Case Report

Safety and efficacy of cold-water immersion in the treatment of older patients with heat stroke: a case series

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Background: Heat stroke treatment focuses on rapid cooling because symptom severity correlates with the duration of hyperthermia (i.e., time during which the core body temperature is sustained above the critical threshold). Several reports have revealed that cold-water immersion is a safe and appropriate therapy for exertional heat stroke in young, otherwise healthy patients. However, few reports have assessed cold-water immersion in older patients. We document three cases of cold-water immersion in older heat stroke patients and evaluate its safety and efficacy.

Case presentation: Three older patients with severe heat stroke were treated with cold-water immersion. Core body temperatures decreased rapidly, and no complications occurred during the treatment.

Conclusion: Cold-water immersion can achieve rapid cooling and is effective in treating heat stroke. With special precautions, it can be performed safely for older patients. Further investigation is warranted to establish appropriate cooling methods in older adults.

Key words: Body temperature, heat stroke, hyperthermia, immersion

BACKGROUND

HEAT STROKE IS a serious medical condition characterized by a core body temperature >40°C and central nervous system dysfunction.[1] Pertinent treatments for heat stroke include conductive and evaporative cooling methods, such as cold-water immersion (CWI). To date, randomized controlled trials on the management of heat stroke are lacking, and the preponderance of clinically relevant evidence is mainly from case series.[1] Furthermore, few reports have assessed the efficacy and safety of cold-water immersion in older patients. Here, we report a case series of three older heat-stroke patients to evaluate the safety and efficacy of cold-water immersion.

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CASE PRESENTATION

Case 1

A 72 -year-old man was found lying unresponsive in a garden and was brought to the hospital. On arrival, he was in a state of deep coma (Glasgow Coma Scale [GCS] score = 3: eye [1] verbal [1] motor [1]) with a blood pressure of 74/41 mmHg; pulse rate, 129 b.p.m.; bradypnea; and oxygen saturation, 98% (10 L O_2/min). A venous route was secured. His core temperature, measured using a temperature-sensing Foley catheter, was 41.3°C (Fig. 1). The patient was moved to an inflatable pool (Fig. 2) in the emergency department for CWI. Tracheal intubation was performed in the pool. Vital signs including non-invasive blood pressure, heart rate, electrocardiogram, respiratory rate, percutaneous oxygen saturation, and core body temperature were monitored using IntelliVue X2 (Philips, Amsterdam, The Netherlands). The monitors were affixed with waterproof films, and no complications occurred during cooling. The temperature of the water was 6.6°C, and the water level was up to chest height. His temperature reduced to 39.1°C and blood

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pressure elevated to 150/90 mmHg after 20 min of cooling (Fig. 1). Cooling was terminated 60 min after arriving at the hospital; his body temperature decreased to 36.5°C.

He was admitted to the intensive care unit for systemic management, and on day 2 of admission, he regained consciousness and was extubated. He subsequently recovered to his baseline status and was transferred to another hospital on day 36 for continued rehabilitation.

Case 2

An 81-year-old man was found lying unconscious outdoors and was brought to the hospital by air ambulance. When the flight doctor examined the patient, he was in a state of semi-coma, and benzodiazepine was administered during transport for seizures. On arrival at the hospital, he was in a state of deep coma (GCS = 3) with a blood pressure of 157/85 mmHg; pulse rate, 156 b.p.m.; bradypnea; and oxygen saturation, 91% (10 L O_2/min). Tracheal intubation was performed. Because his core temperature was 40.4°C, CWI was started. After 18 min of cooling, his temperature was 36.9°C, and cooling was terminated (Fig. 1).

On day 2 of admission, he regained consciousness and was extubated. Complications arose because of pressure ulcers associated with lying down outdoors, but the patient was discharged on day 30.

Case 3

A 90-year-old woman was found lying unresponsive and brought to the hospital. On arrival, she was in a state of deep coma (GCS = 3) with a blood pressure of 103/55 mmHg; pulse rate, 132 b.p.m.; respiratory rate, 36 breaths/min; and oxygen saturation, 100% (10 L O_2/min). Because her core temperature was 41.6°C, CWI was started. After 16 min of cooling, her temperature reduced to 38.8°C (Fig. 1).

Fig. 2. Inflatable pool (Kohshin Kaigoohuro, Kohshin Rubber Co. Sendai, Japan) filled with cold water to initiate cold-water immersion.

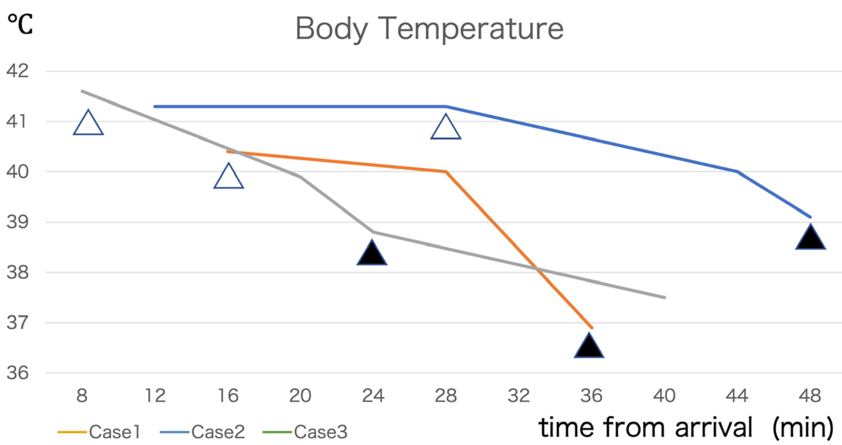

Fig. 1. Shifts in body temperature in three cases treated with cold-water immersion. White arrows Δ indicate commencement of cooling; Black arrows ▲ indicate cessation of cooling. Vital signs were monitored using IntelliVue X2 (Philips, Amsterdam, The Netherlands) and temperature measurements were recorded using a temperature-sensing Foley catheter (BARD Co. Murray Hill, NJ).

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Table 1. Patient characteristics, vital signs, cooling time, cooling rate, and modified Rankin Scales in three heat stroke patients

	Age	Sex	Onset	Underlying disease	Drug	Temperature on arrival (°C)	GCS	BP	HR	RR	SPO_2 (%)	Time of cooling (min)	Temperature at stop cooling (°C)	Time from arrival to target temperature (min)	Cooling rate (°C / min)	Cardio vascular event	Modified Rankin scale
Case 1 3	72	M	Outdoor	Parkinsonism	Dopamine agonist	41.3	E1V1M1	74/ 41	129		98	(101)	20	39.1	49	0.11	None
Case 2	81	M	Outdoor			40.4	E1V1M1	157/ 85	156			18	36.9	34	0.19	None	2
Case 3	90	F	Outdoor	HT infarction	Antihypertensive 5	41.6	E1V1M1	103/ 55	132	36	100	16	38.8	23	0.18	Brain	
Mean														35	0.16		

Patient characteristics, vital signs, cooling time, cooling rate and modified Rankin scales in three heat stroke patients. M, male; F, female; GCS, Glasgow coma scale; BP, blood pressure; HR, heart rate; RR, respiratory rate; SPO_2, oxygen saturation of peripheral artery; min, minutes.

A head computed tomography revealed a low-density area in the pons, leading to a diagnosis of brain infarction, which caused the patient to collapse and eventual heat stroke.

She did not regain consciousness and was transferred to another hospital on day 85.

Table 1 shows patients' age, sex, backgrounds, vital signs on arrival, cooling time, cooling rate, and prognoses.

DISCUSSION

THE SAFETY AND efficacy of CWI therapy, which involves a rapid rate of cooling, makes CWI suitable in young and otherwise healthy people for treating heat stroke. However, concerns include that it hinders life-saving treatments such as airway protection. Moreover, owing to issues such as monitoring vital signs and patient discomfort, it is rarely used in older patients.[1–3] We examined the records of patients who underwent CWI and discussed whether they achieved rapid cooling, experienced treatment complications, and it was suitable for the elderly.

We undertook CWI in nine heat stroke patients (2017–2020), including those presented here. Indications for CWI treatment include a core temperature ≥40°C and impaired consciousness, and CWI was applied at the physician's discretion. The criterion for terminating CWI treatment was core body temperature <39°C.

Deaths purportedly because of over-cooling have been reported.[4] Therefore, we carefully observed over-cooling in this case series, which highlights the importance of CWI treatment cessation at 39°C[2] and close monitoring of the core body temperature.

In this study, the cooling rate was 0.16°C/min (mean), similar to that of previous studies.[1,2,3] In exertional heat stroke, a cooling rate of ≥0.1°C/min is desirable to improve prognosis,[2] indicating that a sufficient cooling rate was obtained in this study. Evaporative and convective cooling can produce 0.04–0.11°C/min at best.[1]

In our report, 35 min (mean) passed from arrival at the hospital to reaching the target temperature. According to a nationwide study of heat stroke in Japan, the median time taken to reach the target temperature was 105.5 min.[5] The cooling methods included primarily evaporation, fan use, and gastric lavage. Although CWI therapy was not investigated,[5] it would be able to increase the cooling rate.

The inflatable pool we used was designed to keep the patient's head above the water level (Fig. 2). The patient was in the sniffing position, which made it easy to manually secure an airway. Therefore, when tracheal intubation was necessary, it was performed unencumbered. Chest compressions could be initiated even when the patient was underwater; however, cardiopulmonary resuscitation or defibrillation

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for any adverse event would require pool drainage. Draining sufficient water to expose the chest was estimated to take 20 s, which would not pose any clinical problems. Elevated blood pressure during the cooling process is associated with rapid vasoconstriction, therefore maintaining the possibility of a cardiovascular event. Present study included, no reports exist of myocardial infarction, fatal arrhythmia, or cerebrovascular accidents related to cooling methods.[1,3,4,6] However, vascular complications and arrhythmia could theoretically occur, making it safer to monitor blood pressure and administer vasodilators or sedatives before performing cooling methods for hypertensive patients. In this study, one patient experienced a cerebral infarction; however, it was not associated with the current treatment method.

Patient discomfort or agitation was noted in the literature[4,6] but not in our study. Severe heat stroke often results in unconsciousness, making it unlikely that patient discomfort will interfere with treatment. If patient discomfort or agitation is a problem, it may be addressed by administering sedatives.

Because older hyperthermic patients found at home, unconscious, are at risk of contracting infections, they should be administered antibiotics along with cooling therapy to minimize delay in treating sepsis. Heat stroke is a common occurrence during outdoor activities or work, even in older people.[4] Patients who are active outdoors are less likely to develop infections, therefore making them good candidates for immediate CWI.

CONCLUSION

WE STUDIED THE reports of three older patients with severe heat stroke, who underwent CWI therapy. CWI involves the use of simple equipment, achieves rapid cooling, and may improve prognosis. With special precautions, it can be performed safely in older patients. For older patients, careful monitoring and preparation for complications is essential. Further investigation is warranted to determine appropriate cooling methods for older persons with heat stroke.

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DISCLOSURE

APPROVAL OF THE Research Protocol: Not applicable.

Informed Consent: The patients provided informed consent for the publication of this case report.

Registry and the Registration No. of the study/trial: Not applicable.

Animal Studies: Not applicable.

Conflict of Interest: None declared.

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