Executive Summary: Society of Critical Care Medicine Guidelines for the Treatment of Heat Stroke

KEYWORDS: cold water immersion; cooling methods; emergency medicine; heat stroke; heat-related illness; intensive care unit; medication prophylaxis; practice guideline

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Heat-related illness is a leading cause of weather-related fatalities, and its prevalence is expected to increase (1). Heat stroke, the most severe form of heat-related illness, is defined as a core temperature greater than 40°C presenting with CNS abnormalities. Heat stroke can affect anyone, but certain populations are at higher risk including infants, elderly, athletes, domestically displaced, and outdoor workers (e.g., firefighters, construction workers, landscapers, military personnel, etc.) (2).

The increasing prevalence of heat stroke has emphasized the need for timely critical care and emergency services (3). Rapid cooling is an essential intervention to restore normal physiologic activity and minimize morbidity and mortality (4). Cold water immersion (CWI) is frequently cited as the preferred modality, but CWI may not be feasible in some settings or during mass casualty events, raising questions on the best alternative strategy (5). Additionally, once cooling has been achieved, critical care management of heat stroke is often centered around maintenance of organ support with minimal direct evidence to guide clinical decision-making. This executive summary provides an overview of the recommendations crafted by an international panel of multidisciplinary clinicians for the management of heat stroke. The seven Population, Intervention, Comparison, and Outcome (PICO) questions included in the guideline are presented in **Table 1**. For a detailed description of methodology, results, and rationale, the reader is referred to the complete guideline (6).

RECOMMENDATIONS

The panel issued a total of two strong recommendations, five good practice statements, and one "only-in-the-context of research" statement for these clinical practice guidelines (6). The infographic provides a brief summary of these recommendations (**Fig. 1**).

Recommendation 1

We recommend active cooling methods over passive cooling in patients with heat stroke (strong recommendation, very low certainty of evidence).

Remarks

CWI or ice water immersion will result in the fastest rate of temperature reduction and shortest time to target temperature (< 39°C).

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TABLE 1.
Population, Intervention, Comparison, and Outcome Questions and Summary of Recommendations

Population, Intervention, Comparison, and Outcome Question	Recommendation
Population: Patients with heat stroke Intervention: Active cooling methods Comparison: Passive cooling methods Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, hospital survival, rate of temperature reduction, time to target temperature, achievement of target temperature within 30 min, organ dysfunction, adverse effects/complications, or hospital length of stay	We recommend active cooling methods over passive cooling in patients with heat stroke (strong recommendation; very low certainty of evidence)
Population: Patients with heat stroke Intervention: CWI (or other active method if not CWI) Comparison: Alternative method Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, hospital survival, rate of temperature reduction, time to target temperature, achievement of target temperature within 30 min, organ dysfunction, adverse effects/complications, or hospital length of stay	Clinicians should prioritize cooling methods that achieve the most rapid rate of cooling, which is ice water immersion (1–5°C) or CWI (9–12°C) (Good Practice Statement)
Population: Patients with classic heat stroke Intervention: CWI Comparison: Method other than CWI Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, hospital survival, rate of temperature reduction, time to target temperature, achievement of target temperature within 30 min, organ dysfunction, adverse effects/complications, or hospital length of stay	Clinicians may use similar cooling strategies for either classic or exertional heat stroke (Good Practice Statement)
Population: Patients with exertional heat stroke Intervention: CWI Comparison: Method other than CWI Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, hospital survival, rate of temperature reduction, time to target temperature, achievement of target temperature within 30 min, organ dysfunction, adverse effects/complications, or hospital length of stay	Clinicians may use similar cooling strategies for either classic or exertional heat stroke (Good Practice Statement)
Population: Patients with heat stroke Intervention: Reaching the target temperature within 30 min Comparison: Not reaching the target temperature within 30 min Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, survival, organ dysfunction, adverse effects/complications, or hospital length of stay	Clinicians should choose cooling methods that reach the target temperature within 30 min of recognition of heat stroke symptoms (Good Practice Statement)

(*Continued*)

TABLE 1. (*Continued*)
Population, Intervention, Comparison, and Outcome Questions and Summary of Recommendations

Population, Intervention, Comparison, and Outcome Question	Recommendation
Population: Patients with heat stroke Intervention: Achieving a faster cooling rate (≥ 0.155°C/min) Comparison: Not achieving a faster cooling rate (< 0.155°C/min) Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, survival, organ dysfunction, adverse effects/complications, or hospital length of stay	Clinicians should prioritize cooling modalities that achieve a cooling rate ≥ 0.155°C/min (Good Practice Statement)
Population: Patients with heat stroke	We recommend against the use of dantrolene in patients with heat stroke (strong recommendation, very low certainty of evidence)
Intervention: Medications that either directly or indirectly affect temperature control	The routine use of acetaminophen, nonsteroidal anti-inflammatory drugs, and salicylates for temperature reduction should be avoided (Good Practice Statement)
Comparison: No medications Outcome: Survival with good neurologic function long-term (i.e., after 6 mo), survival with good neurologic function at discharge, hospital survival, rate of temperature reduction, time to target temperature, achievement of target temperature within 30 min, organ dysfunction, adverse effects/complications, or hospital length of stay	Prophylactic antibiotics or prophylactic antiseizure medications should only be used in the context of research (Only in the Context of Research Statement)

CWI = cold water immersion.

The outcome that was emphasized for this PICO was cooling rate because there were insufficient data to compare active vs. passive cooling methods on clinical outcomes such as survival, length of stay, organ dysfunction, and complications. A meta-analysis of randomized controlled trials (RCTs) (7–39) was performed that pooled the cooling rates for all active cooling methods and demonstrated a faster cooling rate with active vs. passive cooling in participants with experimental exertional hyperthermia (mean difference = 0.04°C/min [95% CI, 0.03–0.05°C/min]). The overall certainly of evidence for the recommendation is very low, primarily due to indirectness (experimental exertional hyperthermia vs. actual heat stroke subjects), imprecision, and inconsistency.

Active cooling can be performed via numerous mechanisms, and there is substantial variability in the cooling rates achieved with each. For example, ice water and CWI have a cooling rate of approximately 0.178°C/min and 0.154°C/min, respectively, compared with methods such as fan cooling (0.057°C/min) or evaporative cooling (0.002°C/min) which are much slower. The CNS is extremely vulnerable to excessive heat and both the degree and duration of hyperthermia affect normal physiologic processes. In fact, cell death increases in an exponential manner as temperature exposure time increases (40). Data directly comparing cooling rates on clinical outcomes though are limited. One review combined case series data (not amenable to Grading of Recommendations, Assessment, Development, and Evaluation methodology) and reported higher mortality and a higher rate of complications when cooling rates of greater than 0.15°C/min were not achieved (41). Similarly, two large case series reported zero fatalities when target temperatures were reached within 30 minutes (primarily with CWI) (42, 43). The panel decided active methods that achieve a cooling rate of at least 0.155°C/min should be prioritized over those that do not achieve this rate. These include ice water immersion and CWI. CWI/ice water immersion may be associated with undesirable effects for patients,

2025 SCCM Guideline for the Treatment of Heat Stroke

Society of Critical Care Medicine

- **Heat-related illness** is a *leading cause of weather-related fatalities* that are increasing in prevalence.
- **Heat stroke**, the most severe form of heat-related illness, is defined as a core temperature >40°C with central nervous system symptoms & can lead to significant morbidity & mortality.

Methods: An international team of multidisciplinary clinicians was formed to develop evidence-based guidelines, using GRADE methodology, on the management of heat stroke.

PICO:

1.) Cooling modalities

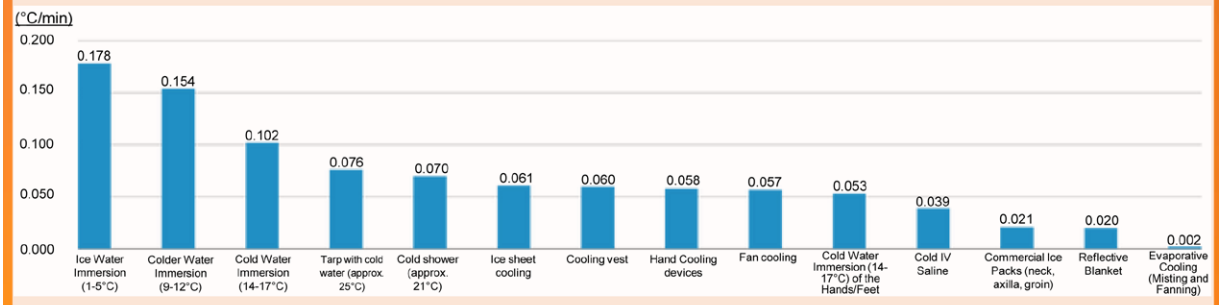
2.) Medications to reduce temperature

1. We recommend active cooling methods over passive cooling in patients with heat stroke.
[*Strong recommendation; very low certainty of evidence*]

- Prioritize cooling methods that achieve the most rapid rate of cooling which is ice- or cold-water immersion.
  Good Practice Statement
- Use similar cooling strategies for either classic or exertional heat stroke.
  Good Practice Statement
- Prioritize cooling modalities that achieve a cooling rate ≥0.155°C/min and reach the target temperature within 30 min from recognition.
  Good Practice Statements

2. We recommend <u>against</u> the use of dantrolene in patients with heat stroke.
[*Strong recommendation; very low certainty of evidence*]

- Avoid routine use of acetaminophen, NSAIDS & salicylates for temperature reduction.
  Good Practice Statement
- Prophylactic antibiotics or prophylactic antiseizure medications should only be used in the context of research.
  Only in the Context of Research Statement



- The figure above displays the weighted mean cooling rate (°C/min) for each available cooling method, from fastest (left) to slowest (right).
- The table below displays each cooling method and the final core temperature achieved with that cooling method after 30 minutes for a given initial core temperature. Target final core temperatures (<39 C°) are colored green and near-target final core temperatures (39-40 C°) are colored yellow.

	Initial Core Temperature (°C)						
	40.0	40.6	41.1	41.7	42.2	42.8	43.3
Cooling Method	Final Core Temperature (°C)						
Ice Water Immersion (1-5°C)	**34.7**	**35.3**	**35.8**	**36.4**	**36.9**	**37.5**	**38.0**
Colder Water Immersion (9-12°C)	**35.4**	**36.0**	**36.5**	**37.1**	**37.6**	**38.2**	**38.7**
Cold Water Immersion (14-17°C)	**36.9**	**37.5**	**38.0**	**38.6**	*39.1*	*39.7*	40.2
Tarp with Cold Water (approx. 25°C)	**37.7**	**38.3**	**38.8**	*39.4*	*39.9*	40.5	41.0
Cold Shower (approx. 21°C)	**37.9**	**38.5**	*39.0*	*39.6*	40.1	40.7	41.2
Ice Sheet Cooling	**38.2**	**38.8**	*39.3*	*39.9*	40.4	41.0	41.5
Cooling Vest	**38.2**	**38.8**	*39.3*	*39.9*	40.4	41.0	41.5
Hand Cooling Devices	**38.3**	**38.9**	*39.4*	*40.0*	40.5	41.1	41.6
Fan Cooling	**38.3**	**38.9**	*39.4*	*40.0*	40.5	41.1	41.6
Cold Water Immersion (14-17°C) of the Hands and/or Feet	**38.4**	*39.0*	*39.5*	40.1	40.6	41.2	41.7
Cold IV Saline	**38.8**	*39.4*	*39.9*	40.5	41.0	41.6	42.1
Commercial Ice Packs (neck, axilla, groin)	*39.4*	*40.0*	40.5	41.1	41.6	42.2	42.7
Reflective Blanket	*39.4*	*40.0*	40.5	41.1	41.6	42.2	42.7
Evaporative Cooling (Misting and Fanning)	*39.9*	40.5	41.0	41.6	42.1	42.7	43.2

Figure 1. Summary of guidelines recommendations for the management of heat stroke. To convert Celsius to Fahrenheit, multiply by 1.8 and add 32. GRADE = Grading of Recommendations, Assessment, Development, and Evaluation, NSAIDS = nonsteroidal anti-inflammatory drugs, SCCM = Society of Critical Care Medicine.

introduce hazards for hospital staff (e.g., slips and falls), complicate patient monitoring (e.g., cardiac monitor leads falling off), and interfere with ongoing resuscitation and procedures. Nevertheless, when considering the consequences of prolonged exposure to extreme body temperatures (i.e., long-term cognitive dysfunction and/or death), the panel determined that the desirable effects far outweighed the undesirable effects. CWI (or other methods of active cooling) may not be available or feasible in some settings such as austere environments, mass casualty events, or resource-limited regions. In these instances, clinicians are advised to select the method or combination of methods that will achieve the fastest rate of temperature reduction, aiming to achieve the target temperature within 30 minutes of recognition of heat stroke symptoms (see full online guideline). Careful planning and foresight are needed so required resources are readily available.

Recommendation 2

We recommend against the use of dantrolene in patients with heat stroke (strong recommendation, very low certainty of evidence).

Dantrolene is a treatment option for patients with malignant hyperthermia and its use in heat stroke has been considered due to overlap in pathophysiologic mechanisms. Three RCTs have compared dantrolene with placebo in patients with heat stroke (44–46). One is available in abstract form only. Meta-analyses have demonstrated no reduction in the risk of mortality (three trials; risk ratio [RR], 1.01 [95% CI, 0.11–9.31]), a mean difference in cooling time (two trials) of −10.5 minutes (95% CI, −28.5 to 7.6 min), a difference in hospital length of stay (one trial) of 1.85 days (95% CI, 0.99–2.70 d), no difference in the risk of adverse events (two trials; RR, 0.99 [95% CI, 0.46–2.15]), and a difference in incidence of recovery of consciousness as defined by a Glasgow Coma Score of greater than or equal to 13 points at less than or equal to 90 minutes of RR 2.5 (95% CI, 0.56–11.16). The overall certainty of evidence was very low due to risk of bias, imprecision, and inconsistency. When formulating the strength of the recommendation, the panel considered the quality of evidence, the wide CIs, including the fact that differences noted were not statistically significant, acquisition cost, and required resources. Furthermore, some outcomes were only analyzed via one study.

Other medication therapies, such as acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDS), and salicylates, have no evidence supporting a desirable effect in the setting of heat stroke. Further, the panel recognized the risk for known adverse effects (e.g., hepatotoxicity, acute kidney injury, bleeding), which may be more prevalent in heat stroke patients. The routine use of acetaminophen, NSAIDS, and salicylates for temperature reduction should, therefore, be avoided. Due to the lack of any available evidence, antibiotic prophylaxis and seizure prophylaxis should only be used in the context of research.

RESEARCH AGENDA

Several challenges exist with conducting ethical clinical trials in patients with heat stroke. Given these challenges, most data arise from experiments conducted using healthy volunteers in controlled settings. Data utilizing endpoints like survival, survival with good neurologic function, organ failure, etc. are lacking. Further studies are needed that report outcomes in patients with heat stroke (vs. experimental hyperthermia) evaluating the relationship between cooling rate, time to temperature target, and clinical outcomes. Finally, research focused on treatment strategies in the critical care setting for comatose/symptomatic patients post-cooling is needed. A blueprint for future studies has been proposed (5) .

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