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Techniques and Procedures

A NOVEL TECHNIQUE FOR ICE WATER IMMERSION IN SEVERE DRUG-INDUCED HYPERTHERMIA IN THE EMERGENCY DEPARTMENT

Alfred Z. Wang, MD, Ivan P. Lupov, MD, and Brian K. Sloan, MD

Department of Emergency Medicine, Indiana University School of Medicine, Indianapolis, Indiana
Reprint Address: Alfred Z. Wang, MD, Department of Emergency Medicine, Indiana University School of Medicine, 1701 N. Senate Avenue, Indianapolis, IN, 46202

☐ **Abstract—Background: Methamphetamine can cause life-threatening hyperthermia and treatment must be aggressive and rapid. There are multiple methods of cooling, with cold-water immersion being one of the most effective treatment options. However, this method is technically difficult to institute in the emergency department setting. Case Report: We report 2 patients who presented with life-threatening hyperthermia from methamphetamine and were treated in the emergency department with a novel technique of using a body bag filled with ice water to perform rapid cooling. Why Should an Emergency Physician Be Aware of This?: This method of cooling is a safe, rapid, and efficacious method for emergency physicians to perform cold water immersion in the department.** © **2019 Elsevier Inc. All rights reserved.**

☐ **Keywords—emergency medicine; methamphetamine; hyperthermia; body cooling; cooling rates**

INTRODUCTION

Methamphetamine can cause a life-threatening hyperthermia and treatment must be rapid and aggressive (1). Reports describe multiple ways of cooling (including ice packs, cold intravenous fluids, cold water sprays), with cold water immersion as one of the most effective treatment options (2–5). Cold water immersion has been shown to be the most effective way to cool patients with exertional heat stroke, however, this method is technically difficult to utilize in the emergency department setting (2). To our knowledge, we are the first to report two cases using an easily attainable body bag for the purpose of a water immersion bath in patients with methamphetamine-induced heat stroke.

CASE REPORT

The first case presented as a 21-year-old male (patient A) who came to the emergency department for evaluation of acute methamphetamine ingestion. When the patient arrived, he was unresponsive and altered. Physical examination was significant for clear lungs, soft abdomen, dilated and reactive pupils, and no rigidity or clonus in his extremities. Initial vital signs included blood pressure of 148/84 mm Hg, pulse of 115 beats/min, respiratory rate of 20 breaths/min, room air saturation of 100%, and rectal temperature of 42.2°C (107.9°F). The patient was intubated for airway protection and a declining clinical course. Initially, the patient was cooled with a cooling blanket and large bags of ice were placed on the chest, abdomen, and thighs, with providers actively massaging these bags over the patient's body. Small ice bags were also placed in his axilla and around his neck. A temperature-sensing Foley catheter was placed. After 46 min of active massage, the patient's temperature remained high at 40.4°C (Figure 1). The patient was then placed in a plastic body bag (Tiger Medical Products, Shangai, China), which was subsequently filled with a slurry of ice and water, zipped closed, but allowing the head and upper torso to be exposed so there was easy

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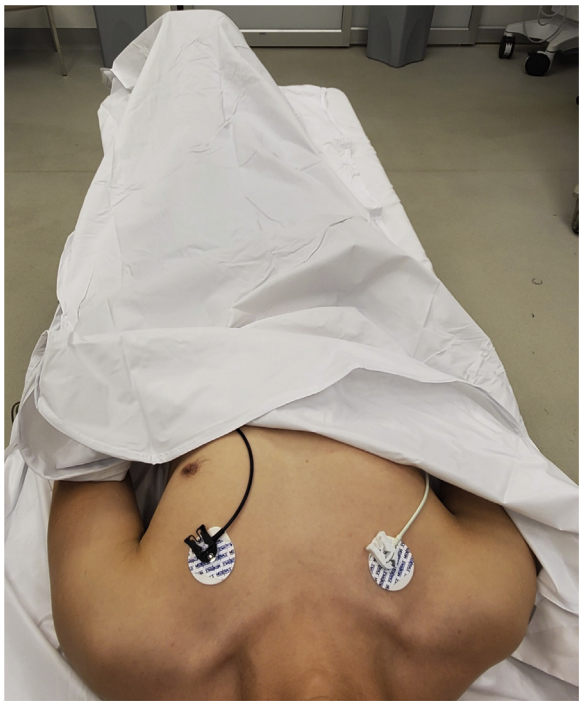

Figure 1. Demonstration of body bag immersion technique.

access to monitoring lines, Foley temperature-sensing probe, and peripheral intravenous lines (Figure 1). The ice slurry was applied so that it covered the patient's lower body and torso, but was kept at a level that did not cover a portion of the patient's chest to allow for the cardiac monitoring probes to remain adherent. Tape was used to secure the portion of the zipper that was closed to insure minimal leakage of water.

With this ice immersion method, the patient's temperature decreased rapidly from 40.4°C to 36.5°C over 39 min (Figure 2). He was then removed from the body bag and dried off. His temperature remained below 38°C after ice bath removal.

Further history was obtained from the patient's grandmother after resuscitation. Patient had consumed 2 g of methamphetamine orally, as well as some possible balloons filled with methamphetamine. Of note, a subsequent computed tomography scan of his abdomen did not demonstrate any bags. Patient received supportive care for 9 days in the intensive care unit. He made a full recovery and was discharged at his baseline mental status.

The second case involved a 46-year-old male (patient B) with extensive history of polysubstance abuse and hepatitis C, who was brought to the emergency department after being found down for an unknown time by his brother outside of his apartment. On arrival, he was unresponsive. Physical examination demonstrated dilated pupils, tachycardia, diaphoresis, flushed skin, and muscle rigidity, but no clonus. Initial vitals were blood pressure 110/85 mm Hg, pulse of 140 beats/min, respiratory rate of 40 breaths/min, and temperature of 41.8°C (107.2°F). The patient was subsequently intubated for airway protection and declining clinical course. A temperature-sensing Foley catheter was placed and the patient was aggressively cooled.

As this case presented within 1 week of the previous case, the patient was immediately placed in a body bag, which was then filled with an ice slurry. The bag was zipped closed and taped to ensure that the patient was fully covered in ice. The patient's temperature decreased

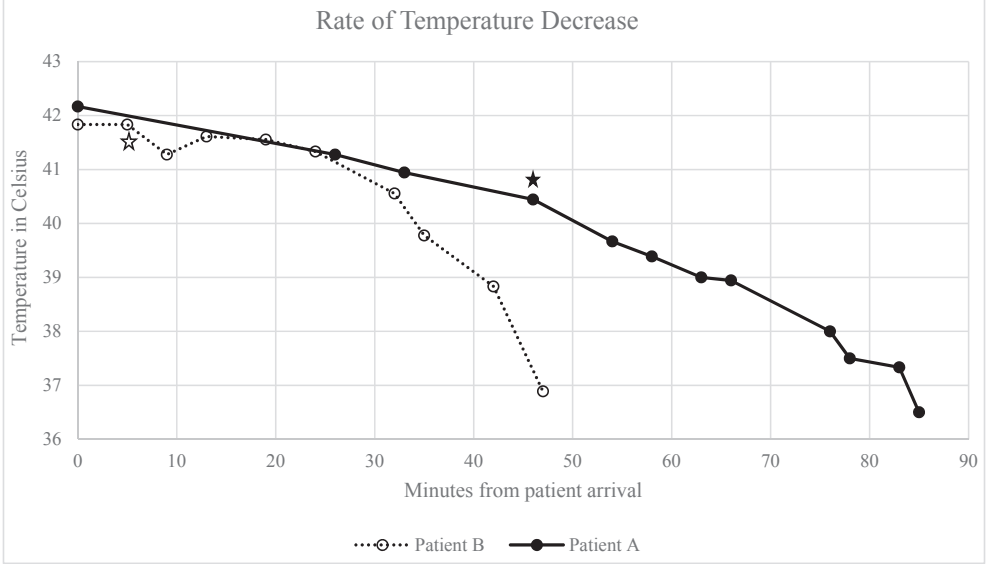

Figure 2. Rate of temperature decrease for patient A and patient B. Symbols (★ and ☆) represent time of immersion for patient A and patient B, respectively.

from 41.8°C to 36.9°C within 42 min (Figure 2). Once the patient's temperature dropped to 38.8°C, he was removed from the ice bath. Like the previous patient, his temperature remained below 38°C after ice bath removal.

Patient B was extubated within 24 h without any cognitive deficits. He ultimately signed out against medical advice that same day.

DISCUSSION

Methamphetamine use is responsible for approximately 102,000 emergency department visits annually (6). Clinical presentation can range from behavioral disturbances to hypertension and, more seriously, severe hyperthermia (7). Methamphetamine-induced hyperthermia is thought to be caused by disruption of normal thermoregulatory mechanisms, as well as adrenergic overload that causes psychomotor agitation (8,9). Treatment for hyperthermia is aggressive supportive care, including benzodiazepines to control agitation as well as external cooling measures (1).

Because the prognosis for these patients is directly related to the magnitude of hyperthermia and its duration, rapid cooling is imperative (10). Multiple methods have been described, including mist and fan technique, but the most effective way described has been cold water immersion (3,5,10). Cases of exertional heat stroke, specifically in the field environment, have shown that immediate cold water immersion decreases morbidity and mortality (11,12). However, in the emergency department, availability and logistics may deter rapid mobilization of an ice bath, including such items as a water impermeable bed (2). One method that we found to be readily available and effective was placing a patient in a body bag and filling it with ice. The body bag we utilized was a single use, Latex-free, cadaver bag kit, 36″ × 90″, manufactured by Tiger Medical Products. This method had a cooling rate of 0.10°C/min and 0.12°C/minute for our 2 patients, comparable to the reported cooling rate of 0.15°C/min for reported ice water immersion (3,11). This was faster than the rate of cooling from ice massage in our first patient (0.04°C/min).

We hypothesize that the body bag cooling is superior to ice massage because of the near complete surface area contact when the body bag is filled with ice and closed. One issue that presented was that the bag was not impermeable, and it only leaked at the point the zipper started. This problem was easily ameliorated with a bucket that collected the leakage. Another issue that we had thought would be a complication was adherence of cardiac monitoring pads to the patient's skin. However, in our experience, this was not an issue, as we kept the upper chest of the patient free of ice slurry contact. Furthermore, by keeping the upper chest exposed, we were able to easily access the patient's i.v. lines in his upper arm (Figure 1).

WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?

Patients with severe amphetamine-induced hyperthermia need to be identified and treated rapidly (5,12). We recommend that these patients receive supportive care, such as airway management and appropriate sedation, along with aggressive cooling. Although cold-water immersion is the most effective technique, it is often difficult to perform in the emergency department. This case report of using a body bag presents a safe and efficacious method for emergency physicians to perform cold water immersion in the department.

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