

CASE REPORT

Three Cases of Severe Hyponatremia During a River Run in Grand Canyon National Park

Emily A. Pearce, BS, EMT-P; Thomas M. Myers, MD; Martin D. Hoffman, MD

From the Grand Canyon National Park, Preventive Search and Rescue Team, Branch of Emergency Services, Grand Canyon, AZ (Ms Pearce and Dr Myers); and the Department of Physical Medicine and Rehabilitation, Department of Veterans Affairs, Northern California Health Care System, and University of California Davis Medical Center, Sacramento, CA (Dr Hoffman).

We present 3 cases of severe hyponatremia occurring on a commercially guided river rafting trip on the Colorado River in Grand Canyon National Park. All 3 women appeared to have been overhydrating because of concern about dehydration and required evacuation within 24 hours of each other after the staggered onset of symptoms, which included fatigue and emesis progressing to disorientation or seizure. Each was initially transferred to the nearest hospital and ultimately required intensive care. Imaging and laboratory data indicated all 3 patients had hypervolemic hyponatremia. Unlike the well-documented exercise-associated hyponatremia cases commonly occurring in prolonged endurance athletic events, these 3 unique cases of acute hyponatremia were not associated with significant exercise. The cases illustrate the diagnostic and treatment challenges related to acute hyponatremia in an austere setting, and underscore the importance of preventive measures focused on avoidance of overhydration out of concern for dehydration.

Key words: arginine vasopressin, exercise, exercise-associated hyponatremia, hypertonic saline, hyponatremia, sodium, syndrome of inappropriate ADH secretion, water-electrolyte imbalance

Introduction

Exercise-associated hyponatremia (EAH) is known to be a possible complication of endurance athletic activities and military training exercises that may have a fatal outcome.^{1–5} It is now recognized that the underlying pathophysiology of EAH involves overhydration.^{6,7} Hypervolemic hyponatremia has also been reported among persons participating in lower intensity activities such as hiking^{8–15} and Bikram yoga,¹⁶ and while awaiting rescue from a fall into a crevasse.¹⁷ Here, we describe 3 cases of severe hyponatremia developing within a 2-day period on a single commercially guided river rafting trip through Grand Canyon National Park.

A Colorado River trip through Grand Canyon is perhaps the premier whitewater river trip in the world. Renowned for its rapids, scenery, and remoteness, the Colorado River in Grand Canyon is 446 km long. Along its course, the Colorado River drops more than 670 m in elevation and essentially splits the 486,000 hectare Grand Canyon

National Park in half. River runners may travel down the Colorado River on professionally guided (commercial) trips or on self-guided (noncommercial or private) trips. Trips with large motorized pontoon rafts average 7 to 9 days to travel the entire distance and navigate more than 160 rapids, whereas smaller oar-powered boats average 13 to 18 days. Each year roughly 25,000 people run the river through Grand Canyon, 17,000 as commercial passengers and nearly 8,000 on self-guided trips.¹⁸

The Grand Canyon is located entirely in northern Arizona, and desert conditions exist in the canyon bottom, as much as 1520 m below the rim. Daytime high temperatures average near 40°C during the summer months and can reach more than 50°C. Entry or exit from the canyon is only achieved either by lengthy foot travel on isolated trails and routes or by helicopter for the majority of its length. As a result, nearly all emergency evacuations off the river are made by helicopter.

Case Presentations

RIVER TRIP AND PATIENT EVACUATIONS

The river trip launched mid-morning on June 11, 2006, in an 11-m motorized pontoon raft for 7 days of travel

Corresponding author: Martin D. Hoffman, MD, Department of Physical Medicine & Rehabilitation (117), Sacramento VA Medical Center, 10535 Hospital Way, Sacramento, CA 95655-1200 (e-mail: mdhoffman@ucdavis.edu).

through the Canyon. Aboard were 17 passengers and 3 river guides. The weather was dry, hot, and sunny, with a high temperature of 40.5°C. Guides instructed the passengers to drink plenty of water, and passengers were encouraged to wear rain gear during rapids to prevent getting wet and cold from the 8.8°C dam-released Colorado River water.

The first day was uneventful, but by mid-afternoon on the second day, the first patient began feeling unwell, with fatigue and stomach discomfort. The morning had included 2 short (<2 km) hikes, but she opted out of the second hike. The guides believed she had not been drinking enough and was experiencing dehydration and heat exhaustion. She and all other passengers were strongly advised to drink more water supplemented with an electrolyte drink mix (Hydralyte, 45 to 55 mEq/L of sodium) and to eat salty snacks.

At noon on the third day, a stop was made where a ranger station is located for the first patient to be evacuated by helicopter because she was feeling worse and had been having emesis and diarrhea. After her evacuation, the river trip continued downstream. Less than 2 hours later, the second patient suddenly became disoriented and had a grand mal seizure while on the boat. She, too, was evacuated by helicopter. Shortly thereafter, the river trip made camp for the evening, and the third patient abruptly began to vomit and became unresponsive. Unable to secure safe evacuation because of darkness, she remained comatose at camp, and was monitored by the river guides. She was evacuated by helicopter at dawn on the fourth day of the trip. The others remaining on the river finished the trip uneventfully 3 days later.

PATIENT PREHOSPITAL AND HOSPITAL CLINICAL HISTORIES

Patient 1

The first patient, an overweight (73 kg) 67-year-old woman, had a medical history significant for hypertension treated with hydrochlorothiazide and enalapril. She had no rafting experience. She slipped and fell into the water at the river's edge during the first night while urinating, but was uninjured. Mid-afternoon on the second day of the trip, she began complaining of feeling "tired and full" and reportedly had not urinated for some time. She was given bananas, almonds, and crackers and encouraged to consume an electrolyte drink. She began vomiting and having diarrhea that evening. She was given more electrolyte drink, salted crackers, and pita bread. She slept poorly and vomited again during the night, and guides continued to encourage her to drink more of the electrolyte drink and eat crackers.

Neither total fluid intake nor extent of fluid loss through vomiting and diarrhea was documented.

On the morning of the third day of the trip, she was still feeling tired and weak, and the river guides decided she should be evacuated. Several hours later and 45 km further downstream, she was wheeled by litter nearly 1 km to a remote backcountry ranger station staffed by an emergency medical services-trained ranger. Upon arrival at approximately noon, she was noted to be "shaking all over" despite the 41.1°C heat. A medical evacuation by National Park Service (NPS) helicopter was requested. The NPS flight paramedic found her alert and oriented with a Glasgow Coma Scale (GCS) of 15. She was hypertensive at 175/85 mm Hg and had a heart rate of 80 beats/minute. An electrocardiogram (ECG) was unremarkable. An intravenous (IV) line was established with 0.9% normal saline infused at a maintenance rate. She was flown out and initially transported to Grand Canyon Clinic on the rim. There, she appeared alert and was oriented, but somewhat confused when answering questions, anxious, and repeating phrases. The remainder of her neurologic examination was nonfocal. She remained hypertensive, with her systolic blood pressure in excess of 180 mm Hg. Her serum sodium concentration was 114 mEq/L. Other laboratory values are shown in the [Table](#). She was started on an IV drip with a total of 600 mL normal saline infused as she was helicoptered for admission to the nearest hospital 145 km away.

Upon arrival at the emergency department, her serum sodium concentration was slightly higher at 119 mEq/L. Her initial oxygen saturation was 92% on room air, heart rate was 87 beats/minute, and blood pressure was 193/75 mm Hg. The physical examination showed neurologic deterioration, with significant agitation, confusion, and disorientation. Also noted were dry mucous membranes, a slightly distended abdomen, and slightly flushed and dry skin. The ECG and head computed tomography scan were unremarkable. She was given lorazepam and droperidol, and received a total of 1500 mL IV normal saline. A Foley catheter returned 1500 mL clear urine. Her oxygen saturation on room air deteriorated to 77%, improving to above 90% with 15 L of oxygen by non-rebreather mask. She was intubated and admitted to the intensive care unit (ICU) for further care. At this point, her serum sodium had improved to 123 mEq/L. She was treated with an unknown volume of IV normal saline, and was discharged from the ICU approximately 36 hours after admission, with normal serum sodium and potassium concentrations and a normal mental status. She went on to fully recover uneventfully.

Patient 2

This 72-year-old, overall healthy woman weighing approximately 70 kg had a medical history significant

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