Hyponatremia-Associated Rhabdomyolysis Following Exercise in an Adolescent With Cystic Fibrosis

abstract

Adolescents with well-controlled cystic fibrosis, including good lung function and appropriate growth, commonly participate in competitive athletic activities. We present the case of an adolescent male with cystic fibrosis, hyponatremia, dehydration, and rhabdomyolysis after participating in football practice on a summer morning. The patient presented with severe myalgia and serum sodium of 129 mmol/L, chloride 90 mmol/L, and creatine phosphokinase 1146 U/L. Aggressive hydration with intravenous 0.9% saline resulted in clinical improvement with no renal or muscular sequelae. Health care providers need to educate patients with cystic fibrosis about maintaining adequate hydration and sodium repletion during exercise. Research is needed regarding the appropriate amount and composition of oral rehydration fluids in exercising individuals with cystic fibrosis, as the physiology encountered in these patients provides a unique challenge to maintaining electrolyte balance and stimulation of thirst. Pediatrics 2012;130:e220–e223

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KEY WORDS
cystic fibrosis, dehydration, hyponatremia, rhabdomyolysis, adolescent

ABBREVIATIONS
CF—cystic fibrosis
CK—creatine kinase

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Cystic fibrosis (CF) is an autosomal recessive disorder involving multiple systems that can cause progressive lung disease, pancreatic insufficiency, and chronic malnutrition in children. As treatments have improved, many children with CF are now well nourished and growing at normal rates. As older children and adolescents, they often engage in competitive athletic activities despite their fundamentally altered physiology. We report exercise-induced hyponatremia and dehydration with rhabdomyolysis in an athletic adolescent with CF.

CASE REPORT

A 14-year-old otherwise healthy boy with well-controlled CF presented to the emergency department complaining of severe muscle soreness in the calves, thighs, arms, and back persisting several hours after completing a football training session on a summer morning. The practice lasted 3 hours and consisted mostly of sprints and distance runs. The ambient temperature ranged from 80 to 88°F. He reported consuming only minimal amounts of water during practice to avoid vomiting and denied urination until ~8 hours after his first morning void. The patient had no recent illnesses and no previous history of documented dehydration. His last hospitalization at age 10 years was for a pulmonary exacerbation requiring a brief inpatient stay for intravenous antibiotics. He had been in good health and had no difficulty keeping up with his peers in athletic activities. Vital signs were within normal limits, aside from an elevated heart rate of 95 beats per minute compared with baseline in the 60s. He weighed 56.6 kg compared with 60.0 kg at his last office visit 8 days prior. He was alert and oriented to person, place, and time. Physical examination was notable for tenderness to palpation of multiple muscle groups, but was otherwise unremarkable. Laboratory testing revealed serum sodium of 129 mmol/L, chloride 90 mmol/L, bicarbonate 22 mmol/L, creatinine 1.2 mg/dL, and serum urea nitrogen 19 mg/dL. Unfortunately, no previous metabolic panels were available for comparison. Creatine kinase (CK) was 1146 U/L (normal 39–308 U/L). White blood cell count was elevated at 19 900 with a normal differential. Hemoglobin and hematocrit were within normal limits at 16.6 g/L and 48.0%, respectively, but elevated above his baseline of 15.3 g/L and 44.8%. Urinalysis was normal with a specific gravity of 1.003, but was not obtained until ~90 minutes after intravenous fluids were given. The patient was given a bolus of 2 L of intravenous normal saline over the first 2 hours, and a third liter at a rate of 500 mL/h per protocol for treatment of rhabdomyolysis in adults. The rate was reduced to twice maintenance on the ward to avoid pulmonary edema in the context of this patient’s underlying lung disease. Subsequent laboratory testing 6 hours after presentation revealed sodium of 134 mmol/L and CK of 2562 U/L despite aggressive hydration. The patient was discharged the following morning with resolution of pain, good urine output, a serum sodium of 136 mmol/L and a stabilized CK of 2625 U/L. He did not suffer any significant renal or muscular sequelae, as evidenced by no muscle weakness, improvement in pain, and normal urination at follow-up with his primary care physician the next week. His serum urea nitrogen and creatinine 8 weeks later were 16 mg/dL and 0.8 mg/dL, respectively, at an emergency department visit for constipation. He was instructed about the importance of hydration with exercise, especially in hot weather. With no evidence-based guidelines available for exercising adolescents with CF, we recommended consuming high-electrolyte sports beverages such that he felt the need to urinate at least every 2 hours, and to stop exercising if he could not drink at least that much.

DISCUSSION

Our report highlights a previously unreported complication in healthy, athletic children with CF. In addition to maintaining adequate growth and lung function through appropriate nutrition, pulmonary toilet, and medication adherence, patients with CF can improve their health through regular exercise. Participation in sports allows patients with CF to join peers in normal childhood activities and to enjoy the benefits of exercise. Several studies have shown the benefits of exercise in patients with CF, including improved exercise capacity and possible preservation of pulmonary function with aerobic exercise.1–2 Possible complications of exercise in children with CF include pneumothorax, hypoglycemia, musculoskeletal injury, and cardiac arrhythmia.3 There have been no previously published case reports on hyponatremic dehydration with rhabdomyolysis in patients with CF. Our patient demonstrated oliguria with hyponatremia and hypochloremia consistent with hyponatremic dehydration. The elevated CK and intense myalgia on physical examination are consistent with rhabdomyolysis, which was likely caused by a combination of factors, including dehydration, hyponatremia, and intense physical activity. The degree of hyponatremia at the time of presentation was milder than in previous reports of rhabdomyolysis, in which serum sodium levels ranged from 110 to 115 mmol/L.4,5 We believe that it is reasonable to consider that the hyponatremia contributed to the muscle injury. Children with CF are probably more susceptible to dehydration with exercise than are healthy children for several reasons, including increased salt and water losses from the skin and an impaired thirst response. Decreased thirst drive in patients with CF, termed voluntary dehydration, has been hypothesized to be the result of hyperosmotic sweat, which results in
TABLE 1 Electrolyte and Carbohydrate Concentrations of Popular Sports Drinks (With Unit Conversion from mg/8 oz to mmol/L)

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Sodium mg/8 oz</th>
<th>mmol/L</th>
<th>Potassium mg/8 oz</th>
<th>mmol/L</th>
<th>Carbohydrate % daily value/8 oz</th>
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<tr>
<td>Gatorade15</td>
<td>110</td>
<td>19.9</td>
<td>30</td>
<td>3.2</td>
<td>6</td>
</tr>
<tr>
<td>Powerade16</td>
<td>100</td>
<td>18.1</td>
<td>25</td>
<td>2.7</td>
<td>6</td>
</tr>
<tr>
<td>All Sport17</td>
<td>55</td>
<td>10.0</td>
<td>60</td>
<td>6.4</td>
<td>6</td>
</tr>
<tr>
<td>Propel Zero18</td>
<td>80</td>
<td>14.5</td>
<td>20</td>
<td>2.1</td>
<td>0</td>
</tr>
<tr>
<td>SoBe Life Water19</td>
<td>25</td>
<td>4.5</td>
<td>25</td>
<td>2.7</td>
<td>2</td>
</tr>
</tbody>
</table>

hyposmotic serum, thus diminishing the hypothalamic stimulus for thirst.6,7 Fluid replenishment with high sodium chloride content has been shown to stimulate thirst and to prevent a significant serum sodium decrease.7

Patients with CF may be at increased risk for rhabdomyolysis during exercise, given their propensity for dehydration and hyponatremia. Previously reported hyponatremia-induced rhabdomyolysis in patients who do not have CF has been associated with diuretic use, psychogenic polydipsia, and extreme exercise with water intoxication.1,5,8,9 Exercise has also led to rhabdomyolysis and hyponatremia in patients who do not have CF.10,11 There are no evidence-based guidelines for the exercising adolescent population with CF. Most popular textbooks endorse increased sodium intake, but lack specific recommendations. The Pediatric Nutrition Handbook, published by the American Academy of Pediatrics, advises the consumption of sports drinks that contain significant quantities of electrolytes for this population.12 UpToDate extrapolates recommendations from the Cystic Fibrosis Foundation’s data on infant requirements.13,14 According to these sources, children older than 5 are recommended to receive 1.5 to 2.0 teaspoons of salt per day under extreme conditions, including strenuous and/or prolonged exercise, especially in the heat. We have some insight, based on a study by Kriemler et al.7 (n = 6), which showed that a solution consisting of 50 mmol/L NaCl with 6% carbohydrates resulted in increased fluid intake in exercising adolescents with CF, and a lower serum sodium deficit compared with water. More research is needed to establish evidence-based salt and water supplementation recommendations. Table 1 shows the composition of popular US sports drinks, demonstrating a relatively low sodium concentration compared with the higher concentrations that may be required in exercising patients with CF.

Our patient now adds 1 tsp of table salt to a 20-oz bottle (591 mL) of Gatorade for consumption during athletic activities. The additional salt increases the sodium concentration by 169.2 mmol/L, to a total concentration of 189.1 mmol/L per 20-oz beverage. He also drinks a sufficient volume to result in urination at least every 2 hours. With that regimen, he has had no subsequent symptoms and continues to participate in a rigorous football regimen with his physicians’ support.

CONCLUSIONS

Children with well-controlled CF should exercise like their peers, but their altered physiology dictates extra caution regarding their hydration and electrolyte status, especially in light of the risk of rhabdomyolysis, as illustrated by this case. Providers need to instruct their athletically inclined patients with CF on maintaining proper hydration by using the best evidence available. More research is needed to determine optimal recommendations for adequate hydration and electrolyte maintenance during exercise in this growing population.

REFERENCES

Elk Grove Village, IL: American Academy of Pediatrics; 2009:1006–1007


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