Pediatric Hospital Medicine: Review Questions

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QUESTIONS

Choose the single best answer for each question.

1. A 14-year-old girl with mild persistent asthma is admitted to the hospital for an acute exacerbation. She is started on supplemental oxygen, oral prednisolone (1 mg/kg), and albuterol nebulized mist treatments every 3 hours. During morning rounds, she reports worsening subjective dyspnea. On physical examination, the patient's temperature is 99.2°F, heart rate is 110 bpm, respiratory rate is 20 breaths/min, blood pressure is 128/88 mm Hg, and oxygen saturation is 98% on 2 L per nasal cannula. She is alert but appears uncomfortable. Of the following, which sign or symptom is most concerning for impending respiratory failure?

(A) Ability to speak in full sentences without pauses
(B) Diffuse symmetric end-expiratory wheezing on lung examination
(C) Diminished symmetric breath sounds without wheezing on lung examination
(D) Presence of symmetric, fine basilar crackles that clear with coughing

2. A previously healthy 15-year-old girl is admitted to the hospital following an ingestion of a bottle containing unknown pills. Results of laboratory testing reveal a serum sodium level of 142 mEq/L, potassium level of 3.3 mEq/L, chloride level of 102 mEq/L, and bicarbonate level of 10 mEq/L. An arterial blood gas shows a pH of 7.32 and P_{CO_2} of 12 mm Hg. Which of the following best describes the acid-base disorder that is present in this patient?

(A) Anion gap metabolic acidosis
(B) Anion gap metabolic acidosis and metabolic alkalosis
(C) Anion gap metabolic acidosis and respiratory acidosis
(D) Anion gap metabolic acidosis and respiratory alkalosis
(E) Nonanion gap metabolic acidosis

Questions 3 and 4 refer to the following case.

A previously healthy 3-month-old infant born at term is admitted to the hospital with a 2-day history of acute gastroenteritis. The parents note that he has had little interest in breast-feeding and will not take breast milk or formula from a bottle. He is alert but irritable with a weak cry. Physical examination is notable for a slightly sunken anterior fontanelle, dry mucous membranes, diminished skin turgor, and capillary refill of 2 seconds (normal, < 2 sec). The serum sodium level is 136 mEq/L.

3. This patient's volume status is most consistent with which of the following?

(A) Euvolemia
(B) Hypervolemia
(C) Mild dehydration
(D) Moderate dehydration
(E) Severe dehydration

4. What is the most appropriate initial hydration strategy for this patient?

(A) Oral rehydration with breast milk or formula
(B) Intravenous (IV) fluid bolus of 5% dextrose in water at 10 mL/kg
(C) IV fluid bolus of 0.25 normal saline at 10 mL/kg
(D) IV fluid bolus of 0.45 normal saline at 10 mL/kg
(E) IV fluid bolus of 0.9 normal saline at 10 mL/kg

5. A previously healthy 16-year-old boy is admitted for observation following an episode of syncope during a soccer game. He currently feels well and is asymptomatic. The syncopal event was witnessed, and there was no antecedent trauma or seizure-like activity during or following the event. He has previously felt lightheaded during strenuous exertion

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but has never experienced syncope. He takes no prescription medications or herbal remedies and denies use of illicit drugs. Physical examination is unremarkable. Blood urea nitrogen, serum creatinine, and serum electrolytes, including potassium, magnesium, and calcium, are normal. Of the following, which finding or symptom is associated with a higher risk for sudden death?

(A) A personal history of classic neurocardiogenic syncope
(B) A family history of coronary artery disease in the patient's grandparents
(C) Exertional chest pain not affected by movement
(D) The finding of an isolated inverted T wave in lead V_1 on an electrocardiogram
(E) The presence of symptomatic orthostatic hypotension

ANSWERS AND EXPLANATIONS

1. **(C) Diminished symmetric breath sounds without wheezing on lung examination.** This patient is experiencing a severe asthma exacerbation. Although the patient has been managed appropriately, her symptoms have progressed, which indicates that her clinical status is worsening.[1] Notably, the patient is alert, but she appears uncomfortable. Other warning signs of impending respiratory failure include use of accessory muscles with severe retractions, presence of cyanosis, or inability to speak in full sentences.[2] The use of accessory muscles is a signal that the normal respiratory muscles are unable to provide adequate mechanical force to generate airflow. Severe retractions indicate that the chest wall muscles are working to produce adequate airflow, but the muscles will likely fatigue, leading to respiratory failure. Cyanosis in severe asthma exacerbations occurs when ventilation is no longer sufficient to deliver an appropriate amount of oxygen to tissues. Inability to speak in full sentences suggests that oxygenation and ventilation are poor and unable to sustain normal speech patterns. Fine basilar crackles that improve with coughing are not a sign of impending respiratory failure. The development of diminished breath sounds without the presence of wheezing is concerning for impending respiratory failure because it indicates that the patient is no longer able to generate a sufficient amount of high-velocity airflow to produce wheezing.

2. **(D) Anion gap metabolic acidosis and respiratory alkalosis.** Based on this patient's pH of 7.32, either a metabolic or respiratory acidosis is present. The P_{CO_2} is diminished (< 40 mm Hg), which is consistent with the presence of at least a metabolic acidosis. Applying Winter's formula (predicted P_{CO_2} = 1.5 [serum bicarbonate] + 8), this patient's predicted P_{CO_2} is 23 mm Hg. However, the patient's actual P_{CO_2} (12 mm Hg) is less than predicted, which is consistent with respiratory alkalosis. Lastly, this patient's anion gap (serum sodium – [serum chloride + serum bicarbonate]) is elevated at 30 mEq/L (normal, 8–16 mEq/L).[3] Therefore, the patient has a mixed anion gap metabolic acidosis and respiratory alkalosis. A possible etiology of the acid-base disorder in this patient is an acute salicylate overdose. Salicylate toxicity disrupts the oxidative mechanisms within cells, leading to the development of an anion gap metabolic acidosis. Moreover, salicylates in high concentrations stimulate the central respiratory center to cause respiratory alkalosis.

3. **(D) Moderate dehydration**. The evaluation of the degree of dehydration in infants can be based on physical examination findings. Vital sign abnormalities (heart rate and blood pressure) often correlate with the degree of dehydration. If available, comparison of current weight to a recent pre-illness weight may also be useful to gauge the degree of dehydration. Signs of dehydration on physical examination include a sunken fontanelle, dry mucous membranes, reduced skin turgor, and/or delayed capillary refill. The classification of dehydration is separated into 3 general categories based on the percentage of body weight loss: mild (< 5%); moderate (5%–10%); or severe (> 10%). Infants with mild dehydration may be irritable but are alert and may be consoled. They may have a slightly sunken fontanelle and dry mucous membranes. Skin turgor and capillary refill are normal. Infants with moderate dehydration are more irritable and difficult to console. The fontanelle is usually sunken and skin turgor is diminished. Generally, capillary refill is normal to modestly delayed. Infants with severe dehydration are often described as listless or lethargic. In addition to the presence of a sunken fontanelle, dry mucous membranes, and diminished skin turgor, capillary refill is often delayed.[4,5] Based on the physical examination, the patient has moderate dehydration. Euvolemia or hypervolemia are incorrect because the physical examination findings are consistent with hypovolemia.

4. **(E) IV fluid bolus of 0.9 normal saline at 10 mL/kg.** The patient has isonatremic dehydration. Acute IV fluid resuscitation should consist of isotonic fluids

to restore intravascular volume. Although hypotonic solutions may have a role in correcting intravascular volume depletion, they should not be provided as IV fluid boluses given their hypotonicity.[6] Fluid boluses with hypotonic solutions increase the risk of fluid shifts, which may cause seizures. Of the IV fluids listed, isotonic saline (0.9 normal saline) would be the most appropriate to initially replete the infant's intravascular volume.[7] Given the infant's apathy and inability to breast or bottle feed, oral rehydration would not be an appropriate first-line therapy to correct the dehydration if IV fluid is readily available.

5. **(C) Exertional chest pain not affected by movement.** The incidence of sudden cardiac death in infants through adolescents ranges from 1.3 to 8.5 per 100,000 patient-years. Males are more likely to experience sudden cardiac death compared with females,[8] and the etiology may be either cardiac or noncardiac. Sudden cardiac death in children younger than 1 year of age is most often related to ductal-dependent complex cyanotic congenital heart disease. In older children (aged > 1 yr) and adolescents, the possible diagnoses are more variable and include congenital heart disease, anomalies of the coronary arteries, myocardial disease, arrhythmia, or high-risk behaviors (eg, illicit drug use). Evaluation of patients presenting with unexplained syncope should focus on warning signs associated with a higher risk of sudden cardiac death, including the presence of exertional chest pain, dyspnea at rest or with minimal exertion, lightheadedness, palpitations, or an irregular heart beat.[9] Prior cardiac history, such as infectious complications (eg, rheumatic heart disease, myocarditis) or prior cardiac surgeries, should be explored. Careful examination of the patient's family history is essential. The presence of late-onset atherosclerotic coronary artery disease in family members does not predict sudden death, although this may be important so that the likelihood of developing atherosclerotic disease is addressed. Identifying a family history of sudden death is important given the known genetic predisposition and patterns of inheritance for certain cardiac syndromes, such as Brugada syndrome, long QT syndrome, hypertrophic cardiomyopathy, or Marfan syndrome. A history of classic neurocardiogenic syncope does not place an individual at higher risk for sudden death. In the absence of other findings, orthostatic hypotension is not associated with sudden death. An isolated T-wave inversion present in lead V_1 is a normal finding on an electrocardiogram.

REFERENCES

1. Keogh KA, Macarthur C, Parkin PC, et al. Predictors of hospitalization in children with acute asthma. J Pediatr 2001;139:273–7.
2. Roy S, Milgrom H. Management of the acute exacerbation of asthma. J Asthma 2003;40:593–604.
3. Fall PJ. A stepwise approach to acid-base disorders. Practical patient evaluation for metabolic acidosis and other conditions. Postgrad Med 2000;107:249–50, 253–4, 257–8 passim.
4. Shavit I, Brant R, Nijssen-Jordan C, et al. A novel imaging technique to measure capillary-refill time: improving diagnostic accuracy for dehydration in young children with gastroenteritis. Pediatrics 2006;118:2402–8.
5. Tibby SM, Hatherill M, Murdoch IA. Capillary refill and core-peripheral temperature gap as indicators of haemodynamic status in paediatric intensive care patients. Arch Dis Child 1999;80:163–6.
6. De Bruin WJ, Greenwald BM, Notterman DA. Fluid resuscitation in pediatrics. Crit Care Clin 1992;8:423–38.
7. Duke T, Molyneux EM. Intravenous fluids for seriously ill children: time to reconsider. Lancet 2003;362:1320–3.
8. Liberthson RR. Sudden death from cardiac causes in children and young adults. N Engl J Med 1996;334:1039–44.
9. Berger S, Utech L, Fran Hazinski M. Sudden death in children and adolescents. Pediatr Clin North Am 2004;51:1653–77.

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