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Commentary

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Are Recommended Heat Stroke Treatments Adequate for Australian Workers?

Matt B Brearley[1,2,*]

[1]National Critical Care and Trauma Response Centre, Level 8 Royal Darwin Hospital, Rocklands Drive, Darwin NT 0810, Australia; [2]Thermal Hyperformance, PO Box 1356, Howard Springs NT 0835, Australia

*E-mail: matt.brearley@nt.gov.au

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Abstract

Workers that combine physical exertion with exposure to hot conditions are susceptible to heat-related illnesses, including heat stroke. Despite recognition of cold water immersion as the heat stroke treatment of choice in the peer-reviewed literature, it was not included within recommended treatments of leading Australian healthcare training organizations and was omitted from Safe Work Australia's recently updated 'Managing the risks of working in heat' guidance material. On this basis, the guidance material appears an opportunity lost to assist Australian industry transition their heat stroke management to reflect the evidence. It is recommended that Australian providers of healthcare training, and those reliant on such information, review the efficacy of their heat stroke treatments.

Keywords: cooling; exertional heat stroke; heat stress; heat stroke treatment; water immersion

The public health implications of exposure to heat include increased ambulance call-outs, emergency department presentations, hospital admissions, and deaths (Bi et al., 2011). This 'heat-health' burden is generally attributed to groups with impaired dissipation of body heat, including infants, chronic disease sufferers and the elderly. Yet, compromised heat dissipation does not solely define vulnerability to hot environments, as elevated metabolic heat production may contribute. In non-clinical settings, metabolic heat production is proportional to physical exertion, classifying the combination of high work rate and heat exposure as a potential health risk (Oppermann et al., 2017). The insulative properties of protective clothing and heat exposure across consecutive work shifts exacerbate the risk, prompting the recognition of workers engaged in labour-intensive occupations as an additional population group susceptible to heat.

Notwithstanding the apparent risks, heat as a workplace hazard remains poorly characterized and managed (Gubernot et al., 2014). With heat stress research rapidly evolving, Governments and peak industry groups play an important role distilling relevant information to minimize the impact of heat on workers. Safe Work Australia (SWA), the Australian government statutory body tasked with improving work health and safety, recently updated its 'Managing the risks of working in heat' guidance material. In addition to minimizing heat stress risk, the SWA document provides recommendations for diagnosis and treatment of heat-related illnesses including heat exhaustion and heat stroke. While heat exhaustion is the most common heat-related illness observed from emergency department presentations (Sanchez et al., 2010), the lack of clinical diagnosis criteria permits a variety of definitions. The acute phase of heat exhaustion is synonymous with elevated heart rate, respiratory rate, low blood pressure, profuse sweating, and ashen appearance (Armstrong et al., 2007), leading to thirst, weakness, discomfort, anxiety, and dizziness (Lipman et al., 2014) that manifests as an inability to effectively perform physical work in the heat (Casa et al., 2015). This mild to moderate illness can progress to the more severe (exertional) heat stroke if sufferers remain exposed to heat in the absence of treatment (Lipman et al., 2014).

Heat stroke is differentiated from heat exhaustion by neurologic impairment and hyperthermic (>40°C) core temperature (T_c). Yet, determining whether a heat-affected work colleague is suffering heat exhaustion or heat stroke in field settings is challenging due to inaccuracy of the commonly utilized T_c surrogates: axilla, temporal, oral, and tympanic temperature (Casa et al., 2007). Due to influence of ambient conditions, these measurement sites typically underestimate deep tissue T_c and are not appropriate for the diagnosis of heat stroke (Armstrong et al., 2007).

The SWA guidance material recommends that an ambulance should be sought immediately regardless of whether heat exhaustion or heat stroke is suspected. However, the 30-min 'window' or 'golden half hour' to reverse the abnormally high T_c of heat stroke sufferers (Casa et al., 2007; Belval et al., 2018), thereby limiting development of systemic inflammation response syndrome (Epstein et al., 2015), is a key omission. Put simply, heat stroke survivability is the product of the extent and duration of T_c elevation (degrees-minutes), expressed as the area under the T_c curve (Roberts, 2017). Lowering T_c below 40°C within 30 min of collapse ensures survival (Adams et al., 2015).

Armed with such information, it is intuitive to expect managers and workplace health and safety representatives to facilitate access to cooling methods that reflect the urgency of correcting a worker's abnormally high T_c. This is particularly relevant for workers in remote settings, as professional medical assistance may not be administered within the 30-min window. Here, permanent disability or death of a heat-affected worker may hinge upon the ability of work colleagues to administer cooling treatment(s) that remedy elevated T_c within the desired time frame. Objective assessment of cooling treatments is achieved by comparison to the T_c cooling rate classifications of ideal (≥0.16°C.min^{-1}), acceptable (≥0.08°C.min^{-1}), or unacceptable (<0.08°C.min^{-1}) (McDermott et al., 2009).

The SWA recommended cooling treatments for heat stroke are detailed in Table 1. Relocating workers away from heat, removing barriers to heat exchange (clothing) and improving airflow are standard recommendations. While effectiveness of such treatments is dependent upon environmental conditions surrounding the patient, it is generally accepted that these methods confer insufficient cooling for heat stroke treatment (McDermott et al., 2009). Application of cold packs/ice to the neck, groin and axilla regions and splashing/sponging temperate water are therefore, the primary recommended cooling strategies. Despite the theoretical basis of ice pack application and treatment recommendation by leading Australian healthcare training organizations (Australian Resuscitation Council, 2016; Australian Red Cross, 2018; St John Ambulance Australia, 2018), the insufficient cooling power of ice packs applied to shallow arteries has been noted (Brearley and Walker, 2015). In practice, T_c cooling rates 0.03–0.07°C.min^{-1} (Kielblock et al., 1986; Sinclair et al., 2009) are considered unacceptably slow with a recommendation to discontinue this practice (McDermott et al., 2009).

The splashing/sponging technique is most effective in dry, cool/thermoneutral environments that maximize evaporative potential (Armstrong et al., 2007), yet even in these settings, T_c cooling (~0.03°C.min^{-1}) is considered unacceptably slow. Dousing the patient with copious volumes of water (20–40 l) can improve cooling, as can the use of cold water, however such resources could be deployed to achieve the 'gold standard' treatment of immersing the torso and extremities in cold water (Casa et al., 2015). Despite recognition of cold water immersion as the heat stroke treatment of choice by the Wilderness Medical Association (Lipman et al., 2014), American College of Sports Medicine (Armstrong et al.,

Table 1. Safe Work Australia recommended treatments for heat stroke.

Move the worker to a cool place with circulating air.
Remove unnecessary clothing, including personal protective equipment.
Loosen tight clothing.
Make a wind tunnel by suspending sheets around, not on, the worker's body. Use a fan to direct gentle airflow over the worker's body.
Cool the worker by splashing room temperature water on their skin or sponging their skin with a damp cloth.
Apply cold packs or wrapped ice to the worker's neck, groin and armpits.

2007) and the National Athletic Trainers Association (USA) (Casa et al., 2015), and a recently published consensus statement on prehospital care of exertional heat stroke (Belval et al., 2018), it was omitted from the guidance material. This method generally lowers T_c at rates deemed ideal (Brearley and Walker, 2015), and is used in dynamic field settings through the use of a tarpaulin (Luhring et al., 2016; Hosokawa et al., 2017), and static field settings, such as temporary sporting medical facilities (DeMartini et al., 2015). Here, rapid diagnosis (mean T_c of 41.4°C) and cold water immersion (T_c cooling rate of 0.22°C.min^{-1}) of 274 heat stroke patients resulted in 100% survivability, with 93% cleared for home discharge (DeMartini et al., 2015).

Where full body immersion is not feasible, evidence-based alternatives (in order of efficacy) are lower body immersion, rotation of cold, wet towels over the entire body and the aforementioned cold water dousing and fanning (Casa et al., 2015). The lower T_c associated with heat exhaustion permits recommendation of less aggressive cooling techniques (Casa et al., 2015), with the rotation of cold, wet towels an evidence-based adjunct to the strategies recommended by the guidance material (Table 2). This procedure only requires access to ice-cold water and towels or equivalent medium throughout the work-shift, permitting implementation for workers in remote settings (Brearley et al., 2015).

Concerns regarding a cardiovascular cold-shock response from cold water immersion may explain its exclusion from the SWA guidance material, yet immersion causes no side effects for otherwise healthy individuals (Buchheit and Laursen, 2009). More likely, the omission of cold water immersion from guidance material reflected the heat stroke treatments recommended by leading healthcare training organizations (Australian Resuscitation Council, 2016; Australian Red Cross, 2018; St John Ambulance Australia, 2018). These organizations recommend ice pack cooling of shallow arteries and whole-body application of a wet cloth/sheet combined with fanning. Based upon the unacceptable cooling rates of these methods, the 'Managing the risks of working in heat' guidance material appears an opportunity lost to assist Australian industry transition their management of heat stroke to reflect the evidence. It is therefore recommended that Australian providers of healthcare training, and those reliant on such information, review the efficacy of their heat stroke treatments.

Table 2. Safe Work Australia recommended treatments for heat exhaustion.

Move the worker to a cool place with circulating air.
Remove unnecessary clothing, including personal protective equipment.
Loosen tight clothing.
Cool the worker with cold compresses or apply cold water to skin.

Declaration for publication

While this commentary was unfunded, the author consults with organizations to minimize heat stress of workers and to prevent heat stroke. Heat stress management guidance provided by government agencies may alter the nature of this work.

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