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Response

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RESPONSE

Dear Editor-in-Chief:

In our original manuscript (6), we deliberately separated medical emergencies from other treatments of hyperthermia. In all cases, immediate immersion cooling was recommended. However, we challenged the need to use ice-cold water for hyperthermic patients, unless it could be established that cutaneous circulation was no longer viable. Although we are neither clinicians nor diagnosticians, we suspect that the prognosis for individuals with cooler central nervous tissues, which can be achieved rapidly in temperate water, may be equivalent to that for those with cool rectums, although both can coexist. In our response, we shall address four points that have been raised.

Rectal temperatures and tissue damage—although all core temperature indices have useful applications, data obtained using each method must be interpreted with appropriate caution. Accordingly, we do not dismiss the core temperatures presented by Proulx et al. (3,4), but we do seek to put these data into a different context. Rectal temperatures provide a valid and reproducible index of the thermal energy content of the rectum. However, because rectal tissue perfusion is less than that of other core tissues (2), thus reducing its capacity to invariably represent most core temperatures, and because rectums do not have a unique relationship between tissue temperature and cell necrosis, then we encourage those investigating the dynamics of tissue cooling to consider using methods for which the obligatory phase delay will not result in a failure to detect an event that may have already occurred.

Core cooling rates—we wrote that "none of the esophageal temperature cooling rates reported by Proulx et al. (4) differed significantly from one another across any of the water temperatures investigated." Their original data corroborate this statement (Table 2). Rectal temperature cooling rates were not challenged nor should they be. However, readers may choose to ponder the physiological significance of such cooling rates, when this core index is widely accepted to have a phase delay in excess of 10–15 min (2,5). Indeed, these data cannot be conveniently quoted as interchangeable core cooling indices. Casa and Kenny refer in their letter to supporting data obtained using partitional calorimetry (3,4). We avoided commenting upon the veracity of such indirect methods in our article. However, the principles of thermodynamics inform us that, under non–steady-state conditions, the necessary assumptions of these computations are largely violated, rendering such calculations mathematically correct, yet scientifically invalid.

Thermal gradients—our knowledge concerning the interaction of core and cutaneous thermoreceptors in the modulation of skin blood flow in normothermic individuals is still incomplete, and even less is known when body heat content is moved either side of the neutral state. Thus, we have relied upon the thermoneutral observations of Kregel et al. (1), who reported that sympathetic discharge to skeletal muscles was unaffected at immersion temperatures >21°C, but was elevated at temperatures <15°C, and very powerful in water <10°C. Therefore, we recommend using cooling procedures that are less likely to reduce skin blood flow. During maximal peripheral vasoconstriction, convective heat transfer is minimized and the conductive path lengthens, resulting in nonphysiological factors increasingly dictating heat loss. Consequently, one should observe faster cooling from poorly perfused tissue beds in water <10°C, and rectal, but not esophageal cooling rates are consistent with this prediction (4).

Cold-shock risk—Readers must independently evaluate this risk from the literature, which covers a broad cross-section of the community. Athletes represent a particularly resilient subgroup. Thus, ice-water immersion recommendations that may be harmless for athletes may have dangerous consequences when applied to high-risk individuals. The esophageal temperature data of Proulx et al. (4) and Taylor et al. (6) show that little time is gained by using cold water, when cooling high-priority tissues. Given these surprisingly similar cooling rates for critical core sites, then attention must be directed toward risk minimization and then to comfort. In emergency situations in the field, where the presence of any temperature sensor is unlikely, one must immediately immerse the patient in the most readily available cool-temperate water if hyperthermia is suspected.

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