridor.
 - Often these children have personality changes.
 - The natural history is life-long recurrence.
 - The goal of therapy is to remove most of the lesions to prevent spreading while preserving airway anatomy.
145. The predominant pathophysiological abnormality leading to hypoxemia in bronchiolitis caused by respiratory syncytial virus infection is:
- V/Q mismatch.
 - Right-to-left intrapulmonary shunting.
 - Hypoventilation with relative alveolar hypoxemia.
 - Diffusion barrier.
 - All of the above.
146. A 5-month-old with severe respiratory syncytial virus bronchiolitis is noted to be slightly edematous with puffiness of the periorbital area and low urine output. Past medical history is unremarkable for prematurity or other perinatal disorders. It is also negative for any liver or kidney diseases. Physical examination does not reveal evidence of hepatomegaly or pronounced component of the second heart sound. Laboratory data shows that serum electrolytes are within normal limits. The most likely explanation for this finding is:
- Hypoalbuminemia.
 - Hyponatremia with low urine Na^+ .
 - Congestive heart failure owing to cor pulmonale.
 - High antidiuretic hormone levels with hyperaldosteronism.
 - None of the above.
147. Evaluation of urine for the patient in the previous question will most likely show:
- Low urine Na^+ .
 - High urine Na^+ .
 - Normal urine Na^+ .
 - Any of the above.
148. In acute asthma, which one of the following demonstrates the most severe decrease?
- Maximum mid-expiratory flow rate.
 - Mean expiratory forced reserve.
 - Functional vital capacity.
 - Forced expiratory volume 1.0 ($\text{FEV}_{1.0}$).
149. After treatment of an acute attack of asthma, which of the following is least likely to improve?
- Maximum mid-expiratory flow rate.
 - Mean expiratory forced reserve.
 - Functional vital capacity.
 - $\text{FEV}_{1.0}$.
150. Which one of the following parameters is least likely to decrease during an acute attack of asthma?
- Inspiratory capacity.
 - Vital capacity.
 - Expiratory reserve volume.
 - Maximum expiratory flow rate.
 - Residual volume.
151. Pathophysiological changes that occur in an acute episode of asthma include all of the following except:
- Hypocapnia is caused by alveolar hyperventilation secondary to activation of pulmonary reflexes.
 - Hypocapnia correlates with the degree of airway obstruction.
 - The degree of hyperoxia correlates well with the degree of airway obstruction as measured by $\text{FEV}_{1.0}$.
 - Elevated PaCO_2 occurs when $\text{FEV}_{1.0}$ falls below 20% predicted.
 - Elevated PaCO_2 is not seen if peak expiratory flow rate is greater than 25% predicted.
152. True statements regarding an acute asthmatic attack include:
- Left ventricular afterload is advantageously lowered by the significantly negative intrathoracic pressure with inspiration.
 - A decrease in pulsus paradoxus always indicates an improvement in the patient's clinical condition.
 - Hypocapnia seen in the early stages of an attack correlates with the degree of airway obstruction.
 - Pulsus paradoxus is because of a combination of increased left ventricular afterload and ventricular interdependence during inspiration.
 - None of the above.

153. Hypoxemia during status asthmaticus results from:
- V/Q mismatch.
 - Increased O₂ requirement.
 - Increased interstitial lung fluid.
 - All of the above.
154. FEV_{1.0} is an important parameter in the evaluation of a patient in status asthmaticus because of all of the following, except:
- FEV_{1.0} correlates with PaO₂.
 - FEV_{1.0} inversely correlates with PaCO₂.
 - PaCO₂ elevation occurs when FEV_{1.0} falls below 20% predicted.
 - Pulsus paradoxus is present in all patients with an FEV_{1.0} less than 20% predicted.
155. At an FEV_{1.0} less than 20% predicted:
- PaCO₂ rises.
 - Hypoxemia occurs.
 - Pulsus paradoxus is present in all patients.
 - All of the above.
156. A 3-year-old boy developed acute airway obstruction possibly secondary to pneumococcal epiglottitis at home. An emergency cricothyrotomy was performed using a 16-gage angiocath, which was connected to a size 3.0 endotracheal tube adapter. Oxygen is delivered at a rate of 4 L/minute from an E-cylinder. The pressure gauge reading on the E-cylinder is at 1100 PSI. The transport team leader asks you, "How much time do we have before we run out of O₂?" (The cylinder factor for the E-cylinder is 0.3 L/PSI) Your answer should be:
- 8.2 minutes.
 - 82 minutes.
 - 820 minutes.
 - 8 hours.
 - Cannot be determined with the information provided.
157. Which one of the combinations of values below best describes ventilation/perfusion ratio in the normal lung in the upright posture?
- | <u>Apices</u> | <u>Bases</u> |
|---------------|--------------|
| a. >1 | >1 |
| b. >1 | <1 |
| c. <1 | >1 |
| d. <1 | <1 |
| e. 1 | 1 |
158. Which of the following would be the most compelling indication for tracheostomy in a fire victim?
- Full thickness facial burns.
 - Apnea.
 - Proximal laryngeal damage.
 - Severe pulmonary edema.
 - Circumferential full-thickness burns of the neck.
159. Which of the following statements is true regarding the growth and development of lung units in infants?
- The lungs of newborn infants lack true alveoli
 - Terminal bronchioles grow and bifurcate to give rise to respiratory bronchioles during infancy.
 - Interalveolar Pores of Kohn are well developed in the neonate.
 - Alveoli form via septation of saccules.
 - The number of secondary acini increases during the first year of life.
160. A patient with pneumonia is breathing an FiO₂ of 0.4. The PaCO₂ on arterial blood gases is 40 torr, and the PaO₂ is 100. The patient's temperature is 37°C and the barometric pressure is 747. Assuming that the respiratory quotient is 0.8, what is the alveolar-arterial O₂ gradient in this patient?
- 30.
 - 130.
 - 180.
 - 430.
 - 140.
161. Which of the following is primarily responsible for the production of tumor necrosis factor?
- Platelets.
 - Macrophages.
 - B-lymphocytes.
 - T-lymphocytes.
 - Neutrophils.
162. A 10-year-old girl was involved in a motor vehicle collision, and is noted to have moderate respiratory distress. A chest radiograph shows a large left-sided pneumothorax. BP is normal. After a chest tube is inserted and is functioning properly, a persistent large air leak is noted. A repeat chest radiograph shows that there is still persistent pneumothorax. The patient's condition remains stable. The most appropriate next step in the management of this patient is:

- a. Insert a second chest tube.
 - b. Perform an immediate thoracotomy.
 - c. Repeat a chest radiograph in 8 hours.
 - d. Initiate jet ventilation.
 - e. Perform a bronchoscopy.
163. When ketamine is administered by the intramuscular route, a larger dose is necessary to induce general anesthesia, compared with the intravenous route. The most likely explanation for this is:
- a. Upregulation of drug receptors.
 - b. Tachyphylaxis.
 - c. Slower absorption.
 - d. Incomplete absorption.
 - e. Tissue metabolism.
164. Recovery after alveolar injury is characterized by which of the following processes:
- a. Serum factors enter the alveoli and delay the healing process.
 - b. Polymorphonuclear leukocytes clear the alveolar debris.
 - c. Alveolar type I cells divide and multiply to reconstitute the alveolar surface.
 - d. The surface is first reconstituted by alveolar type II cells that, in turn, evolve into alveolar type I cells.
 - e. The pericytes multiply and evolve into alveolar type I cells.
165. Which of the following is the earliest evidence of inspiratory muscle fatigue after discontinuation of mechanical ventilation?
- a. An increase in respiratory rate.
 - b. An increase in PaCO₂.
 - c. Alternation of abdominal and thoracic breathing every few breaths.
 - d. Primary thoracic inspirator effort when supine.
 - e. Abdomen moving inward during inspiration.
166. Which of the following statements is correct regarding the physiology of hemoproteins within the Hb or myoglobin?
- a. CO₂ increases the affinity of Hb for O₂.
 - b. O₂ has a stronger affinity for Hb than myoglobin.
 - c. CO₂ combines with nonoxygenated Hb to form carbaminohemoglobin.
 - d. 2,3-DPG increases Hb affinity for O₂ by competing with hydrogen ion for binding sites.
 - e. O₂ and hydrogen ions bind to the same sites on Hb.
167. An 18-day-old infant male underwent insertion of an aorticopulmonary shunt estimated to be 5 mm in diameter for pulmonary atresia. Postoperatively it is noted that he has a large left-to-right shunt and continues to receive conventional mechanical ventilation. Which of the following interventions is most likely to reduce the left-to-right shunt flow?
- a. Intravenous hydralazine.
 - b. Intravenous nitroprussid.
 - c. Increase arterial pH.
 - d. Increase FiO₂.
 - e. Increase PEEP.
168. Which of the following is the major precursor of arachidonic acid?
- a. Glutamic acid.
 - b. Leucine.
 - c. Isoleucine.
 - d. Linoleic acid.
 - e. Valine.
169. A child with pneumonia and respiratory failure is receiving conventional mechanical ventilation. Minute ventilation (MV) is 2 L/min and the PEEP is set at 5 cmH₂O. Hb is 9 gm% and arterial blood gases show that arterial O₂ saturation is 85%. Cardiac output is estimated to be 2 L/min. O₂ Transport from lungs to tissues will be most improved by which of the following:
- a. Increasing MV to 3 L/min.
 - b. Increasing PEEP to 10 cmH₂O.
 - c. Increasing Hb to 14 gm%.
 - d. Increasing O₂ saturation to 95%.
 - e. Increasing cardiac output to 2.4 L/min.
170. Stimulation of juxtacapillary receptors (J receptors) produces:
- a. Rapid shallow breathing.
 - b. Bronchodilation.
 - c. Hypotension.
 - d. Cough.
 - e. Tachycardia.
171. Which of the following types of cells is most likely to manifest injury at the onset of ARDS?:
- a. Clara cells.
 - b. Pulmonary macrophages.
 - c. Pulmonary endothelial cells.
 - d. Type I epithelial pneumocytes.
 - e. Type II epithelial pneumocytes.

172. Rebreathing during the use of Mapleson D breathing circuit while under anesthesia can be minimized by:
- Increasing fresh gas flow.
 - Decreasing fresh gas flow.
 - A short expiratory flow.
 - Fast respiratory rate.
 - None of the above.
173. Barotrauma is a recognized complication of positive pressure ventilation. Which of the following ventilatory strategies is expected to be associated with the least risk of barotrauma:
- A tidal volume (TV) of 5 mL/kg and a PEEP of 10 cmH₂O.
 - A TV of 7 mL/kg and a PEEP of 15 cmH₂O.
 - A plateau pressure less than 35 cmH₂O with a decelerating waveform.
 - Peak airway pressure of 50 cmH₂O with a square waveform inspiratory flow.
 - A TV of 10 mL/kg and a mean inspiratory flow of 60 L/minute.
174. Regional lung overdistention at end-inspiration rarely occurs during mechanical ventilation in which of the following settings:
- Diffuse idiopathic pulmonary fibrosis.
 - ARDS.
 - Acute exacerbation of chronic obstructive pulmonary disease (COPD).
 - Auto-PEEP of 15 cmH₂O without bronchospasm (emphysema).
 - Acute bronchospasm with hyperinflation.
175. When a patient is receiving conventional positive pressure ventilation at a specific fixed TV, which of the following fixed end points will result as conditions change?
- A uniform expansion of all lung units based on the plateau pressure.
 - A constant plateau pressure in spite of changing respiratory rate.
 - A constant end-inspiratory lung volume in spite of varying airway resistance.
 - A constant increase in intrathoracic pressure in spite of changes in lung compliance.
 - None of the above.
176. A 1-year-old boy with ARDS is on pressure-limited ventilation with an inspiratory time of 1 second, SIMV of 20 bpm, PIP of 30 cmH₂O, and PEEP of 8 cmH₂O. The chest radiograph has shown significant improvement over the past 24 hours, and the FiO₂ has been weaned from 0.7 to 0.45. Failure to decrease the inspiratory time may result in all of the following except:
- Decreased venous return.
 - Decreased physiological dead space.
 - Auto-PEEP.
 - Pneumomediastinum.
177. Nitric oxide is synthesized from which of the following?
- Arginine.
 - Glutamic acid.
 - Leucine.
 - Isoleucine.
 - Linoleic acid.
178. A 1-day-old infant underwent insertion of an aorticopulmonary shunt measuring 5 mm in diameter for an underlying cyanotic congenital heart disease. He has been admitted to the ICU for postoperative care and is on conventional positive pressure ventilation. A large left-to-right shunt is noted while he is on the ventilator. Which of the following is most likely to reduce the left-to-right shunt blood flow?
- Hydralazine.
 - Increasing FiO₂.
 - Administration of inhaled nitric oxide.
 - Increasing PEEP on the ventilator.
 - Increasing arterial pH.
179. A 9-month-old infant who was on mechanical ventilation for pneumonia and respiratory failure was extubated. Which of the following is the earliest evidence of inspiratory muscle fatigue after discontinuation of mechanical ventilation?
- Alternation of abdominal and thoracic breathing every few breaths.
 - Primary thoracic inspiratory efforts when supine.
 - An increase in respiratory rate.
 - An increase in arterial CO₂.
 - Abdomen moving inward during inspiration.
180. What is the toxic byproduct of the combination of nitric oxide with oxygen?
- Nitric oxide.
 - Nitric dioxide.
 - Nitrous oxide.
 - Hb.
 - All of the above.

181. A HeliOx has been shown to be of benefit in which of the following clinical situations?
- Croup.
 - COPD.
 - Asthma.
 - Fixed upper airway narrowing.
 - All of the above.
182. Marked hypertrophy of smooth muscles in the bronchial arteries and bronchial tree is present in a lung biopsy specimen from a 19-month-old infant. Which of the following is the most likely underlying lung disease in this patient?
- Primary pulmonary hypertension.
 - Chronic asthma.
 - BPD.
 - Dysmotile cilia syndrome.
 - Tracheobronchomegaly.
183. Respiratory failure characterized by hypercapnia, but a normal $P_{A}O_2 - P_{a}O_2$ difference would most likely occur in which of the following conditions?
- Pneumonia with a lobar pattern.
 - ARDS.
 - Upper airway obstruction.
 - Pulmonary edema is association with severe head injury.
 - Severe status asthmaticus.
184. Which of the following is equivalent to intrapleural pressure at rest?
- Airway pressure and the surface tension of the pleura.
 - Pressure exerted by the weight of the lung at vertical levels.
 - Airway pressure minus alveolar pressure.
 - The surface tension of the alveoli.
 - The net pressure resulting from the elastic recoil of the lung and chest wall.
185. Bronchogenic cyst is most likely to occur in which of the following locations?
- Subpleural region.
 - Middle mediastinum.
 - Upper lobe.
 - Anterior mediastinum.
 - Lingula.
186. Which of the following is the most important factor responsible for the hysteresis of the pressure–volume curve of the normal lung in vivo?
- Elastin and collagen properties.
 - The Laplace relationship.
 - Airway compliance.
 - Frequency dependence of compliance.
 - Air–surface interface.
187. Which of the following results in increased mechanical efficiency of the diaphragm?
- Increasing the curvature of the dome of the diaphragm.
 - Shortening of the muscle fibers.
 - Increasing end-expiratory lung volume above the relaxed volume of the rib cage and the abdomen.
 - Completely relaxing the abdomen.
 - Inspiration against a resistive load.
188. Which of the following distributions of cell types in bronchoalveolar lavage fluid is more consistent with ARDS?
- | | <i>Alveolar macrophages</i> | <i>Lymphocytes</i> | <i>PMNs</i> |
|----|-----------------------------|--------------------|-------------|
| a. | 25% | 4% | 70% |
| b. | 25% | 2% | 4% |
| c. | 85% | 2% | 12% |
| d. | 85% | 12% | 2% |
| e. | 92% | 5% | 2% |
189. A 16-year-old adolescent female with cystic fibrosis is admitted to the pediatric ICU with hemoptysis of sufficient severity to require several blood transfusion therapies. Of the following, which procedure would be most appropriate at this time?
- Perfusion lung scan.
 - Bronchial arteriography.
 - Pulmonary arteriography.
 - MRI of the chest.
 - CT scan of the chest.
190. From birth until 6 years of age, functional residual capacity (FRC) increases as a function of total lung capacity because:
- Airway resistance increases.
 - Chest wall compliance decreases.
 - The t for expiratory flow increases.
 - A child spends progressively more time in the erect posture.
 - Laryngeal adductors become active during expiration.

191. Therapy with a helium–oxygen mixture (HeliOx) can be used in children with severe subglottic stenosis because:
- HeliOx is a bronchodilator.
 - HeliOx is less dense than air.
 - HeliOx is less viscous than air.
 - Flow through large airways is dependent on gas viscosity.
 - Flow through large airways is always transitional.
192. Which of the following is the most prominent histological feature of BPD?
- Disrupted airway branching pattern.
 - Decreased number of alveoli.
 - Deficient bronchial cartilage.
 - Eosinophilic infiltration of alveolar septa.
 - Capillary hyperplasia.
193. An infant with BPD is on oxygen. The current fraction of inspired oxygen that maintains a PaO_2 of 55 mmHg and a barometric pressure of 760 mmHg is 0.27. The infant is being transferred to another hospital via a plane flying at a high altitude, which results in a reduction in the barometric pressure to 623 mmHg. What FiO_2 will be required to maintain the same PaO_2 assuming a constant respiratory quotient of 0.8, a constant PaCO_2 of 40 mmHg, and a body temperature of 37°C :
- | | |
|----------|----------|
| a. 0.24. | d. 0.33. |
| b. 0.27. | e. 0.37. |
| c. 0.30. | |
194. The function of surfactant associated with protein C is:
- To stimulate surfactant synthesis.
 - To facilitate formation of surfactant films at air–liquid interface.
 - To regulate surfactant release.
 - To inhibit enzymes that inactivate surfactant.
 - Not related to normal surfactant function.
195. Type I pulmonary pneumocytes are best described as:
- Cells involved in surfactant synthesis.
 - Cells involved in neurohumoral release and synthesis.
 - Cells involved in glycoprotein synthesis.
 - Cells that function as stem cells for type II alveolar cells.
 - Cells that minimize the barrier to gas exchange.
196. Forced vital capacity is useful as an index of pulmonary impairment because:
- It shows the least decline in the supine position.
 - It is affected only in obstructive lung diseases.
 - It has a high intrasubject reproducibility.
 - It has a large standard deviation.
 - It remains stable with increasing height.
197. Which of the following is used to calculate work of breathing?
- Pressure–volume curve.
 - Flow–volume curve.
 - Pressure–flow curve.
 - Volume–time curve.
 - Flow–time curve.
198. A 14-year-old male is admitted to the pediatric ICU for heroin overdose. Alveolar carbon dioxide is 85 mmHg at a barometric pressure of 760 mmHg and water vapor pressure of 47 mmHg. Upon arrival and while breathing room air, his alveolar–arterial oxygen tension difference was 10 mmHg. Assuming that the fraction of inspired oxygen of room air is 0.21 and the respiratory quotient is 0.8, the patient’s arterial oxygen tension would be:
- 23 mmHg.
 - 33 mmHg.
 - 43 mmHg.
 - 53 mmHg.
 - 63 mmHg.
199. A medication is being administered to a patient at intervals equivalent to its half-life. How many half-lives will it take for the plasma concentration of the medication to reach 97% of the final steady-state levels?
- | | |
|----------------------|---------------------|
| a. One half-life. | d. Four half-lives. |
| b. Two half-lives. | e. Five half-lives. |
| c. Three half-lives. | |
200. If the patient in Question 199 requires extracorporeal life support, what would be the effect of this modality of therapy on the half-life of the medication?
- Increase.
 - Decrease.
 - Remain the same.
 - Volume of distribution decreases dramatically.