Pediatric Anesthesiology Review

Clinical Cases for Self-Assessment

Second Edition

Robert S. Holzman
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Preface

This text is designed for those who would become consultants in pediatric anesthesia. It is based on a curriculum developed in our department since 1992 to illustrate the breadth and depth of the practice of pediatric anesthesia. Weekly meetings are held with our fellows and many of our faculty who are or who have been associate examiners of the American Board of Anesthesiology. The program is an integral part of the didactic series in the Department of Anesthesiology, Perioperative and Pain Medicine at Boston Children's Hospital.

An ability to explain *why* various data are required before or during the care of a patient or *why* a certain anesthesia care plan was chosen was critical to us in our philosophy of the course, and we have tried to preserve that ideal during the crafting of this text. Although the interactive aspect of a dialog between examiner and examinee cannot be effectively recreated through a textbook, the reader is encouraged – strongly so – to use this book in creative ways to mimic the spontaneity achievable through conversation. First of all, a "buddy" system is advisable. Recording your answers is extremely useful when using the questions as prompts; the contemplative reader will listen critically to the responses he or she has offered into the recorder and then hopefully improve with time and practice. When all else fails, you can find the closest 4-year-old, who will gleefully ask you "why" after every response, uncannily similar to a board exam. Using materiality as the best endpoint for adequate answers, the discerning reader should attempt to answer the question to the satisfaction of an imaginary partner – whether the patient her- or himself, a parent, a surgeon, a pediatrician, or another anesthesiology colleague calling for help. With practice and introspection, it is amazing how similar, rather than different, the answers are to those diverse audiences.

The written examinations, seen at the beginning of the text as a baseline in pediatric medicine, are primarily knowledge-based, reflecting factual medical information necessary for the subspecialty practice of pediatric anesthesiology.

This second edition has the same purpose as the first – to accompany the reader's journey in attaining proficiency, expertise, and, finally, mastery in pediatric anesthesiology. The formatting of the book is designed to encourage the reader's free flow of ideas. One should begin with looking at both facing pages, then progress to

covering the answers on the right, and eventually cover the questions on the left, so that probing questions become self-generated. In this very simple, programmed text manner, practice at generating the appropriate breadth and depth of answers, and then questions, can be encouraged.

With this basic guidance, the reader is encouraged to be creative throughout this book, to use imagination as well as a fund of knowledge in bringing yourself "into the operating room" and managing the patient in an expert fashion, one that would, in the eyes of peers as well as patients and their families, merit the awarding of "consultant in pediatric anesthesiology."

Boston, MA, USA

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Part I
Pediatric Medicine for Pediatric Anesthesiologists

Chapter 1
Newborn Medicine

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Questions

1. In the neonatal period (day 0–28 of life), mortality is higher than any other period in infancy and childhood. Regarding neonatal mortality, the following is true:
   1. It is inversely correlated with birth weight with most deaths occurring in neonates with birth weights <1.5 kg.
   2. It is most commonly due to prematurity and its complications.
   3. Most neonatal deaths occur in the first week of life.
   4. The high neonatal mortality in African-American babies is due to the higher rate of premature births in this group.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

2. Regarding apnea of prematurity:
   1. It occurs in nearly all infants born weighing <1000 g.
   2. It usually resolves by 36–37 weeks postconceptual age (PCA).
   3. It is treated with theophylline or caffeine.
   4. Infants with this problem require home monitoring until 60 weeks PCA.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

3. Which of the following are associated with poor fetal growth and therefore SGA births?
   1. Reduced uteroplacental blood flow
   2. Intrauterine infection
   3. Chromosomal abnormalities
   4. Poor maternal nutrition
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

Answers

1. E. all of the above

Low birth weight, which is distinct from preterm birth (see definitions), occurs in approximately 7 % of live births in the USA. Mortality of low birth weight infants is higher than mortality of normal birth weight infants by approximately the following:

Moderately low birth weight (MLBW 1501–2500 g) 40 times increased, very low birth weight (VLBW 1000–1500 g) 200 times increased, and extremely low birth weight (ELBW <1000 g) 600 times increased.

Mortality for low birth weight infants has decreased with improvements in newborn care. Common causes for mortality in the newborn are different for term and preterm newborns.

Term: congenital anomalies, birth asphyxia, infection, and meconium aspiration syndrome.

Preterm: respiratory distress syndrome (RDS), intraventricular hemorrhage (IVH), infection, and necrotizing enterocolitis (NEC).

The LBW (<2500 g) rate in the USA has increased from 6.6 to 7.5 % from 1981 to 1997. The USA still lags behind many industrialized countries in neonatal mortality, while the rate of teen pregnancy exceeds that of many industrialized countries.

2. A. 1, 2, 3

Apnea is defined as cessation of airflow into the lungs for a specified period of time, usually 1–20 s. Once the known potential causes for apnea have been ruled out, the diagnosis of apnea of prematurity can be made. Infants with apnea of prematurity may be discharged home without monitoring provided they have had 7–10 days free of apneic spells. The incidence of SIDS does increase with decreasing birth weight, but apnea of prematurity is not an independent risk factor for SIDS.

3. E. all of the above

Intrauterine growth restriction can be considered a final common pathway for a myriad of influences on the fetus including genetic factors and environmental influences. The intrauterine environment is determined by uterine blood flow, placental function, and placental and umbilical circulation. Maternal factors that affect birth weight include maternal weight gain, maternal age, and medical conditions such as hypertension or diabetes mellitus.

4. What maintenance fluid would you order for a 2 kg, 2-week-old who will be NPO for 6 h?
   A. D5 0.2 NS at 8 mL/h
   B. D10 0.45 NS at 10 mL/h
   C. D5 LR at 10 mL/h
   D. D5 0.45 NS at 12 mL/h

5. Which of the following is (are) true regarding maintenance fluids, electrolytes, and glucose administration to the newborn after the first week of life?
   1. Approximately 100–125 mL/kg/day of water will replace urine output and insensible losses.
   2. Glucose utilization, 6–10 mg/kg/min, can be supplied with D10 given at 100 mL/kg/day.
   3. Excessive sodium losses, due to renal tubular immaturity, must be replaced with 0.9 % NS.
   4. Preterm newborns require less fluid than term infants because of their decreased urine output.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

6. Newborns have difficulty maintaining temperature because:
   1. They have a large surface area relative to their weight.
   2. Their increased tone leads to excessive heat loss.
   3. Shivering thermogenesis is limited.
   4. Brown fat is a poor insulator.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

4. D. D5 0.2 NS at 8 mL/h

Water administration to term older infants and children is related to caloric expenditure in the following manner on a 1 mL/cal basis:

0–10 kg: 100 cal/kg/day divided by 24 h/day = 4 mL/kg/h

10–20 kg: 50 cal/kg/day divided by 24 h/day = 2/mL/kg/h

20 kg: 20 cal/kg/day divided by 24 h/day = 1 mL/kg/h

Sodium requirements are in the neighborhood of 2–3 meq/kg/day. 0.2–0.45 % NS is adequate for sodium replenishment for children up to 45 kg.

Fluid requirements for the newborn change dramatically in the first few days of life. For DOL #1, the fluid needed by the newborn is 60–80 mL/kg/day, gradually increasing to 100–140 mL/kg/day over the subsequent several days. D10 provides sufficient glucose to the newborn.

5. A. 1, 2, 3

The newborn has higher insensible fluid losses than older children. Transdermal evaporative losses are affected by the ambient temperature, while respiratory evaporative losses are affected by the humidity. Maintenance glucose requirements can be met with the administration of 6–8 mg/kg/min. D5 at 100 mL/kg/day provides 5 g/kg/day or 5000 mg/kg/day of glucose or 3.5 mg/kg/min (5000 mg/kg/day × 1 day/1440 min/day = 3.5 mg/kg/min). D10 given at 100 mL/kg/day will provide 6.7 mg/kg/min of glucose. Normal newborns lose little sodium in the first few days of life, often receiving only D10W during the first 24 h of life. Preterm newborns require more fluid because of increased transdermal losses.

6. B. 1, 3

Surface area/weight in a newborn is three times that of an adult. Newborns lose heat at a rate approximately four times that of adults. Nonshivering thermogenesis, which occurs in the brown fat, is a neonatal response to cold. In nonshivering thermogenesis, fat is oxidized and oxygen consumption is increased.

7. The neutral thermal environment for a 10-day-old 1.5 kg infant lying on a warm mattress in a draft-free room of moderate humidity:
   1. Is a room temperature of 34–35 °C
   2. Is the environment at which the baby will be actively warmed
   3. Is the environment at which 02 consumption is lowest
   4. Includes warming lights
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

8. The Apgar score:
   1. Has a 0–10 scale
   2. Is a useful guide to interventions needed in neonatal resuscitation
   3. Can be used to estimate the likelihood of neonatal acidosis
   4. Was developed in the 1950s by Virginia Apgar, an anesthesiologist
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

9. The Apgar score includes all of the following, which are scored 0–2, except:
   1. Heart rate
   2. Presence of gag reflex
   3. Respiratory effort
   4. Tone
   5. Reflex irritability
   6. Color
      A. 1
      B. 2
      C. 3
      D. 4
      E. 5
      F. 6

7. B. 1, 3

The neutral thermal environment is one with the ambient temperature in which the newborn loses the least amount of heat while maintaining normal body temperature. A neutral thermal environment is one in which the infant neither gains nor loses heat. The newborn loses heat by four means:

Convection to the cooler surrounding air

Conduction to the cooler surfaces which contact the newborn's skin

Radiation to nearby solid objects

Evaporation from moist skin and lungs

Newborns respond to ambient temperature below the neutral thermal environment with increased oxygen consumption to produce heat. The increased oxygen consumption response is limited, however, and once this occurs, the temperature of the newborn begins to fall.

8. E. All of the above

This score is of value in assessment of the newborn at birth and the effectiveness of any resuscitation efforts. Apgar scores at 1 and 5 min correlate poorly with longer-term neurologic outcome. The American Academy of Pediatrics and American College of Obstetrics and Gynecology emphasize using the Apgar score only as a tool in evaluating the condition of the newborn at the time of birth.

9. F

The Apgar score range is 0–10. Term newborns without congenital anomalies with a normal cardiopulmonary adaptation to extrauterine life should have a score of 8–9. Newborns with a score of 0–3 require resuscitation. Most cases of low Apgar scores are due to inadequate ventilation, not to cardiac causes.

In her original work (Apgar, V Current Research in Anesthesia and Analgesia 1953:32;260), Dr. Virginia Apgar demonstrated that the score could differentiate between infants born to mothers who had general anesthesia and infants born to mothers who had spinal anesthesia.

10. A newborn whose Apgar score was 2 at 1 min has been intubated and is being adequately and appropriately ventilated. The heart rate is now 60/min. The next intervention should be:
    1. Volume expansion with 10 cc/kg isotonic fluid
    2. Correction of acidosis with NaHCO3, 1 meq/kg slowly
    3. Observation and active warming in the special care nursery
    4. Closed cardiac massage
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

11. Intraventricular hemorrhage in preterm infants has been associated with:
    1. Acidosis
    2. Hypoxemia
    3. Cerebral blood flow alterations
    4. Germinal matrix hyperplasia
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

12. Possible consequences of germinal matrix hyperplasia (GMH)/intraventricular hemorrhage (IVH) include:
    1. A normal neurologic exam after grade I IVH
    2. Posthemorrhagic hydrocephalus (PHH)
    3. Motor and cognitive deficits in 50 % of infants with grade IV IVH
    4. Hydrocephalus in virtually all infants with grade III–IV IVH
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

10. D. 4

The goals of neonatal resuscitation are to prevent morbidity and mortality of hypoxic-ischemic damage and to reestablish spontaneous respiratory effort and cardiac output. Although the 1 min Apgar score is useful in evaluation of the newborn, there are occasions when intervention should be immediate. Please review resuscitation of the newborn in one of the references.

11. A. 1, 2, 3

Immature vessels in the gelatinous subependymal germinal matrix of preterm newborns are subject to various forces predisposing the preterm to intraventricular hemorrhage (IVH). Contributory factors include prematurity, respiratory distress syndrome (RDS), pneumothorax, hypotension, hypertension, and increased venous pressure. Most IVH occurs within the first week of life and can present with seizures, apnea, cardiovascular instability, and acidosis. The risk for IVH decreases with increasing gestational age. In many surveys, approximately one-half of infants with birth weights <1500 g have imaging evidence of IVH.

12. E. All of the above

The incidence of IVH increases with decreasing birth weight: 60–70 % of 500–750 g. Infants and 10–20 % of 1000–1500 g infants have IVH. There are four grades defined by ultrasound (done through the anterior fontanelle):

Grade I: bleeding in the germinal matrix

Grade II: blood in the ventricle filling <50 % of the ventricle

Grade III: >50 % of the ventricle filled with blood

Grade IV: grade III + intraparenchymal blood

Marked clinical deterioration (apnea, seizures, metabolic acidosis, decreased tone) accompanies the occurrence of the IVH, usually within the first week of life. Neurological sequelae are more severe in newborns with the more severe grades of IVH.

13. The initial laboratory evaluation of a healthy neonate with normal perinatal history who has a brief seizure and who is now clinically stable should include:
    1. Measurement of electrolytes, Ca+2, and glucose
    2. Neuroimaging
    3. An EEG
    4. A lumbar puncture
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

14. Regarding neonatal respiratory distress syndrome (RDS):
    1. It is rare in infants born after 30 weeks of gestation.
    2. It is due to surfactant deficiency.
    3. Lung compliance is decreased in infants with RDS.
    4. It is associated with the premature closure of the PDA (patent ductus arteriosus).
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

15. Which of the following are features of RDS?
    1. Grunting
    2. Nasal flaring
    3. Air bronchograms on CXR
    4. Central cyanosis with peripheral plethora
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

16. Therapies for RDS include:
    1. Distending airway pressure
    2. Administration of sodium bicarbonate
    3. Surfactant administration
    4. Hypertonic fluid administration
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

13. E. All of the above

The most common cause of seizures in the newborn is hypoxic-ischemic encephalopathy. Other causes include infectious, metabolic, hemorrhagic (see above), and structural abnormalities. Seizure types in the newborn include:

Myoclonic, involving the extremities

Focal, often involving the facial muscles

Subtle, involving chewing, blinking, and respiratory alterations including apnea and multifocal clonic seizures

14. A. 1, 2, 3

RDS occurs in approximately 75 % of infants born at <28 weeks of gestation and in about 5 % of those born after 37 weeks. Increased incidence (controlling for gestational age) is seen in infants of diabetic mothers, multi-fetal pregnancies, and cesarean delivery. Preterm white males have the highest incidence. Surfactant deficiency leads to higher surface tension within the alveoli, the development of atelectasis and a decreased FRC leading to hypoxemia.

15. A. 1, 2, 3

Rapid, shallow breathing, indicative of poor compliance, is seen within minutes of birth in RDS. The natural course is one of progressive cyanosis and dyspnea. Newborns with RDS exhibit nasal flaring, grunting (in an effort to develop end-expiratory distending airway pressure), and tachypnea. Affected and untreated infants may develop mixed acidosis, hypotension, temperature instability, and apnea.

16. B. 1, 3

Impaired gas exchange in the lung is the basic pathophysiology requiring treatment. Warm humidified oxygen should be given to maintain Sp0 >90 %. If this is not accomplished with an Fi0 of 60 %, CPAP via nasal prongs should be started. At this point, administration of exogenous surfactant via endotracheal tube should also be considered, and assisted mechanical ventilation may be needed. Surfactant administration should be started within the first 24 h of life and may be repeated every 6–12 h for up to two to four doses depending upon the clinical situation.

17. Transient tachypnea of the newborn (TTN):
    A. Is primarily seen in prematures born between 30 and 34 weeks of gestation
    B. Can progress to chronic lung disease if untreated
    C. Resolves within 24–48 h
    D. Has a CXR identical to that seen with RDS

18. The ductus arteriosus:
    1. Has right to left blood flow in the normal fetus
    2. Closes in the postnatal period as a result of higher oxygen tension in the blood
    3. If open in the preterm, may lead to congestive heart failure
    4. If open in the newborn, causes a characteristic harsh diastolic murmur
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

19. The diagnosis of PDA is supported by:
    A. The presence of a shadow at the aortic knob on CXR
    B. The presence of diminished peripheral pulses due to excessive pulmonary blood flow
    C. The presence of pulsus paradoxus
    D. The findings of bounding pulses, tachypnea, and a systolic murmur

20. Which of the following maternal/perinatal factors is (are) often associated with congenital heart disease?
    1. The presence of a chromosomal abnormality
    2. Maternal rubella infection
    3. Maternal alcohol abuse during pregnancy
    4. Maternal cocaine use during pregnancy
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

17. C. Resolves within 24–48 h

TTN is seen in newborns following an uneventful term vaginal or cesarean delivery. The infants may have a minimal oxygen requirement. TTN resolves within 2–3 days. It is thought to be due to delayed absorption of fetal lung fluid. CXR will show prominent pulmonary vascular markings, fluid lines in the fissures, and over-aeration.

18. A. 1, 2, 3

In the fetus, RV output is 66 % of the combined ventricular output, and the ductus arteriosus carries 90 % of that RV output to the descending aorta, with 10 % going to the lungs. In the normal newborn, the patent ductus arteriosus (PDA) may have a continuous murmur, often described as machinelike. In newborns, a large PDA may present with bounding pulses, cardiomegaly, and other signs of CHF. Bounding peripheral pulses are the result of increased LV stroke volume due to the increased LV volume load and diastolic runoff due to the low diastolic pressure. A small PDA may be asymptomatic.

19. D. The findings of bounding pulses, tachypnea, and a systolic murmur

The CXR in a newborn with a large PDA will show increased pulmonary vascular markings and possibly cardiomegaly. The echo will show an enlarged left atrium, picked up by an abnormal LA/Ao ratio. The ductus can often be seen with 2D echo. The LA is enlarged due to the R to L shunt through the PDA. Spontaneous closure of the PDA beyond infancy is rare. The risk of endarteritis is such that all PDAs should be closed either surgically or via catheter closure.

20. A. 1, 2, 3

Infants born to mothers who abused cocaine have many problems, but an increased incidence of congenital heart disease is not one of them. Problems these children do have as a result of intrapartum cocaine exposure include spontaneous abortion, preterm birth, IUGR, microcephalus, abnormal EEG, poor expressive language and verbal comprehension, and later behavioral problems.

21. In persistent pulmonary hypertension of the newborn (PPHN):
    1. Pulmonary blood flow is decreased.
    2. There is systemic hypoxemia.
    3. Blood flow through the PDA is right to left.
    4. The systemic vascular resistance is much lower than it was during fetal life.
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

22. At birth, the right ventricle:
    A. Is hypoplastic
    B. Is approximately as thick-walled as the left ventricle
    C. Has much thicker walls than the left ventricle
    D. Has poor contractility until PVR decreases

23. Which of the following congenital heart defects is the most common in full-term newborns?
    A. Coarctation of the aorta
    B. Tetralogy of Fallot
    C. Patent ductus arteriosus
    D. Ventricular septal defect
    E. Hypoplastic left heart syndrome

24. Hypoglycemia is seen in the following neonates:
    1. SGA newborns
    2. Infants with polycythemia/hyperviscosity
    3. Preterm newborns
    4. Infants with Beckwith-Wiedemann syndrome (macroglossia, visceromegaly, omphalocele)
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

21. A. 1, 2, 3

PPHN may occur in term and postterm infants after birth asphyxia, meconium aspiration, group B streptococcal sepsis, or polycythemia. The normal decline in pulmonary vascular resistance (PVR) that usually occurs after birth does not occur. Excessively high PVR leads to a return to a fetal pattern of circulation, with increased right to left flow through the PDA from the RV and markedly diminished pulmonary blood flow.

Labile hypoxemia, out of proportion to CXR findings, is seen. Hypoxemia, hypercarbia, and acidosis worsen the degree of pulmonary vasoconstriction. A transthoracic echocardiogram can confirm the diagnosis and rule out other causes of profound hypoxemia such as congenital heart disease.

22. B. Is approximately as thick-walled as the left ventricle

During fetal life, the RV delivers approximately 90 % of its output to the systemic circulation via the open ductus arteriosus and 10 % to the very high-resistance pulmonary circulation. The ECG of a newborn shows prominent right-sided forces with right axis deviation and large R waves. The upright T waves in the precordial leads seen at birth often revert to negative within a few days after birth.

23. D. Ventricular septal defect

Ventricular septal defects (VSD) comprise approximately 25 % of all congenital cardiac lesions, exclusive of PDA in preterms, bicuspid aortic valves, and peripheral pulmonic stenosis. The majority are of the membranous type, located posteroinferiorly, anterior to the septal leaflet of the tricuspid valve. The severity of the VSD can be characterized by the ratio of pulmonary to systemic flow (Qp/Qs). An infant with a ventricular septal defect with a Qp/Qs >2:1 will exhibit clinical signs and symptoms of congestive heart failure (CHF) such as effortless tachypnea, diaphoresis, and poor feeding (the equivalent of “exercise intolerance” in the newborn).

24. E. All of the above

There are four groups of newborns at risk for hypoglycemia: infants of diabetic mothers, IUGR newborns, very immature and/or ill newborns, and newborns with metabolic/genetic disorders such as galactosemia, glycogen storage diseases, etc.

25. Hypoglycemia in the term neonate:
    1. Is diagnosed only by the presence of signs and symptoms and not a specific number
    2. Should only be treated if it occurs after the first 3–4 h of life
    3. Is very rarely seen in large, term infants
    4. Is commonly defined as a glucose of <45 g%
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

26. Symptoms and signs of hypoglycemia in the neonates include:
    1. Tremors or seizures
    2. Apnea
    3. Lethargy
    4. Poor feeding
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

27. In the treatment of glucose of <30 mg% in a newborn under anesthesia in the OR, an IV bolus of 200–300 mg/kg glucose (2–3 mL/kg of D10) is given, followed by:
    1. 4 mL/kg/h of D10
    2. D5.2 NS at maintenance
    3. 6–8 mg/kg/min glucose
    4. Glucagon 0.3 mg/kg IM up to a maximum of 1.0 mg
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

28. Regarding hemoglobin in the newborn:
    1. The mean venous hemoglobin in term infants is 18 g/dl.
    2. The physiologic anemia in preterm infants lasts longer and has a lower nadir than that seen in full-term infants.
    3. Hemoglobin concentration increases during the first few days of life as plasma volume decreases.
    4. RBC survival is normal (120 days) in term infants.
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

25. D. 4

The incidence of hypoglycemia varies with the definition used, the population studied, and the method of measurement. In term infants, a glucose of less than 35 mg% requires intervention, while symptomatic infants with glucose measurements >40 mg% also may be treated. Preterm newborns are not more tolerant of low glucose than full-term newborns. Term infants and preterm newborns are equally at risk for severe neurodevelopmental sequelae if left with a low serum glucose.

26. E. All of the above

In the newborn, hypoglycemia may present with neurologic (apnea, seizures, lethargy, coma) or sympathomimetic (pallor, palpitations, diaphoresis) symptoms. The brain in a newborn uses glucose at a rate of approximately 20 mg/min or 4–5 mg/100 g brain/min. The rate of glucose utilization of 5–7 mg/kg/min for a 3.5 kg newborn leads to an overall rate of glucose utilization of 17–24 mg/min.

27. B. 1, 3

Treating hypoglycemia with larger amounts of glucose than 200–300 mg/kg results in rebound hypoglycemia. If the hypoglycemic newborn is seizing, 400 mg/kg may be given. The infusion is begun following the bolus and the glucose level is closely followed afterward. The prognosis of asymptomatic hypoglycemia is generally quite good. If hypoglycemia is accompanied by seizures, it is associated with abnormal intellectual development.

28. A. 1, 2, 3

Hemoglobin levels in very low birth weight (VLBW) infants are 1–2 g lower than those of term infants.

29. The physiologic anemia (expected drop in hemoglobin) of infancy:
    1. Is due to decreased erythropoiesis in the oxygen-rich postnatal environment
    2. Occurs more rapidly and has a lower nadir in preterm infants compared to term infants
    3. Occurs at 10–12 weeks of age in term infants
    4. Has its nadir at 9–10 g/dl in term infants
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

30. Neonatal polycythemia:
    1. Is seen in infants of diabetic mothers
    2. Is diagnosed with a venous HCT >65 %
    3. Is treated with partial exchange transfusion in symptomatic infants
    4. Can lead to development of seizures, CNS damage, or necrotizing enterocolitis (NEC)
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

31. Polycythemia in the neonate (a venous HCT >65 % on two separate specimens):
    1. Is commonly idiopathic
    2. Occurs in infants of diabetic mothers
    3. Is associated with prolonged labor and fetal distress
    4. Occurs in newborns with intrauterine growth restriction
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

32. Polycythemia in the neonate should be treated:
    1. In all infants whose venous HCT is >65 %
    2. With simple phlebotomy to reduce the HCT to <60 %
    3. With exchange transfusion to reduce the HCT to <45 %
    4. With partial exchange transfusion in all symptomatic infants whose venous HCT is >65 % on two separate specimens
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

29. E. All of the above

The anemia of prematurity occurs at 1–3 months and may present with pallor, apnea, poor weight gain, tachypnea, and tachycardia. As the total hemoglobin concentration drops, the concentration of fetal hemoglobin decreases; the newborn makes more HbA, a hemoglobin that releases oxygen more readily than fetal Hb. The P50 of fetal hemoglobin is a PaO_2 of 19 mmHg, while that in the adult, with no fetal Hb, is a PaO_2 of 32 mmHg.

30. E. All of the above

With increases in hematocrit from 40 % to 60 %, blood viscosity changes very little. With increases above 65 %, blood viscosity increases rapidly. The incidence of polycythemia is increased in babies born at altitude postmature vs. term infants, SGA babies, infants after delayed clamping of the umbilical cord, and infants of diabetic mothers.

31. A. 1, 2, 3

Clinical manifestations of polycythemia include lethargy, tachypnea, respiratory distress, hypoglycemia, and thrombocytopenia. Infants may appear ruddy or plethoric. Severe complications also may occur such as seizures, necrotizing enterocolitis (NEC), and pulmonary hypertension (PPHN). Although studies are not conclusive, it appears that long-term sequleae such as neurodevelopmental abnormalities can be prevented by treatment of affected infants with partial exchange transfusion.

32. D. 4

The goal of the partial exchange transfusion is to reduce the hematocrit to <50 %. The long-term prognosis of polycythemia is unclear. Some adverse outcomes reported include problems with speech, fine motor control, and perhaps lower IQ scores. Partial exchange transfusion, when performed through an umbilical vein, is associated with an increased incidence of NEC.

33. "Physiologic" hyperbilirubinemia in the healthy term newborn:
    1. Usually does not exceed 8–9 mg/dl of unconjugated (indirect) bilirubin
    2. Is seen only in breastfed infants
    3. Can be partly accounted for by the low levels of glucuronyl transferase in the newborn
    4. Is diagnosed with a bilirubin level >15 mg/dl within the first week of life
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

34. Factors which are important in the decision to institute phototherapy treatment for unconjugated hyperbilirubinemia include:
    1. The neonate's gestational age
    2. The neonate's chronological age
    3. The presence of other illnesses such as sepsis or respiratory distress
    4. The neonate's hemoglobin concentration
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

35. Bilirubin results from hemolysis. Causes of hemolysis in the newborn associated with hyperbilirubinemia include:
    1. Cephalohematoma
    2. Rh or ABO incompatibility
    3. Circulating bacterial endotoxin from group B Streptococcus
    4. Sickle-cell trait
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

36. Bilirubin toxicity:
    1. May be seen in term neonates whose bilirubin levels exceed 25 mg/dl
    2. Need not be seen in term infants whose bilirubin exceeds 30 mg/dl
    3. May be seen in preterm infants weighing <1500 g whose bilirubin level exceeds 15 mg/dl
    4. Results from damage to the basal ganglia and cranial nerve nuclei
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

33. B. 1, 3

Jaundice is observed in approximately 60 % of term and 80 % of preterm infants during the first week of life. The color results from accumulation of unconjugated (indirect-reacting) bilirubin in the skin. "Physiologic jaundice" appears on day 2 or 3 of life, but jaundice appearing at this time may also represent a more severe form. Clinical jaundice and indirect hyperbilirubinemia are reduced upon exposure of the skin to visible light in the blue (420–470 nm) range. Conventional phototherapy is applied continuously, and the baby should be turned to expose the maximum amount of skin. The eyes should be covered. Complications of phototherapy include loose stools, rashes, and dehydration. Exchange transfusion is another more definitive but also more invasive procedure to lower bilirubin.

34. A. 1, 2, 3

There are many algorithms for the use of phototherapy. In general, phototherapy for unconjugated hyperbilirubinemia has begun at lower bilirubin concentrations in younger, smaller, and sicker infants and infants in whom the rate of rise of unconjugated bilirubin is more rapid.

35. A. 1, 2, 3

The causes include factors which increase the amount of bilirubin presented to the liver for conjugation (hemolysis, infection, shortened red blood cell life span) or factors that decrease the liver's ability to conjugate the bilirubin (liver immaturity, enzyme deficiency, prematurity, hypothyroidism).

36. E. All of the above

Kernicterus is the neurologic syndrome resulting from deposition of unconjugated bilirubin in brain cells. The relationship between serum bilirubin levels and kernicterus in healthy term infants is uncertain. The less mature the infant, the greater the susceptibility to kernicterus. Suggested maximum unconjugated bilirubin levels (in mg/dl) in relatively healthy preterms are:

<1000 g: 12–13
1000–1250: 12–14
1250–1500: 14–16
1500–2000: 16–20

37. The clinical signs of bilirubin toxicity include:
    1. Lethargy
    2. High-pitched cry
    3. Rigidity
    4. Choreoathetosis
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

38. A mother with type O+ blood delivers a 35-week, 2600 g infant with type A+ blood. She is breastfeeding. On day 2 of life, the infant's indirect bilirubin is 12 mg/dl. Management includes:
    1. Cessation of breastfeeding for 2–3 days
    2. Coombs test, Hb, RBC morphology, and indices
    3. Partial exchange transfusion
    4. Observation with daily bilirubin measurements
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

39. Group B streptococcal sepsis in the newborn:
    1. May occur early, within the first 72 h after birth, primarily with bacteremia
    2. May occur later, between 10 and 30 days of age often including meningitis
    3. Is fatal in 10–15 % of cases
    4. Will be less likely by treatment of women colonized with the bacteria with appropriate antibiotics during labor
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

40. Congenital rubella infections are characterized by:
    1. Various congenital cardiac defects
    2. Cataracts
    3. Intrauterine growth retardation
    4. Brain calcifications
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

37. E. All of the above

More long-term neurologic problems associated with kernicterus include mental retardation, choreoathetosis, spastic diplegia, and deafness. The incidence of kernicterus at autopsy in hyperbilirubinemic preterm newborns ranges from 2 to 16 %.

38. C. 2, 4

Evaluation of a well newborn with clinical jaundice involves a search for the etiology before deciding that the cause is "physiologic." While it is true that breastfed infants have higher bilirubin measurements than comparable formula-fed infants, breastfeeding is rarely held. Overall, approximately 7 % of term infants have bilirubin levels >13 mg%, while less than 3 % have levels >15 mg.

39. E. All of the above

Sepsis in the newborn may present with a variety of signs and symptoms including apnea, tachypnea, temperature instability, metabolic acidosis, hypoxemia, or DIC. Initial empirical treatment of infants suspected of having systemic bacterial infection usually consists of an aminoglycoside and ampicillin.

40. A. 1, 2, 3

Congenital rubella affects virtually all organ systems. IUGR is the most common manifestation. Other findings include developmental delay, anemia, blueberry muffin skin lesions, structural cardiac defects (PDA, PA stenosis), hearing loss, microphthalmia, cataracts, and meningoencephalitis. Brain calcifications are seen in children with congenital toxoplasmosis or congenital cytomegalovirus infection and two other parts of the TORCH (toxoplasmosis, others, rubella, cytomegalovirus, herpes) acronym of congenital infections.

41. A newborn with a vesicular rash, retinopathy, and meningoencephalitis likely has:
    1. Group B streptococcal infection
    2. Congenital rubella infection
    3. Congenital herpes simplex virus infection
    4. Chlamydia infection

42. Which of the following are risk factors for the development of BPD or chronic lung disease (CLD) of infancy?
    1. Lower gestational age
    2. Prolonged mechanical ventilation and oxygen therapy
    3. Male gender
    4. Exchange transfusion
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

43. Bronchopulmonary dysplasia (BPD) or chronic lung disease (CLD) of infancy:
    1. Is only seen in infants who suffered severe RDS
    2. Is caused by oxygen toxicity
    3. Is characterized by hypoxia and hypercarbia
    4. Is seen as often in ex-full-term infants as in ex-preterm newborns
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

44. IM vitamin K is given to newborns:
    1. To make up for the relative deficiency of vitamin K in breast milk
    2. Because newborns have inadequate stores of vitamin K
    3. Because the newborn lacks sufficient bacterial flora to produce vitamin K
    4. To prevent hemorrhagic disease of the newborn due to lack of vitamin K-dependent coagulation factors
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

41. C. Congenital herpes simplex virus infection

Most cases of neonatal herpes occur due to infection during delivery with most cases manifesting themselves in the first month of life. One third of infected infants will never have a skin lesion, while symptoms of encephalitis (lethargy, seizures, poor tone) occur in 50–80 %. Newborns with postnatal infection also often have keratoconjunctivitis. Acyclovir is the mainstay of treatment for HSV. Newborns with intrauterine infection may also present with microcephaly.

42. A. 1, 2, 3

Chronic lung disease results from injury to the newborn lungs from mechanical ventilation and oxygen therapy. It is defined as an oxygen requirement in an infant beyond 36 weeks of postconceptual age. Uncomplicated RDS begins to improve in the third or fourth day, while infants developing CLD show X-ray and clinical worsening. Most affected infants recover by 6–12 months, but some may have respiratory symptoms throughout childhood. Right-sided heart failure may be seen in severely affected infants.

43. B. 1, 3

Treatment of CLD includes nutritional support, fluid restriction, maintenance of adequate oxygenation, and vigorous treatment of infection. Recovery is dependent on growth of healthy new lung tissue. Medications often used to treat these children are diuretics, bronchodilators, and dexamethasone. Infants with CLD often exhibit growth failure, psychomotor retardation, nephrolithiasis (from long-term diuretic therapy and TPN), osteopenia, and subglottic stenosis (from long-term/multiple intubations).

44. E. All of the above

A moderate decrease in some coagulation factors (II, VII, IX, X) occurs in all newborns between the second and third day of life. These gradually return to normal by the tenth day of life. Hemorrhagic disease of the newborn is characterized by GI, nasal, intracranial, or post-circumcision bleeding. Vitamin K administration prevents the fall in vitamin K-dependent factors in term infants but is not effective in all preterm newborns.

45. Which of the following are characteristics of human milk?
    1. It has a casein/whey ratio of 1:4.
    2. It meets all the nutritional needs of infants for only the first 1–2 months of life.
    3. It contains lactose.
    4. Its iron content is adequate for the first year of life.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

46. Instillation of 1 % silver nitrate into the conjunctival sac of newborns shortly after birth:
    1. Is an effective strategy for preventing gonococcal ophthalmia neonatorum
    2. Will not prevent chlamydia conjunctivitis
    3. Can be replaced by instillation of 1 % tetracycline ophthalmic ointment
    4. Should not be considered adequate treatment of ophthalmia neonatorum
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

45. B. 1, 3

There are several advantages to breastfeeding: allergy to cow's milk is avoided, human milk contains antibodies, it is free of contaminating bacteria, it contains macrophages and lactoferrin, and it supplies many important nutrients to the infant. Supplements of iron and vitamin D should be started at 4–6 months. If the water supply is not adequately fluoridated, the infant should receive this as a supplement as well.

46. E. All of the above

Other routines of newborn care include warming and drying to help conserve heat, treatment of the umbilical cord with triple dye, bacitracin or another bactericidal agent, and screening for various diseases (these are state-specific).

Chapter 2
Respiratory System

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Questions

1. Respiratory syncytial virus (RSV):
   1. Is the second most important lower respiratory tract pathogen in early childhood.
   2. Causes infected cells to form characteristic syncytia.
   3. Confers lifelong immunity after one infection.
   4. Infects well over one million children annually.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

2. Which of the following is part of the clinical presentation of RSV bronchiolitis?
   1. It is commonly seen in children less than 2 years of age.
   2. Young infants with the illness may have lethargy and apnea.
   3. Respiratory distress (caused by small airway obstruction).
   4. Wheezes, rales, and rhonchi all may be heard on auscultation of the lungs.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

3. Respiratory syncytial virus (RSV) can cause:
   1. An upper respiratory illness.
   2. Bronchiolitis.
   3. Otitis media
   4. Pneumonia.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

Answers

1. C. 2, 4

RSV is the most important respiratory tract pathogen in childhood. It is the major cause of bronchiolitis and pneumonia in children less than 1 year of age, although placentally transmitted antibody may offer protection for the first 4–6 weeks of life. RSV is a medium-sized RNA virus that produces characteristic syncytial cytopathology. The occurrence of outbreaks each fall and winter and the very high incidence in the first year of life are characteristics not seen with other respiratory viruses.

2. E. All of the above

Infants and children infected with RSV first present with the rhinorrhea, then cough accompanied by audible and auscultatory wheezing. There is intermittent fever and the clear rhinorrhea persists throughout the illness. Hospitalized infants with RSV have normal CXRs only about 10 % of the time.

3. E. All of the above

RSV most typically causes coryza and pharyngitis, often with fever. In 10–40 % of infected children, there is lower respiratory tract involvement (pneumonia, bronchiolitis). RSV infection is usually an outpatient illness. Generally 1–3 % of infected infants are hospitalized.

4. Infection with RSV:
   1. Is very common among infants.
   2. Often leads to more serious respiratory distress in infants aged 2–6 months.
   3. Occurs in epidemics annually during the months of November through April.
   4. Confers lifelong immunity to the RSV virus.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

5. The pathologic changes brought about by RSV infection include:
   1. Necrosis of the respiratory epithelium.
   2. Edema of the submucosa.
   3. Destruction of cilia.
   4. Small airway obstruction by edema and necrotic cells.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

6. Infection with RSV leads to more severe respiratory distress in:
   1. Ex-preterm newborns
   2. Infants with seizure disorders
   3. Children with congenital heart disease
   4. Infants with sickle cell trait
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

7. Treatments for RSV bronchiolitis include:
   1. Amoxicillin
   2. Ribavirin
   3. Racemic epinephrine
   4. Oxygen
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

4. A. 1, 2, 3

Annual epidemics of RSV occur during the 4–5 months of the winter. It is estimated that up to 50 % of susceptible infants undergo infection during each epidemic. Infection is almost universal by the second birthday. Reinfection occurs at a rate of 10–20 % per epidemic throughout childhood with higher rates in day care settings.

5. E. All of the above

The pathology seen in the lung includes necrosis of the respiratory epithelium, mucus secretion, and edema of the submucosa. These changes lead to mucus plugging of the small airways with distal hyperinflation or atelectasis.

6. B. 1, 3

Infection of immunocompromised infants with RSV often results in more severe disease. RSV infection in the first few weeks following bone marrow or solid organ transplant can be as high as 50 %. Children for whom immunoprophylaxis is considered useful are ex-preterm newborns with BPD or CLD and ex-preterm newborns discharged from hospital during RSV season.

7. C. 2, 4

Most hospitalized infants are hypoxemic, requiring humidified oxygen therapy. A trial of inhaled bronchodilators is often undertaken and continued if the clinical status of the child improves.

Antibiotics are not useful in uncomplicated RSV bronchiolitis. They may be indicated if a consolidated pneumonia develops, however. Ribavirin has been shown to have a modest effect on the course of RSV pneumonia, but hospital stay and mortality have not been reduced. Long-term effects are unknown. It is currently recommended only for high-risk infants with RSV such as those with CLD, congenital heart disease, or immunodeficiency.

8. True statements regarding the prognosis for infants with RSV bronchiolitis include:
   1. Infants who develop the illness are more likely to have recurrent wheezing later in life.
   2. Approximately 1–2 % of infants hospitalized with this illness die.
   3. Two to 5 % of hospitalized infants with this illness develop respiratory failure.
   4. Anti-RSV antibody administration will dramatically decrease the severity of the illness.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

9. The differential diagnosis of wheezing in children during the first year of life includes:
   1. Bronchiolitis (RSV).
   2. Ataxia-telangiectasia with pulmonary involvement.
   3. Gastroesophageal reflux (GER).
   4. Cystic fibrosis.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

10. Asthma, a chronic disease of reversible airway obstruction:
    1. Is characterized by episodes of recurrent wheezing and coughing
    2. Only rarely has an allergic basis in children
    3. Often begins before the sixth birthday
    4. Is decreasing in prevalence and severity
       A. 1, 2, 3
       B. 1, 3
       C. 2, 4
       D. 4 only
       E. All of the above

8. A. 1, 2, 3

Administration of Palivizumab (Synagis), a monoclonal antibody against RSV or RSV-IVIG, high-titer antibody against RSV, is recommended for protecting high-risk infants from serious complications of RSV. It has been shown to reduce total hospital days in this population.

9. E. All of the above

Wheezing is a manifestation of obstruction in the lower respiratory tract in children. There are many etiologies:

Acute wheezing: asthma (intrinsic, exercise, anxiety, or cold induced), infection, airway foreign body, and aspiration of GI, oral secretions

Chronic: asthma (as above), tracheo- or bronchomalacia, airway compression (various vascular compressions, enlarged lymph nodes, tumors), bronchitis, cystic fibrosis, sequelae of RDS (chronic lung disease or bronchopulmonary dysplasia)

10. A. 1, 2, 3

Asthma is the most frequent admitting diagnosis in children's hospitals. Before puberty, males are affected twice as often as females. Thereafter, the incidence is equal. Thirty percent of children who will later be diagnosed as asthmatics are symptomatic by 1 year of age, and 80 % present by the fourth birthday. Although up to 50 % of asthmatic children are nearly symptom-free by 20 years of age, resolution is rare in children with steroid-dependent disease.

11. Airway narrowing in asthma is due to:
    1. Thickened basement membranes
    2. Edema of the small airways
    3. Mucus secretion
    4. Increased airway smooth muscle tone
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

12. Causes of wheezing in asthmatic children include:
    1. Viral respiratory infections such as RSV infection
    2. Tobacco smoke
    3. Aspirin
    4. Animal dander
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

13. The changes in the small and large airways that occur in asthma lead to:
    1. Increased airway resistance, especially noticeable during exhalation
    2. Hypercarbia resulting from decreased respiratory drive
    3. Ventilation-perfusion (V/Q) mismatch due to nonuniform airway involvement
    4. Increased specific compliance due to much lower resting lung volumes
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

14. Pathophysiologic alterations seen in asthmatic children include:
    1. Nonuniform small airway obstruction
    2. V/Q mismatch
    3. Decreased lung compliance as a result of hyperinflation
    4. Atelectasis
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

11. E. All of the above

The airway obstruction in asthma is due to bronchoconstriction, mucus hypersecretion, mucosal edema, cellular infiltration, and also desquamation of epithelial and inflammatory cells within the airways.

12. E. All of the above

Wheezing is a complex process involving autonomic, immunologic, infectious, endocrine, and psychological factors. In children with extrinsic or allergic asthma, wheezing results from exposure to environmental factors, and these patients have increased, IgE against the implicated allergens. Children with intrinsic asthma do not have such antibodies. Viral infections are the most important infectious triggers of asthma (see RSV). Emotional factors may trigger wheezing and children with this chronic disease may suffer emotional consequences from the illness.

13. B. 1, 3

$PaCO_2$ is generally low early in asthma attacks, rising as the obstruction worsens. PaO_2 is often low during an acute exacerbation and may remain so for several days after the worst of the attack is over. Reversible airway obstruction is a hallmark of asthma, with PEFR and FEV1 increasing at least 10 % following bronchodilator administration.

14. E. All of the above

CXR abnormalities often seen in children during acute exacerbations of asthma include hyperinflation, atelectasis, infiltrates, and pneumomediastinum. PEFR and FEV1 are decreased, often by more than 15 %. ABG abnormalities are described above.

15. Treatment of acute exacerbations of asthma includes:
    1. CPAP
    2. Steroids
    3. Cromolyn
    4. Beta-agonists
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

16. Regarding the use of theophylline as a treatment for asthma:
    1. The medication has a narrow therapeutic range.
    2. It inhibits phosphodiesterase and is an adenosine receptor antagonist.
    3. It is effective orally and intravenously.
    4. Side effects include sleep disturbances, nausea, vomiting, and headaches.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

17. Which of the following are common side effects of nebulized albuterol?
    1. Nausea and vomiting
    2. Jitteriness, sleep disturbances
    3. Suppression of adrenal secretion
    4. Tachycardia
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

18. Complications of asthma seen in children with asthma include:
    1. Pneumothorax.
    2. Pneumonia.
    3. Pneumomediastinum.
    4. Sudden death.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

15. C. 2, 4

Therapy of acute asthma is aimed at lessening bronchoconstriction and reducing inflammation. Oxygen is administered by mask or nasal prongs. Bronchodilation is achieved with various inhaled medications such as beta-2 agonists (albuterol) and/or cholinergic antagonists (ipratropium bromide). Systemic corticosteroids are often given for a short course. CPAP will likely worsen air trapping and is avoided. Commonly is useful for prophylaxis, especially with exercise-induced asthma. Cromolyn is a maintenance medication with little use during acute exacerbations.

16. E. all of the above

Theophylline may be given orally as a sustained release preparation for children with moderately severe asthma as an alternative to inhaled steroids or cromolyn. It also may be used IV in the treatment of acute severe asthma. The therapeutic range is 10–20 mg%. Toxicity may be seen with serum levels of 25–30 mg%.

17. C. 2, 4

Other treatments for asthma include:

Ipratropium: a cholinergic antagonist that may cause tachycardia and abdominal pain. Cromolyn: an inhaled powder, which may cause coughing especially when first used. It is used as a preventive measure in asthma, not a treatment of acute exacerbations.

Albuterol: the jitteriness from albuterol usually occurs with excessive use of either the PO or inhaled forms.

18. E. All of the above

Death from childhood asthma is rare, but mortality rates have been increasing. Mortality rates are several times higher in African-American children than in white children.

19. Clinical manifestations of cystic fibrosis include:
    1. Productive cough and recurrent respiratory infections
    2. Hemoptysis, pneumothorax, and atelectasis
    3. Maldigestion due to exocrine pancreatic insufficiency
    4. Diabetes insipidus
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

20. Cystic fibrosis, the major cause of severe chronic lung disease in children:
    1. Occurs in 1:3,000 white and 1:17,000 black live births
    2. Is characterized by thickened secretions
    3. Primarily involves the pulmonary and gastrointestinal systems
    4. Is inherited as an autosomal dominant trait
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

21. Treatments that patients with cystic fibrosis (CF) might receive include:
    1. Pancreatic enzyme replacement, high calorie diets, and fat-soluble vitamin supplements
    2. Antibiotics to control progression of pulmonary infections
    3. Bronchodilator and anti-inflammatory agents
    4. Oxygen
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

19. A. 1, 2, 3

CF is characterized by obstruction and infection of the airways and malabsorption of many important nutrients. After 10 years of age, 85 % of children with cystic fibrosis will develop diabetes mellitus. People with CF have varying degrees of the following respiratory tract problems: failure to clear mucus secretions, dehydrated mucus secretions, and chronic infection in the respiratory tract. The rate of progression of lung disease is the chief determinant of morbidity and mortality. The first lung pathology is bronchiolitis, followed later by bronchiectasis. Interstitial disease is not a regular feature although eventually fibrosis does develop. The paranasal sinuses are filled with secretions and the epithelial lining is hyperplastic and hypertrophic. The nasal mucosa is edematous and develops polyps.

20. A. 1, 2, 3

The CF gene is most common in Northern and Central Europeans. It codes for a protein called the transmembrane conductance regulator (CFTR) that is expressed largely in epithelial cells of the airways, GI tract, sweat glands, and GU system.

21. E. All of the above

Antibiotics, given PO, IV and via inhalation, are used to control the progression of lung infection. Steroids are used to treat allergic pulmonary aspergillosis. Anti-inflammatory agents may slow the progression of lung disease.

22. Croup, a clinical syndrome of barking cough, hoarseness, and inspiratory stridor, has several causes, including respiratory viruses. Characteristics of croup include:
    1. The illness lasts for 4–6 days.
    2. There is a characteristic CXR finding called the pencil (or steeple) sign indicative of subglottic tracheal narrowing.
    3. Treatment with inhaled racemic epinephrine (0.5 cc of a 2.25 % solution) temporarily improves the stridor.
    4. Dexamethasone, 0.3–0.5 mg/kg, is a treatment for the illness.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

23. Clinical characteristics of croup (laryngotracheobronchitis) include:
    1. Mild temperature elevation, rarely reaching 39 °C
    2. The presence of a URI (upper respiratory infection) for 1–3 days prior to the onset of stridor
    3. A peak incidence during the ages of 18 months to 3 years
    4. A typical barking cough
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

24. Acute epiglottitis presents differently than viral croup in the following way(s):
    1. The course of epiglottitis is much more rapid and fulminating.
    2. The temperature elevation in epiglottitis is greater.
    3. The age range of children with epiglottitis is older.
    4. Very often other family members of children with epiglottitis have been ill with URI symptoms.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

22. E. All of the above

Croup is the most common form of acute upper airway obstruction and is most commonly caused by a virus. Symptoms are characteristically worse at night. Most children with croup progress to stridor and slight dyspnea and then begin to recover. Agitation and crying, with associated more rapid respiratory rate and turbulent airflow, worsen the situation. Children with croup prefer to sit upright.

23. E. All of the above

Older children are generally not seriously ill. Other family members may have a mild respiratory illness. The nighttime worsening may recur for several consecutive days before the illness resolves.

24. A. 1, 2, 3

Epiglottitis is usually seen in children aged 2–7 years, while croup is more often seen in younger children. Epiglottitis is caused by bacteria, croup a virus. Other family members are not acutely ill with respiratory viruses as is the case with croup. Epiglottitis is a severe bacterial infection associated with high fever, rapidly progressing airway obstruction, and dyspnea.

25. Aspirated airway foreign bodies:
    1. Can usually be seen on either a PA or lateral CXR
    2. Most often occur in 2–4-year-old children
    3. Are usually first noted during an acute URI when the child has more severe symptoms than usual
    4. May not be noted until some time after the aspiration episode
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

26. Bacterial tracheitis, a cause of upper airway obstruction that occurs as a super-infection of viral laryngotracheitis:
    1. Is often caused by coagulase+ Staph or Haemophilus influenzae
    2. Is diagnosed with airway endoscopy
    3. Is regularly treated with endotracheal intubation and IV antibiotics
    4. Is seen only in the teenage years
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

27. Regarding acute otitis media (AOM) in children:
    1. Both bacteria and viruses are known causative agents.
    2. Meningitis is a possible complication of untreated bacterial AOM.
    3. It is generally treated with PO antibiotics.
    4. Infants less than 1 month of age with AOM should be thoroughly evaluated for systemic infection.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above