Pediatric Anesthesiology Review

Clinical Cases for Self-Assessment

Robert S. Holzman
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Third Edition

Springer

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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 since 1992 in our department 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 try to mimic the spontaneity achievable through conversation. First of all, a "buddy" system is advisable. Secondly, a small handheld recorder is extremely useful when using the questions as prompts; the contemplative reader will listen critically to the responses he or she has offered and then hopefully improve as the recording continues. 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 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 these diverse audiences.

This third edition has the same purpose as our previous endeavors—to accompany the reader's journey in attaining proficiency, expertise, and, finally, mastery in the consultative practice of 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 side, and eventually cover the questions on the left. In this very simple, programmed text manner, practice at generating the appropriate breadth and depth of answers, and then questions, can be encouraged.

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.

With this basic guidance, the reader is encouraged to be creative throughout this book, to use imagination and 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."

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Part I
Pediatric Medicine for Pediatric Anesthesiologists

Chapter 1
General Pediatrics

Thomas J. Mancuso

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Questions

1. Which of the following are considered risk factors for the development of tuberculosis (TB) in children?
   1. HIV infection
   2. Exposure to an infectious adult
   3. Malnutrition
   4. Passive exposure to cigarette smoke
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

2. Tuberculosis infection may involve which of the following organs/systems?
   1. The lungs
   2. The bones
   3. The CNS
   4. The kidneys
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

3. What percentage of immunocompetent adults infected with tuberculosis will develop active disease during their lives?
   A. 100%
   B. 50%
   C. 25%
   D. 5%
   E. 2%

4. Which of the following factors may affect the accuracy of the Mantoux test (the intradermal injection of 5 TU of PPD in 0.1 ml diluent)?
   1. Concurrent penicillin treatment
   2. The presence of other infections
   3. Presence of fever >38 °C
   4. Prior BCG vaccination
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

Answers

1. A. 1, 2, 3

TB in the USA is unfortunately becoming more common in adults as well as in children. It is an important cause of mortality worldwide. In the USA, infection of children often results from exposure to an untreated individual with active disease. Reservoirs of TB include people with HIV/AIDS, the homeless, patients living in overcrowded conditions, and new immigrants.

2. E. All of the above

TB infection can involve most organ systems. It most commonly affects the lungs. Superficial lymph node infection is a common manifestation of TB infection. The major cause of death in children from TB is meningitis. Cerebrospinal fluid (CSF) findings in TB meningitis include a predominance of lymphocytes in low numbers (50–500 cells/μl), low glucose, and elevated protein. The TB organism is seen in less than 50 % of cases, and CSF cultures become positive only after several weeks. Miliary tuberculosis, so called because the small lesions found throughout the body resemble millet seeds, is due to blood-borne spread of the organism.

3. D. 5%

Predisposing factors for the development of serious disease in patients infected with TB include young age, pregnancy, and decreased vigor of the immune response (HIV/AIDS, poor nutrition, steroid treatment).

4. E. All of the above

Patients previously immunized by bacille Calmette-Guérin (BCG) will show a positive PPD. The BCG vaccine, derived from a mycobacterium related to TB, activates cell-mediated immunity. Since the many vaccines derived from strains of the bacterium differ from one another in antigenicity, the immune response to the vaccines is quite variable.

5. Group A beta-hemolytic streptococci cause:
   1. Scarlet fever tonsillitis
   2. Impetigo
   3. Erysipelas
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

6. Which one of the following is true regarding the nonsuppurative complications of group A beta-hemolytic infections?
   A. Rheumatic fever may develop after tonsillitis.
   B. Neither nephritis nor rheumatic fever develops after impetigo.
   C. Rheumatic fever is caused by the same strains of the organism as nephritis.
   D. Nephritis develops only after scarlet fever rashes.

7. *Helicobacter pylori* (*H. pylori*):
   1. Has been cultured from children with hypertrophic pyloric stenosis
   2. Has been implicated as a cause of chronic abdominal pain in children
   3. Generally causes watery, but not bloody, diarrhea
   4. Is considered a contributing factor in the pathogenesis of peptic ulcer
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

8. Colitis due to infection with toxigenic *Clostridium difficile*:
   1. Is due to overgrowth of the organism after antibiotic therapy
   2. Is characterized by watery, often bloody, diarrhea
   3. Is due to the toxins produced by *C. difficile*
   4. Can also be caused by ingestion of preformed toxin found in poorly refrigerated food
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

5. E. All of the above

This gram-positive organism, also called *S. pyogenes*, can be divided into over 60 subtypes based on surface protein, such as the M proteins. Impetigo is most common in younger children and tonsillitis/pharyngitis in school-aged children.

6. A. Rheumatic fever may develop after tonsillitis.

Many serologic types of group A *Streptococcus* infecting the throat can be associated with rheumatic fever. Nephritis, in contrast, is related to a limited number of types and may occur following skin infections, while rheumatic fever only follows pharyngitis.

7. C. 2, 4

Infection with this bacterium is associated with ulcer disease, acute gastritis, and chronic abdominal pain. *H. pylori* is responsible for at least 50 % of duodenal and gastric ulcers in adults, but it is the cause of a lower percentage of ulcers in children. In some patients with chronic abdominal pain, eradication of *H. pylori* has been associated with diminution of the pain.

8. A. 1, 2, 3

Antibiotic-associated diarrhea is due to toxins produced by *C. difficile*. Overgrowth of the bacteria occurs when antibiotic treatment suppresses normal flora in the GI tract. Symptoms continue for 7–10 days after stopping the antibiotic therapy. In more severe cases, IV and/or enteral vancomycin therapy may be needed. Food poisoning is caused by ingestion of *C. perfringens* capable of forming spores. Botulism is a form of food poisoning caused by ingestion of the neurotoxin made by *C. botulinum*.

9. Regarding the clinical manifestations of bacterial meningitis beyond the neonatal period:
   1. Focal neurologic signs are seen in 10–15% of cases.
   2. If seizures occur, it is very likely that the child will be left with a permanent seizure disorder.
   3. Fever need not be present.
   4. Photophobia, due to inflammation of the optic nerve, may lead to permanently impaired vision.
      A. 1, 2, 3
      B. 1, 3
      C. 2, 4
      D. 4 only
      E. All of the above

10. Regarding the prognosis of bacterial meningitis beyond the neonatal period:
    1. Some degree of hearing loss is seen in approximately 10% of survivors.
    2. Neurologic abnormalities seen shortly after the onset of meningitis may resolve over time.
    3. The mortality rate is 1–5%.
    4. Brain abscesses are commonly seen during the course of antibiotic therapy.
       A. 1, 2, 3
       B. 1, 3
       C. 2, 4
       D. 4 only
       E. All of the above

11. The hemolytic uremic syndrome:
    1. Typically has a prodrome of 3–5 days of diarrhea
    2. May include neurologic dysfunction such as seizures or coma in its presentation
    3. May include hypertension as part of its presentation
    4. Generally is treated with supportive care (careful fluid and electrolyte management, dialysis, and transfusion as needed)
       A. 1, 2, 3
       B. 1, 3
       C. 2, 4
       D. 4 only
       E. All of the above

9. B. 1, 3

Fever is often part of the presentation of bacterial meningitis in children. Lethargy, vomiting, and decreased level of consciousness may also be part of the presentation.

10. A. 1, 2, 3

The worst prognosis is seen in younger children with higher bacterial counts in the CSF. Cerebral or spinal cord infarction, another unusual complication seen in children with bacterial meningitis, can be diagnosed by CT.

11. E. All of the above

HUS is primarily a disease of young children. HUS is characterized by hemolytic anemia, thrombocytopenia, and renal dysfunction. Prognosis for survival is very good, and long-term morbidity such as hypertension and mild azotemia is seen in <10 % of cases. Many causes and associations have been noted. The syndrome can be seen as a result of a toxin-producing *E. coli*, following a prodrome of diarrhea. Treatment is mainly supportive, with careful fluid and electrolyte management.

12. Children with the hemolytic uremic syndrome (HUS):
    1. May have had infection with *E. coli*, *Shigella*, or *Salmonella*
    2. Have anemia, thrombocytopenia, and low WBC counts due to bone marrow failure
    3. Are generally younger than 5 years of age
    4. Are best treated with IV immunoglobulin
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

13. In children with a temperature greater than 39 ° C without a source for the fever:
    1. Bacteremia will likely occur in 1–5% of cases.
    2. Bacteremia, if it occurs, will most often be due to *Streptococcus pneumoniae*.
    3. The risk for occult bacteremia is greatest among those younger than 24 months.
    4. Almost all of the children who have bacteremia will develop purulent complications.
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

14. Which of the following are seen relatively often in children with immunodeficiencies?
    1. Growth failure
    2. Chronic diarrhea
    3. Skin rashes
    4. Recurrent or chronic infections
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

15. Scabies:
    1. Is characterized by beefy red skin with satellite lesions
    2. Has 1–2 mm red papules which may be excoriated or crusted
    3. Is caused by contact with an allergen
    4. Is a pruritic rash, particularly at night
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

12. B. .1, 3

Treatment of children with HUS is supportive. The low red cell and platelet counts are due to hemolysis and increased destruction, respectively. The hemoglobin at presentation may be as low as 2 g/dl and platelet count <100,000/mm^3.

13. A. 1, 2, 3

Children who present with fever without a source often have viral illnesses, but in children <36 months of age, a WBC count with differential may help identify those with a much greater likelihood of bacteremia.

14. E. All of the above

Immunodeficiencies can be primary or secondary. Primary immunodeficiencies can involve defects in B cells, complement, T cells, or neutrophils. Secondary immunodeficiencies can result from malnutrition, viral infections, metabolic disorders (diabetes mellitus, sickle cell disease, uremia) or malignancies, and cancer chemotherapy.

15. C. 2, 4

Scabies is an intensely pruritic rash, and its preferred sites are interdigital spaces, wrists, elbows, and ankles. Other common rashes seen in infants and children include *Candida albicans*, which commonly complicates diaper dermatitis (which does not have the same beefy red appearance and satellite lesions), and tinea corporis, which is well described by its common name, ringworm.

16. Urticaria (hives) in children may be associated with:
    1. Airway edema
    2. Contact with a food or chemical
    3. Exposure to cold
    A. Exercise1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

17. Urticaria:
    1. Is an evanescent rash consisting of red-pink wheals
    2. May be treated with PO diphenhydramine
    3. Is commonly associated with beta-streptococcal infections
    4. Is especially common in children with abnormalities in T-cell function
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

18. The first teeth to erupt, the lower central incisors, do so at the age of:
    A. 4 months
    B. 7 months
    C. 12 months
    D. 15 months

19. Which of the following is the most common form of child maltreatment?
    A. Physical abuse
    B. Neglect
    C. Sexual abuse
    D. Emotional abuse

16. E. All of the above

Urticaria is characterized by a localized or generalized erythematous, raised rash with lesions of various sizes.

17. A. 1, 2, 3

Up to 20 % of the general population experience urticaria at some point in their lives. Angioedema is a different lesion involving deeper skin layers or submucosa that involves the periorbital and perioral areas, lips, tongue, respiratory tract, hands, feet, and GI tract.

Hereditary angioedema (HAE) is a different condition, transmitted as an autosomal dominant trait. HAE results from partial deficiency of C1 esterase, an enzyme that inhibits the first part of the complement system. This deficiency allows activation of the complement system with resultant symptoms such as angioedema. This edema, without urticaria, can involve the airway.

18. B. 7 months

Deciduous teeth erupt as follows:

6–7 months: upper (first) and lower incisors
7–9 months: upper and lower (first) lateral incisors
16–18 months: bicuspids
12–14 months: first molars
20–24 months: second molars

Permanent teeth begin erupting at 6–7 years of age with incisors first and then molars, followed by bicuspids.

19. B. Neglect

Each year in the USA, there are approximately one million confirmed cases of abuse or neglect of children. The true incidence of abuse and neglect is almost certainly much greater than the one million confirmed reports, however. Physicians are required by law in all states to report all cases of suspected child abuse. Cultural and geographic norms vary greatly, but a working definition of abuse is parental (or guardian) behavior that damages the normal physical and psychological development of a child.

20. Sudden infant death syndrome (SIDS) has been associated with:
    1. Inadequate nutrition
    2. Recent immunization
    3. Maternal smoking
    4. Concurrent upper respiratory infection
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

21. SIDS:
    1. Is the most common cause of death in the first 2 weeks of life
    2. Accounts for 35% of post-perinatal deaths/year in the USA
    3. Occurs with the same frequency in all ethnic groups
    4. Has no pathognomonic markers at autopsy
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

22. A brief resolved unexplained event (BRUE):
    1. Would have previously been called a near-miss SIDS event or apparent life-threatening event (ALTE)
    2. Is more likely to occur following immunizations
    3. May present with pallor, cyanosis, limpness, and apnea
    4. Would be much more likely to occur in firstborn children
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

23. Which of the following conditions are often associated with BRUEs?
    1. Gastroesophageal reflux (GER)
    2. Acute upper respiratory infections (URI)
    3. Seizures
    4. Failure to thrive (FTT)
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

20. B. 1, 3

SIDS occurs almost exclusively in the second through fifth months of life with the peak in the midpoint of that time period. The incidence does not differ much in various seasons or in different climates.

21. E. All of the above

The diagnosis is often one of exclusion. The incidence appears to be stable. In some cases of SIDS, there may have been suffocation by an adult, but this is difficult to prove.

22. B. 1, 3

Although infants who suffer an ALTE requiring intervention may seem to have a slightly higher chance of dying from SIDS, most infants who do succumb to SIDS have not had a prior ALTE.

23. A. 1, 2, 3

While these conditions are seen with higher frequency in infants who have suffered an ALTE, they are not seen more often in infants who have succumbed to SIDS. The pathologic hallmark of SIDS is that there is no pathognomonic finding for SIDS.

24. In children with obstructive sleep apnea syndrome (OSAS), also called sleep-disordered breathing:
    1. The physical exam during wakefulness may be entirely normal.
    2. There is anatomical narrowing of the upper airway.
    3. There is abnormal neuromuscular control of upper airway patency.
    4. The complications which may develop include FTT, hyperactivity, and poor school performance.
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

25. Myelomeningocele:
    1. Is the most common severe form of neural tube defect
    2. Occurs less often in children of mothers who took supplemental folate in the periconceptional time period
    3. May be located anywhere along the neuraxis
    4. Is associated with a Chiari type II defect in 80% of cases
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

26. Tetanus immunization is usually done in combination with other immunizing agents (DTP, Td, DT). Active immunization with tetanus toxoid:
    1. Provides 10 years of immunity
    2. Is given with pertussis in children only until 7 years of age
    3. Is unnecessary in persons with superficial clean wounds who have received their last tetanus toxoid within the past 10 years
    4. Should be given to persons with more serious and dirty/animal wounds if their most recent tetanus toxoid dose was given more than 5 years ago
    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

24. E. All of the above

In addition to the problems mentioned, nighttime hypoxemia with resultant pulmonary hypertension and cor pulmonale can develop in children with sleep-disordered breathing. Sleep studies are used to confirm the diagnosis. A history of nighttime snoring is not sufficient to diagnose sleep-disordered breathing.

25. E. All of the above

The caudal neuropore closes by the fourth to fifth week of gestation. Failure of this closure to occur leads to the development of a variety of congenital anomalies including spina bifida occulta, spina bifida cystica, meningocele, and myelomeningocele. Spina bifida occulta is seen in 10 % of the population and generally causes no symptoms. Spina bifida cystica, a saclike lesion associated with unfused vertebrae, is seen in 0.1 % of people. Myelomeningocele is seen in approximately 0.1 % of live births. The location within the cord determines the clinical picture of this condition. Affected children undergo repair within 1–2 days of life and commonly ventriculoperitoneal shunt placement shortly thereafter. The problems (orthopedic, urological, gastrointestinal) persist throughout life. Most children with myelomeningocele have normal intellect.

26. E. All of the above

Tetanus is fortunately very rare in the USA. The bacterium *Clostridium tetani* produces two toxins, but only one, tetanospasmin, produces disease. It is a very potent neurotoxin. Generalized tetanus, the most common presentation, involves trismus, nuchal rigidity, difficulty swallowing, as well as headache. Subsequently, affected individuals develop generalized, uncoordinated muscle spasms. These muscle spasms can lead to fractures, dysphagia, and even respiratory failure.

27. Which of the following statements are true regarding current vaccines given to children?
    1. Paralytic polio is very rarely (1 in 2.6 million) caused by oral polio vaccine (OPV) in either vaccine recipients or contacts.
    2. Although measles vaccine may cause fever in 15% of recipients, more serious side effects are exceedingly rare.
    3. Mumps vaccine may rarely cause orchitis.
    4. Local reactions may occur in up to 25% of recipients of *Haemophilus influenzae* type B vaccine.

    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

28. Therapy for suspected tetanus infection includes:
    1. Penicillin G to kill the *C. tetani*
    2. Tetanus immune globulin (TIG) to neutralize circulating toxin before it binds to neuronal membranes
    3. Active immunization with tetanus toxoid
    4. Dialysis to remove toxin if the patient deteriorates, developing more and more severe muscle spasms

    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

29. Regarding pertussis infection in the USA:
    1. Mortality is highest among infants.
    2. The attack rate of approximately 1 per 1,000,000 is due to high vaccination rate.
    3. Approximately 50% of reported cases are in children <1 year of age.
    4. It is extremely contagious among nonimmunized children.

    A. 1, 2, 3
    B. 1, 3
    C. 2, 4
    D. 4 only
    E. All of the above

27. E. All of the above

28. A. 1, 2, 3

Treatment involves inactivation of the circulating toxin, treatment of the infection to stop toxin production, and supportive care as needed. If there is significant tissue necrosis, IV antibiotics will not reach therapeutic levels, and these wounds must be debrided. In very severe cases, amputation should be considered.

Tetanus is caused by an exotoxin produced by *C. tetani*. TIG has no effect on toxin that has already bound to neural tissue and does not cross the blood-brain barrier.

29. E. All of the above

Herd immunity ("community immunity" – "when the vaccination of a portion of the population (or herd) provides protection to unvaccinated individuals") keeps the incidence of the illness low, protecting those infants who are not fully immunized.

30. The clinical manifestations of pertussis include:
    1. Severe paroxysms of coughing, particularly at night
    2. A characteristic inspiratory sound (whoop) between coughing spells
    3. A calm appearance between coughing spells
    4. Normal temperature throughout the illness
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

31. Complications of pertussis infection include:
    1. Bronchopleural fistula
    2. Seizures and mild, transient encephalitis
    3. Coagulopathy
    4. Pneumonia
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

32. Regarding reactions to pertussis immunization:
    1. Temperature elevations >38 °C are seen in approximately 50% of vaccine recipients.
    2. Seizures occur in approximately 1 of 2000 vaccine recipients.
    3. Reactions seem more common and perhaps more severe in children who are older than 7 years when vaccinated.
    4. Evidence for pertussis vaccine encephalopathy, autism, or SIDS following the vaccine has not been found.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above

33. Regarding vaccination against polio:
    1. The inactivated polio vaccine (IPV) is contraindicated in immunocompromised children.
    2. Lifelong, but type-specific, immunity is conferred by recognized infections.
    3. Paralytic polio has never been seen in a contact of a recipient of OPV.
    4. OPV and BP are trivalent and provide immunity to three virus types.
        A. 1, 2, 3
        B. 1, 3
        C. 2, 4
        D. 4 only
        E. All of the above