Tarp-Assisted Cooling as a Method of Whole-Body Cooling in Hyperthermic Individuals

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Study objective: We investigated the efficacy of tarp-assisted cooling as a body cooling modality.

Methods: Participants exercised on a motorized treadmill in hot conditions (ambient temperature 39.5°C [103.1°F], SD 3.1°C [5.58°F]; relative humidity 38.1% [SD 6.7%]) until they reached exercise-induced hyperthermia. After exercise, participants were cooled with either partial immersion using a tarp-assisted cooling method (water temperature 9.20°C [48.56°F], SD 2.81°C [5.06°F]) or passive cooling in a climatic chamber.

Results: There were no differences in exercise duration (mean difference=0.10 minutes; 95% CI −5.98 to 6.17 minutes or end exercise rectal temperature (mean difference=0.10°C [0.18°F]; 95% CI −0.05°C to 0.25°C [−0.09°F to 0.45°F] between tarp-assisted cooling (48.47 minutes [SD 8.27 minutes]; rectal temperature 39.73°C [103.51°F], SD 0.27°C [0.49°F]) and passive cooling (48.37 minutes [SD 7.10 minutes]; 39.63°C [103.33°F], SD 0.40°C [0.72°F]). Cooling time to rectal temperature 38.25°C (100.85°F) was significantly faster in tarp-assisted cooling (10.30 minutes [SD 1.33 minutes]) than passive cooling (42.78 [SD 5.87 minutes]). Cooling rates for tarp-assisted cooling and passive cooling were 0.17°C/min (0.31°F/min), SD 0.07°C/min (0.13°F/min) and 0.04°C/min (0.07°F/min), SD 0.01°C/min (0.02°F/min), respectively (mean difference=0.13°C [0.23°F]; 95% CI 0.09°C to 0.17°C [0.16°F to 0.31°F]. No sex differences were observed in tarp-assisted cooling rates (men 0.17°C/min [0.31°F/min], SD 0.07°C/min [0.13°F/min]; women 0.16°C/min [0.29°F/min], SD 0.07°C/min [0.13°F/min]; mean difference=0.02°C/min [0.04°F/min]; 95% CI −0.06°C/min to 0.10°C/min [−0.11°F/min to 0.18°F/min]). Women (0.04°C/min [0.07°F/min], SD 0.01°C/min [0.02°F/min]) had greater cooling rates than men (0.03°C/min [0.05°F/min], SD 0.01°C/min [0.02°F/min]) in passive cooling, with negligible clinical effect (mean difference=0.01°C/min [0.02°F/min]; 95% CI 0.001°C/min to 0.024°C/min [0.002°F/min to 0.04°F/min]). Body mass was moderately negatively correlated with the cooling rate in passive cooling (r=−0.580) but not in tarp-assisted cooling (r=−0.206).

Conclusion: In the absence of a stationary cooling method such as cold-water immersion, tarp-assisted cooling can serve as an alternative, field-expedient method to provide on-site cooling with a satisfactory cooling rate. [Ann Emerg Med. 2017;69:347-352.]

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INTRODUCTION

Background

Exertional heat stroke occurring during sport or physical activity is a medical emergency requiring prompt treatment for survival. It occurs when body heat production continuously exceeds the rate of heat dissipation, resulting in a rectal temperature (T_{RE}) greater than or equal to 40.5°C (104.9°F), with central nervous system dysfunction.[1] During exertional heat stroke, the failure of the thermoregulatory system causes body temperature to exceed the critical threshold for cell damage (40.83°C [105.5°F]), resulting in a cascade of events leading to endotoxemia and multiorgan dysfunction if not corrected in a timely manner.[2-4] Minimizing the time that body temperature is above this critical threshold enhances survival and reduces the risk of long-lasting sequelae.[5,6]

Current best practices state that immediate, on-site cooling of exertional heat stroke patients before transport ("cool first, transport second") enhances the chances of survival.[1,7,8] Furthermore, the method of cooling that is considered the criterion standard for exertional heat stroke treatment is cold-water immersion because it provides the greatest body

Editor's Capsule Summary

What is already known on this topic

Immediate on-site cooling of patients with exertional heat stroke enhances the chance of survival. Current methods of cooling include evaporative cooling, immersion cooling, and ice packs to groin and axillae.

What question this study addressed

This randomized, counterbalanced, crossover-design study compared tarp-assisted cooling with climatic chamber cooling in healthy men (8) and women (6) who exercised in a laboratory situation designed to induce hyperthermia to 40°C.

What this study adds to our knowledge

Tarp-assisted cooling, performed with 20 gallons of water and 10 gallons of ice poured onto a tarp, provided quicker cooling of the hypothermic volunteers than the climatic chamber did.

How this is relevant to clinical practice

Tarp-assisted cooling provides another method of cooling hyperthermic patients in the field.

cooling rates (0.15°C/min to ≈0.35°C/min [0.27°F/min to ≈0.63°F/min]).[9-11]

Importance

In certain situations (ie, forward deployment in a military setting or physical labor in a remote setting), cold-water immersion may not be feasible because of spatial, facility, or financial limitations, prompting investigations into alternative methods that provide adequate cooling rates (≥0.155°C/min [0.28°F/min]) to provide proper care.[12-14]

An alternative method of body cooling is tarp-assisted cooling, which requires only a large sheet of waterproof fabric (ie, a tarp or tarpaulin), water, and ice.[15] For application of the tarp-assisted cooling method, 3 or more persons hold the tarp to create a semirecumbent position for the patient who is lying supine on the tarp. Water and ice are poured over the patient, which allows partial body ice water immersion (Figure 1). During cooling, the persons who are holding the tarp oscillate the water to maximize the effect of cooling through the convective and conductive properties of water.[16] To our knowledge, only 1 study to date has investigated the use of the tarp-assisted cooling method in a laboratory setting, in which the participants sat in semirecumbent position on a tarp and were immersed in 40 gallons of 2.1°C [35.78°F], SD 0.8°C [1.44°F] water that was continuously oscillated by researchers.[15] This study resulted in a cooling rate of 0.14°C/min [0.25°F/min], SD 0.05°C/min [0.09/min]; however, the effectiveness of tarp-assisted cooling with a lesser amount of water and ice is unknown.

Goals of This Investigation

As the need for an effective, field-expedient method of cooling becomes more apparent, identification of appropriate cooling modalities warrants further investigation. Therefore, the primary aim of this study was to examine the cooling rate of the tarp-assisted cooling method with limited ice and water after exercise-induced hyperthermia. The secondary aim of the study was to compare the cooling rate of tarp-assisted cooling by sex and body mass. It was hypothesized that the tarp-assisted cooling method would result in cooling rates sufficient for that suggested for exertional heat stroke treatment and that difference in sex and body would not result in a significant difference in cooling rate.

MATERIALS AND METHODS

Study Design and Setting

This study used a randomized, counterbalanced, crossover design and was performed in a laboratory setting.

Figure 1. An example of the 3-person tarp-assisted cooling method.