

# 2

## Cardiovascular System

---

The following chapter will focus on the cardiovascular system. Pertinent questions, answers, and rationale will be reviewed. Answers for this chapter can be found beginning on page 115.

**Key Words:** Heart; cardiovascular; rhythm; ventricles; atrial.

---

1. All of the following are true regarding the interaction between respirations and circulation except:
  - a. The Mueller maneuver decreases afterload.
  - b. The hemodynamic effects of changing intrathoracic pressure dominates over changing intrathoracic volume.
  - c. Hypoxic pulmonary vasoconstriction is noted when alveolar oxygen pressure ( $\text{PaO}_2$ ) drops to less than 60 torr.
  - d. The single most important cardiopulmonary interaction is the effect that ventilator induced changes in intrathoracic pressure have on right ventricular preload.
  - e. Venous return parallels transmural pressure of the right atrium.
2. Ventricular afterload is best approximated by which of the following?
  - a. Ventricular end-diastolic pressure.
  - b. Ventricular end-diastolic volume.
  - c. Systolic blood pressure.
  - d. Mean blood pressure.
  - e. Ventricular wall stress.
3. The mechanism operative in ventricular interdependence is:
  - a. Right-to-left shift of the interventricular septum.
  - b. Constraint of left ventricular expansion by stretch of common ventricular myofibrils.
  - c. Restriction of left ventricular filling by the stretched pericardium.
  - d. All of the above.
4. Which of the following statements is true pertaining to cardiopulmonary interaction?
  - a. The cardiopulmonary interaction is of greatest clinical importance for the failing left ventricle.
  - b. In the failing heart, the effect of changes in intrathoracic pressure on preload will dominate over the effects on afterload.
  - c. In young infants with less compliant ventricles with a limited contractile reserve, positive pressure ventilation with increased intrathoracic pressure may be detrimental.
  - d. Afterload is best approximated by left ventricle preload.
5. All of the following statements are true regarding the fetal circulation except:
  - a. The foramen ovale allows equalization of preload of the right and left ventricles.
  - b. The right ventricle ejects more highly oxygenated blood than the left ventricle, because it receives the umbilical vein blood.
  - c. The right and left ventricular pressures are nearly equal *in utero*.
  - d. The right ventricle ejects more blood than the left ventricle owing to the difference in afterload.

6. Which of the following is true regarding the fetal and newborn myocardium?
  - a. A low contractile element concentration is present in the newborn myocardium.
  - b. Because fetal heart functions at the peak of the ventricular function curve, combined ventricular output is maximum at a resting atrial pressure of 3–5 mmHg.
  - c. Compared with the adult, the newborn heart has higher indices of myocardial performance at rest, but is unable to significantly improve ventricular performance.
  - d. Small increases in afterload decrease cardiac output more significantly in the fetus and the infant compared with the adult, and nitroglycerin increases cardiac output more in the adult compared with the infant.
  - e. All of the above.
7. Hemodynamic changes at birth include:
  - a. Right ventricular afterload decreases, and left ventricular afterload decreases.
  - b. Right ventricular afterload decreases, and left ventricular afterload increases.
  - c. Both right ventricular and left ventricular afterload increase.
  - d. Right ventricular afterload increases, and left ventricular afterload decreases.
  - e. None of the above.
8. Which of the following contributes the most to the total peripheral resistance?
  - a. Aorta and large arteries.
  - b. Small arteries.
  - c. Arterioles.
  - d. Capillaries.
9. The major portion of cardiac  $O_2$  consumption is used to support which of the following?
  - a. Myocardial wall tension.
  - b. The product of stroke volume and mean arterial pressure.
  - c. Electrical activation of the myocardium.
  - d. None of the above.
10. Which of the following situations is considered to be least efficient with regard to myocardial  $O_2$  consumption and myocardial wall tension?
  - a. Poor myocardial compliance.
  - b. A heart with left ventricular hypertrophy.
  - c. A dilated heart with a small preload.
  - d. A dilated heart with a large preload and a thin left ventricular wall.
11. Ischemia of the myocardium with associated symptoms and signs is rarely seen with aortic regurgitation, but is commonly seen with aortic stenosis. Which of the following underlying pathophysiological phenomena related to these clinical entities is true?
  - a. Maintaining blood pressure by increasing stroke volume rather than vasoconstriction is more  $O_2$  efficient.
  - b. The  $O_2$  cost of isometric contraction (pressure work) is much greater than isotonic contraction (volume work).
  - c. Increasing cardiac output by afterload reduction, which increases stroke volume, but decreases pressure, greatly improves the efficiency of the heart.
  - d. All of the above statements are true.
12. Regarding the figure below, match the following statement(s) with their correct answer below:
 
  - a. Area A.
  - b. Area B.
  - c. Both.
  - d. Neither.

\_\_\_\_\_ Represent(s) myocardial  $O_2$  supply.
13. Ischemic heart disease (IHD) should be sought as a diagnosis in neonates who are critically ill. Risk factors for IHD in neonates include:
  - a. Increased intracavity pressure.
  - b. Variable aortic pressure.
  - c. Ductal run-off.
  - d. Global hypoxia and episodes of arterial desaturation.
  - e. All of the above.
14. Which of the following statements is true regarding IHD in critically ill neonates?
  - a. IHD is almost unheard of.
  - b. IHD is treated with  $O_2$ , positive pressure ventilation, and inotropes.
  - c. Symptoms resolve in 48 hours with supportive care, whereas the electrocardiogram and radiographic changes resolve in 2 weeks.

- d. The clinical picture is that of hypoxemia, cardiomegaly, cardiogenic shock, and tricuspid insufficiency.
  - e. All except A are true.
15. Clinical situations in which myocardial ischemia and infarction are recognized in children with congenital heart disease include:
    - a. Right ventricular infarction in total anomalous pulmonary venous drainage.
    - b. Left ventricular infarction in aortic stenosis.
    - c. Biventricular infarction in transposition of the great arteries.
    - d. All of the above.
    - e. None of the above.
  16. Which of the following is a true statement concerning anomalous left coronary artery?
    - a. By 4 months of age, the majority of infants will have developed a coronary fistula.
    - b. Without treatment, 80% of infants will survive to adulthood.
    - c. There is frequently a history of cyanosis at birth.
    - d. The clinical condition may mimic gastroschisis.
    - e. All of the above.
  17. The leading cause of IHD in children is:
    - a. Kawasaki syndrome.
    - b. Left anomalous coronary artery.
    - c. Severe aortic stenosis.
    - d. Atherosclerotic disease.
    - e. None of the above.
  18. Coronary artery involvement and cardiac abnormalities are more common in children with Kawasaki syndrome who exhibit which of the following characteristics?
    - a. Are female older than 8 years of age.
    - b. Have associated torus fracture.
    - c. Have had a fever less than 2 days.
    - d. Have an erythrocyte sedimentation rate of less than 20 mm/hour.
    - e. None of the above.
  19. A 13-year-old male victim of a motor vehicle accident with multiple trauma and closed head injury is in the pediatric intensive care unit (PICU) with elevated intracranial pressure. Poor peripheral perfusion and low urine output is noted with a central venous pressure of 18 mmHg. True statements pertaining to this patient include:
    - a. Impaired left and right ventricular function has been reported in patients with closed head injury.
    - b. Head injury causes an enhanced autonomic response with direct sympathetic cardiac stimulation and an enhanced level of circulating catecholamines.
    - c. ST-T changes on the electrocardiogram are seen in head injury patients.
    - d. Myocardial injury is seen frequently in the setting of thoracic trauma.
    - e. All of the above.
  20. During high permeability pulmonary edema:
    - a. The ratio of extravascular lung water to dry lung weight is decreased.
    - b. The blood-free dry weight of the lung is increased.
    - c. The dry weight of the lung is decreased.
    - d. None of the above is true.
  21. Which of the following statements pertaining to this equation is true?
 

$$Q = K_f (P_c - P_i) - \sigma ( \Pi_c - \Pi_i )$$

    - a.  $K_f$  is the reflection coefficient.
    - b.  $\sigma$  is the filtration coefficient.
    - c. When  $\sigma = 1$ , there is no restriction to passage of protein across the capillary membrane.
    - d. When  $\sigma = 0$  there is absolute restriction to the passage of protein across the capillary membrane.
    - e. None of the above.
  22. Of the various causes of heart failure that produce pulmonary edema not related to congenital heart disease, anthracycline cardiotoxicity is an important type. A factor that potentiates the incidence of heart failure because of anthracycline is:
    - a. Administration of bleomycin.
    - b. Administration of cyclophosphamide.
    - c. Mediastinal radiotherapy.
    - d. All of the above.
    - e. None of the above.
  23. A 13-year-old boy with a previous history of acute lymphoblastic leukemia treated with chemotherapy including doxorubicin presents to the PICU in florid pulmonary edema. The chest radiograph shows an enlarged heart with evidence of alveolar edema. All of the following statements are true of this clinical scenario except:
    - a. Symptoms of congestive cardiac failure caused by doxorubicin toxicity may appear years after the last dose of doxorubicin.

- b. The mortality rate for this patient is at least 50–60%.
  - c. Cardiotoxicity as a result of doxorubicin is dose independent.
  - d. Cardiac enzyme assay and serial chest radiographs have not been useful in the prediction of cardiomyopathy.
  - e. Because anthracyclin cardiomyopathy may be reversible in children, intensive cardiac support with tracheal intubation and positive pressure ventilation may be warranted to treat an acute episode of pulmonary edema.
24. Which of the following is not a cause of high permeability pulmonary edema?
- a. Salicylate intoxication.
  - b. Prolonged exposure to high fraction of inspired oxygen ( $\text{FiO}_2$ ).
  - c. Anaphylaxis associated with pulmonary edema.
  - d. A combination of doxorubicin and cyclophosphamide.
  - e. Heroin overdose.
25. Which of the following organ systems is most frequently affected by heroin overdose?
- a. Kidney.
  - b. Heart.
  - c. Brain.
  - d. Lung.
  - e. Skeletal muscle.
26. Which of the following statements describing pulmonary vascular tree physiology is true?
- a. Normal matching of ventilation to perfusion is achieved by local hypoxic pulmonary vasoconstriction.
  - b. Hypoxic pulmonary vasoconstriction is usually localized and reversible.
  - c. In neonates, hypoxic pulmonary vasoconstriction may persist even after the hypoxia has been corrected.
  - d. Potential anatomic shunts that are present inside the lungs can open up and may account for the cyanosis noted during conditions of elevated pulmonary pressure.
  - e. All of the above.
27. Which of the following physiological changes in response to hypoxia is not likely?
- a. Impairment of short term memory occurs at approximately  $\text{PaO}_2$  of 60 torr.
  - b. When the  $\text{PaO}_2$  falls to less than 60 torr, carotid and aortic bodies are activated leading to tachycardia and hyperventilation.
  - c. Levels of 2,3 diphosphoglycerate increase in 20 minutes.
  - d. Tubular reabsorption of  $\text{Na}^+$  is impaired at a low  $\text{PaO}_2$ .
  - e.  $\text{PaO}_2$  of less than 40 torr produces twitching and seizures.
28. A two and a half-month-old baby with Tetralogy of Fallot is brought to the emergency department and subsequently to the PICU for progressively turning blue soon after waking when his mother began to feed him. He became fussy, began to cry, and since then, has been getting progressively more cyanotic and limp. All of the following are true statements except:
- a. The onset of these symptoms in early morning and with feeding is characteristic.
  - b. The peak incidence is seen at this age.
  - c. There is a strong negative correlation between  $\text{PaO}_2$  and the incidence of attacks.
  - d. Squatting or knee–chest position redistributes systemic blood flow to the upper body to improve pulmonary blood flow, but does not affect arterial oxygen saturation.
  - e. Propranolol can abort the attack and may decrease the frequency of these episodes when used chronically.
29. Cyanosis at a normal  $\text{PaO}_2$  occurs in:
- a. A victim of smoke inhalation.
  - b. A child overdosed on shoe dye.
  - c. A patient with a hematocrit of 75%.
  - d. All of the above.
30. In the postoperative period, a right-to-left shunt helps preserve cardiac output and decreases postoperative complications in children with which of the following conditions?
- a. Repair of Tetralogy of Fallot.
  - b. Repair of truncus arteriosus.
  - c. Fenestrated modified Fontan procedure.
  - d. All of the above.
  - e. None of the above.
31. A 6-month-old child with Down's syndrome who underwent repair of an atrioventricular canal defect was admitted to the PICU 6 hours ago. High pulmonary artery pressure is noted along with a decreased  $\text{O}_2$  saturation to the 80s and evidence of low cardiac output. The first priority after stabilization of the patient is:
- a. Adjust the vent settings.
  - b. Increase  $\text{FiO}_2$ .

- c. Obtain a chest radiograph.
  - d. Obtain an echocardiogram to rule out any residual abnormality.
  - e. None of the above.
32. All of the following statements are true regarding pulmonary circulation in this patient except:
- a.  $O_2$  is a very strong pulmonary vasodilator after cardiopulmonary bypass.
  - b. The effect of hyperventilation on pulmonary vascular resistance is mediated by changes in pH rather than  $PCO_2$ .
  - c. Pulmonary vascular resistance increases with increasing postoperative hematocrit.
  - d. Pulmonary vascular resistance increases in the postoperative night as pulmonary artery pressure is maintained or increases, thus cardiac output decreases.
  - e. Pulmonary vascular endothelial dysfunction after cardiopulmonary bypass is common.
33. A 5-day-old who presented with rapid onset of shock a few hours ago is found to have hypoplastic left heart syndrome and is on a prostaglandin- $E_2$  infusion. The patient is being mechanically ventilated. You notice that the  $O_2$  saturation on pulse oximetry is 92%. You anticipate all of the following except:
- a. Pulmonary congestion.
  - b. Right ventricle may suffer from diastolic overload.
  - c. Use of hyperventilation and tolazoline will improve saturation and the patient's overall condition.
  - d. Pulmonary blood flow is increased.
34. All of the following are true regarding chylothorax except:
- a. Malnutrition is a recognized complication.
  - b. Most frequently seen with intrapericardial procedures.
  - c. May occur without damage to the thoracic duct.
  - d. Pleural fluid may appear serosanguinous and will not clot.
  - e. Pleural effusion may develop as late as 1 month after surgery.
35. Regarding treatment of chylothorax:
- a. Pleural drainage is required to improve ventilation and prevent atelectasis.
  - b. To decrease lymph flow, a high-carbohydrate, high-protein, medium-chain triglyceride diet with reduced fat is recommended.
  - c. Malnutrition is an important complication.
  - d. All of the above.
36. Which of the following is an indication for surgical ligation of the thoracic duct for chylothorax?
- a. Average daily chyle loss of greater than 100 mL/year of the patient's age, after 5 days of medical therapy.
  - b. A flow of chyle that does not diminish after 2 weeks.
  - c. Nutritional complications that are severe.
  - d. All of the above.
37. Match the selections listed below with their appropriate descriptions.
- |   |
|---|
| <ol style="list-style-type: none"> <li>a. The modified Fontan procedure.</li> <li>b. Stage I Norwood procedure.</li> <li>c. Both.</li> <li>d. Neither.</li> </ol> |
|---|
- \_\_\_\_\_ Increased pulmonary vascular resistance results in hypoxemia.
- \_\_\_\_\_ Increased pulmonary vascular resistance results in cardiogenic shock.
- \_\_\_\_\_ Improve(s) systemic oxygenation and reduces the obligatory diastolic overload.
38. Which of the following statements is not true regarding fenestrated Fontan procedure?
- a. Maintains the systemic perfusion when pulmonary vascular resistance is elevated.
  - b. Decreases the incidence of pleural effusion.
  - c. Increases the mortality rate in patients undergoing the procedure.
  - d. Can be closed in the cardiac catheterization laboratory later during hospitalization.
39. When an infant with transposition of the great arteries and an intact ventricular septum presents for repair at 3 months of age, the best approach is:
- a. Senning procedure.
  - b. Mustard procedure.
  - c. Immediate correction by arterial switch.
  - d. Pulmonary artery banding and a Blalock-Taussig shunt.
  - e. None of the above.
40. The two issues of paramount importance after arterial switch are:
- a. Mustard vs Senning's procedures.
  - b. Presence of atrial septal defect and patent ductus arteriosus.

- c. Global performance of left ventricle and focal myocardial ischemia.  
e. None of the above.
41. Chylothorax is least likely to occur with repair of:  
a. Aortic or pulmonary valve surgery or ventricular septal defect.  
b. Patent ductus arteriosus ligation.  
c. Repair of coarctation.  
d. Glenn anastomosis.  
e. Shunt procedure (Blalock-Taussig, Waterston, Pott).
42. Postoperatively, patients with transposition of the great arteries undergoing arterial switch are characterized by all of the following except:  
a. Unrecognized left-to-right shunts or overzealous volume administration that can precipitate sudden hemodynamic compromise.  
b. Focal ischemia is a recognized complication.  
c. Compromised cardiac output responds favorably to afterload reduction.  
d. Global left ventricular systolic dysfunction is not seen.  
e. The left ventricle is typically dilated and tolerates any further load poorly.
43. Following a Blalock-Taussig shunt, true statements include all of the following except:  
a. The ipsilateral arm may be cold and pulseless for 48–72 hours.  
b. Blalock-Taussig shunt is generally performed on the side opposite the aortic arch.  
c. Ipsilateral pulmonary edema is a recognized complication.  
d. Flow is determined by the size of the subclavian artery; size of the graft itself is not critical.  
e. Diuretics should be avoided if possible.
44. Which of the following statements is inaccurate regarding cardiac transplantation?  
a. A major cause of early postoperative failure is right ventricular failure from increased pulmonary vascular resistance.  
b. Matching is based on ABO compatibility.  
c. Systemic hypertension is frequently seen postoperatively caused by cyclosporin-A.  
d. Endomyocardial biopsy is the best way to diagnose rejection when done weekly postoperatively.  
e. Ketamine will enhance myocardial function.
45. A 5-month-old underwent repair of Tetralogy of Fallot through a ventriculotomy with a transannular patch. Central venous pressure is 10 mmHg. Poor perfusion of the extremities is noted with low urine output. A bolus of colloid 15 mL/kg is given over 20 minutes. It is noted that the central venous pressure has decreased to 7 mmHg. This suggests that:  
a. Ventricular compliance has improved.  
b. Afterload has decreased following volume expansion.  
c. Myocardial perfusion has improved.  
d. This clinical scenario is not possible.  
e. A, B, and C.
46. A 12-year-old is admitted to the PICU with septic shock. A pulmonary artery catheter is inserted for hemodynamic monitoring. Left ventricular stroke work index was 30 g/minute/m<sup>2</sup> 4 hours ago. Now left ventricular stroke work index is 55 g/minute/m<sup>2</sup>. This indicates that:  
a. Afterload has increased.  
b. Afterload has decreased.  
c. Contractility has improved.  
d. None of the above.
47. The compensatory state of shock is least likely with:  
a. Cardiogenic shock.  
b. Septic shock.  
c. Hypovolemic shock.  
d. Obstructive shock.
48. Match the selections listed below with their appropriate descriptions.
- |  |
|--|
| a. An adolescent with extensive orthopedic injury receiving positive mechanical ventilation.<br>b. An infant with critical aortic stenosis receiving positive pressure ventilation.<br>c. Both.<br>d. Neither. |
|--|
- \_\_\_\_\_ With inspiration, there is a decrease in pulse pressure without a phase lag and diastolic pressure falls.
- \_\_\_\_\_ With inspiration, there is an increase in pulse pressure without a phase lag and diastolic pressure increases.

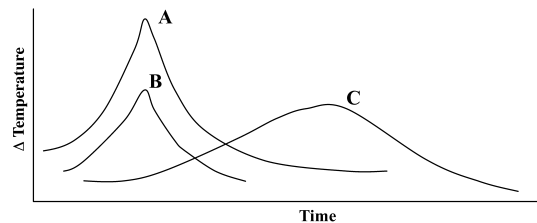
49. A mechanism responsible for pulmonary edema associated with upper airway obstruction does not include which of the following?
- Increased right ventricular afterload.
  - Ventricular interdependence.
  - Increased left ventricular afterload.
  - Decreased left ventricular afterload.
50. An infant with congestive cardiac failure is admitted to the PICU. Intermittent “grunting” is noted. All of the following are true statements regarding this clinical scenario except:
- Grunting is a form of the Valsalva maneuver.
  - Grunting decreases left ventricular afterload.
  - Grunting is a form of the Mueller maneuver.
  - A decrease in left ventricular preload may shift the Starling curve to a more favorable position, thus decreasing myocardial  $O_2$  consumption.
  - This patient is likely to benefit from inotropic drugs.
51. Nitroprusside would be least effective for:
- Congestive heart failure as a result of cardiomyopathy.
  - Mitral regurgitation.
  - Ventricular septal defect with congestive cardiac failure because of significant left-to-right shunt.
  - Myocardial dysfunction following cardiopulmonary bypass.
  - Hypotensive anesthesia.
52. Which of the following statements is least accurate regarding the toxicity of nitroprusside?
- Neuroexcitatory symptoms of delirium, confusion, and convulsions are a result of thiocyanate accumulation.
  - Thiocyanate tends to accumulate in patients with renal dysfunction.
  - Thiocyanate is not removed by either hemo or peritoneal dialysis.
  - Measurement of thiocyanate concentration does not have relevance to detecting cyanide toxicity.
  - Methemoglobin levels should be determined during prolonged infusion of nitroprusside.
53. Match the selections listed below with their appropriate descriptions.
- |                   |             |
|-------------------|-------------|
| a. Nitroprusside. | c. Both.    |
| b. Nitroglycerin. | d. Neither. |
- \_\_\_\_\_ The preferred drug when treating a child with congestive cardiac failure, pulmonary edema, and marginal blood pressure.
- \_\_\_\_\_ The preferred drug for the treatment of congestive cardiac failure induced by mitral or aortic regurgitation.
- \_\_\_\_\_ The preferred drug for congestive cardiac failure with preserved blood pressure, because it produces a greater increase in cardiac output in this setting.
54. Which of the following is true regarding volume resuscitation in shock state?
- Isotonic solutions may be administered safely up to an amount equivalent to 200% of the patient’s circulating blood volume.
  - Hetastarch and Dextran administration should not exceed 200 mL/kg/dose because of concerns about hemostasis.
  - Rapid fluid resuscitation in excess of 40 mL/kg in the first hour of evaluation is associated with improved survival and no increased risk of pulmonary edema in patients with septic shock.
  - Plasma catecholamines increase only marginally in shock states.
  - None of the above.
55. In the United States, trauma is the leading cause of death in children older than 1 year. The major contributor to mortality is:
- Hypovolemic shock.
  - Cardiogenic shock.
  - Septic shock.
  - Head injury.
  - Infection.
56. In the PICU, the major cause of cardiogenic shock is:
- Myocarditis.
  - Kawasaki syndrome.
  - Anomalous left coronary artery.
  - Postoperative repair of congenital cardiac lesions.
  - Isoproterenol treated asthmatics.
57. Impaired cellular metabolism occurs earliest during the clinical course of which type of shock?
- Cardiogenic shock.
  - Septic shock.
  - Hypovolemic shock.
  - Obstructive shock.
  - Anaphylactic shock.

58. In a child who presents with a temperature of 42°C, poor peripheral circulatory status, altered mental status, and acidosis:
  - a. Heat shock protein is released in excessive amounts.
  - b. Anhydrosis results from cellular sweat gland damage.
  - c. Disseminated intravascular coagulation is a recognized complication.
  - d. Riley-Day syndrome is a possibility.
  - e. All of the above.
59. A 14-year-old who sustained a fractured femur suddenly develops chest pain and dyspnea. Pathophysiological changes likely leading to this clinical picture include:
  - a. Sudden right ventricular failure leading to shock.
  - b. Pulmonary vasoconstriction and pulmonary capillary endothelial damage.
  - c. Massive release of vasoactive mediators from pulmonary circulation leading to circulatory failure.
  - d. All of the above.
60. Useful diagnostic work-ups include:
  - a. Microscopic urinalysis.
  - b. Ventilation-perfusion scan.
  - c. Pulmonary angiography.
  - d. All of the above.
61. Therapy for the patient referenced in Question 60 would include all except:
  - a. Optimizing hemodynamics.
  - b. Optimizing oxygenation.
  - c. Prevention of further episodes.
  - d. Removal of emboli.
62. Air embolism with fatal cerebral complications occurs with:
  - a. Laceration of a large vessel following trauma.
  - b. Spinal surgery.
  - c. Cranial surgery.
  - A. All of the above.
63. The most likely diagnosis is:
  - a. Pyelonephritis.
  - b. Chronic rejection.
  - c. Pancreatic shock.
  - d. Perforated duodenal ulcer preceded by hemorrhage.
  - e. None of the above.
64. Anticipated complications in this patient include:
  - a. Hypercalcemia.
  - b. Hyperuricemia.
  - c. Acute respiratory distress syndrome.
  - d. Hypervolemia.
  - e. Appendicitis.
65. Appropriate interventions in the patient would include which of the following?
  - a. Volume restriction.
  - b. Appropriate management of hypercalcemia.
  - c. Surgical exploration.
  - d. Appropriate management of respiratory dysfunction.
66. When managing children at risk of developing shock states, all of the following are true except:
  - a. Urine output in children is normally 2–3 mL/kg/hour.
  - b. It is usual for oliguria to occur before the alterations in blood pressure or the development of significant tachycardia.
  - c. Central filling pressure always reflects intravascular volume accurately.
  - d. Intravascular volume expansion by as much as 30% may not significantly alter right atrial pressure.
  - e. The major determinants of cardiac filling pressure are ventricular function and compliance.
67. A 3-year-old with a 2-day history of frequent episodes of diarrhea is admitted to the PICU with a diagnosis of hypovolemic shock. There is no evidence of systemic infection and chest radiograph shows a normal size heart and normal lung fields. Which of the following statements regarding management of this patient is least accurate?
  - a. It is unlikely that monitoring of central venous pressure adds significantly to careful, repeated physical exams and monitoring of urine output.
  - b. Every attempt should be made to elevate the central venous pressure to greater than 14 mmHg.
  - c. The concept that central filling pressure always reflects intravascular volume accurately is misleading.

**Questions 63–65:** A 12-year-old child who has had renal transplantation presents with sudden onset of acute, severe abdominal pain with prostration. He has been receiving azathioprine and prednisone for the last 4 months. He is hypotensive, poorly perfused, and pale with marked abdominal rigidity. No hematemesis or melena are noted. Urinalysis is unremarkable. Amylase and lipase are 850 and 500 IU/dL, respectively.



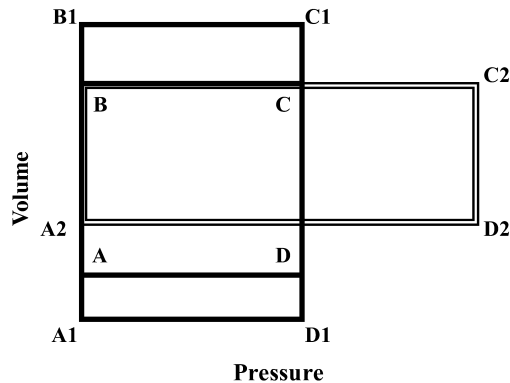
- d. If this patient develops oliguria or anuria, central venous pressure monitoring becomes essential to avoid fluid overload.
68. Regarding metabolic acidosis in the shock state, all of the following are true except:
- Base deficits greater than 10 mEq/L in cardiogenic and septic shock are associated with a worse outcome than a similar situation in hypovolemic shock.
  - Hepatic conversion of lactate or acetate to correct acidosis is impaired in most shock states.
  - Severe metabolic acidosis associated with organic acidemia can be treated with peritoneal dialysis.
  - With correction of acidosis, serious hypercalcemia and hyperkalemia may occur.
69. Which of the following is true of hemodynamic management of shock states?
- When volume resuscitation greater than 50–70 mL/kg is administered in the first 4–6 hours, invasive monitoring should be considered.
  - In patients with acute respiratory distress syndrome, central filling pressures should be maintained at a lower level ( $\leq 10$  mmHg).
  - In patients with increased intracranial pressure, inotropic support may be warranted before preload is fully augmented.
  - Application of pneumatic antishock garments in the field does not alter survival.
  - All of the above.
70. The functional reserve of the cardiovascular system in the infant is limited owing to:
- Abundance of contractile elements in the neonatal myocardium.
  - Sarcoplasmic reticulum is more abundant.
  - Less compliant myocardium leading to increased myocardial wall stress.
  - Pulmonary vascular bed is minimally recruited under basal conditions.
71. The Bezold-Jarisch Reflex refers to:
- Under basal conditions, sympathetic tone to the heart is relatively low, whereas parasympathetic tone is dominant.
  - Stretching of the carotid sinus triggers a parasympathetic-efferent activity resulting in bradycardia and vasodilation.
  - Hypovolemia with a decreased stretching of aortic arch baroreceptors causes a sympathetic output with tachycardia and vasoconstriction.
  - Activation of cardiopulmonary baroreceptors localized in the atrial and ventricular wall result in vagal stimulation with bradycardia and vasodilation.
  - None of the above.
72. Risk factors for infection following radial artery cannulation include:
- Insertion by surgical cut down.
  - Inflammation at the insertion site.
  - Cannulation for more than 4 days.
  - All of the above.
73. The most serious complication of axillary artery cannulation is:
- Thrombosis.
  - Distal ischemia.
  - Embolism.
  - Brachial plexus injury.
  - Infection.
74. Precautions to be taken during pulmonary artery catheter insertion include all of the following except:
- When withdrawing the catheter, always deflate the balloon by disconnecting the syringe and opening the valve to the atmosphere.
  - Dysrhythmias occur most commonly during insertion into the right atrium, probably because of irritation of the arterioventricular node.
  - The catheter should not be advanced more than 10 cm without seeing a change in waveform after entering the right atrium.
  - Balloon rupture is more commonly seen in pediatric patients.
  - Risk of infection is reduced if the catheter is left in place for less than 3 days.
75. The figure below shows various curves that represent cardiac output as measured by the thermodilution technique. Which of the following statements is most accurate?



- Curve "A" represents a patient with a ventricular septal defect.
- Curve "C" is likely to give a falsely high cardiac output.

- c. Cardiac output obtained by Curve "B" will be higher than Curve "A".
- d. Curve "A" will correspond to a higher cardiac output than Curve "B".
- e. All of the above.

**Questions 76–79:** Please reference the figure below. Loop A–B–C–D is the normal pressure volume loop of the cardiac cycle.



- 76. In the normal loop (A–B–C–D), the point at which the aortic valve opens is:
  - a. Point B.
  - b. Point C.
  - c. Point A.
  - d. Point E.
  - e. Point D.
- 77. An intervention is performed which results in loop A–B<sub>1</sub>–C<sub>1</sub>–D. The most likely explanation for this change is:
  - a. A bolus of intravenous fluid.
  - b. An increase in afterload.
  - c. An increase in contractility.
  - d. All of the above.
- 78. Provided there is no change in pressure, loop A<sub>1</sub>–B–C–D<sub>1</sub> is most likely a result of:
  - a. Increased preload.
  - b. Increased contractility.
  - c. Decreased contractility.
  - d. None of the above.
- 79. Provided the contractility is unchanged, loop A<sub>2</sub>–B–C<sub>2</sub>–D<sub>2</sub> is most likely a result of:
  - a. Increased end-diastolic pressure.
  - b. Increased afterload.
  - c. Increased contractility.
  - d. Decreased afterload.
  - e. None of the above.