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Water-immersion treatments for exertional hyperthermia

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Publication Details

Caldwell, J., van den Heuvel, A., Kerry, P., Clark, M., Patterson, M., Peoples, G. E. & Taylor, N. A.S. Water-immersion treatments for exertional hyperthermia. Defence Human Sciences Symposium; Melbourne, Australia: Australian Government Department of Defence; 2009.

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Water-immersion treatments for exertional hyperthermia

Abstract

Ice--cold water immersion can rapidly extract heat from hyperthermic patients. However, access to ice or cold water is limited when in the field, and some researchers have concerns regarding the possible adverse impact of the sudden cold-water immersion of hyperthennic individuals. We hypothesised that wannier-water immersions could still facilitate rapid cooling in profoundly hypertbennic people, and this would be due to less powerful cutaneous vasoconstrictor responses. These hypotheses were tested in two separate experiments.

Keywords

treatments, hyperthermia, water, exertional, immersion

Disciplines

Arts and Humanities | Life Sciences | Medicine and Health Sciences | Social and Behavioral Sciences

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Water-immersion treatments for exertional hyperthermia

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Ice-cold water immersion can rapidly extract heat from hyperthermic patients. However, access to ice or cold water is limited when in the field, and some researchers have concerns regarding the possible adverse impact of the sudden cold-water immersion of hyperthermic individuals. We hypothesised that warmer-water immersions could still facilitate rapid cooling in profoundly hyperthermic people, and this would be due to less powerful cutaneous vasoconstrictor responses. These hypotheses were tested in two separate experiments.

In the first experiment, eight males were heated to an oesophageal temperature of 39.5°C, and were then cooled using each of three methods (3 trials): air (20-22°C); cold-water immersion (14°C); temperate-water immersion (26°C). The time to reach an oesophageal temperature of 37.5°C averaged 22.81 min (air), 2.16 min (cold) and 2.91 min (temperate). While the between-trial comparisons were significant ($P < 0.05$), cooling in temperate water took only marginally longer than in cold water. Indeed, one cannot imagine that the 45 sec cooling time difference would have any meaningful physiological or clinical implications.

It was assumed that this rapid heat loss was due to less powerful peripheral vasoconstriction. However, cutaneous vascular responses were not measured in this experiment. Therefore, a second experiment was undertaken, in which eight males participated in four whole-body, water-immersion trials; two at 14°C, and two at 26°C. Trials A (26°C) and B (14°C) occurred from a thermoneutral state, while trials C (26°C) and D (14°C) were preceded by whole-body heating. For each of the water immersions, forearm blood flow decreased significantly relative to the pre-immersion baselines ($P < 0.05$). However, when these immersions followed thermoneutral rest, these blood flow reductions did not differ significantly between the two water temperatures ($P > 0.05$). Conversely, when immersion followed heating, the thermal state of the core modulated vasoconstriction. During trials C and D, significant vasoconstriction was observed for each immersion temperature ($P < 0.05$). However, significantly more powerful vasoconstriction was evident within the cooler water ($P < 0.05$), even though core temperatures did not differ significantly between these trials prior to immersion ($P > 0.05$). This difference is attributable to local thermal influences, either via local thermal effects on vasomotor tone, or through a reflex elevation in sympathetic activation. This more powerful constrictor response will reduce convective heat delivery from the body core to the periphery, as well as suppressing conductive heat loss through the skin.

While the core-to-water thermal gradient was much smaller with temperate-water cooling, greater skin and deeper tissue blood flows supported a superior convective heat delivery. Thus, a sustained physiological mechanism (blood flow) appears to have countered a less powerful thermal gradient, resulting in clinically insignificant differences in heat extraction between the cold and temperate cooling trials. Therefore, it is recommended that hyperthermic patients with a viable cutaneous circulation be cooled in water at a less stressful temperature (24-26°C), and not in either ice-cold or cold water, as others have recommended.