स्वास्थ्य एवं
परिवार कल्याण मंत्रालय
MINISTRY OF
HEALTH AND
FAMILY WELFARE
सत्यमेव जयते

Azadi Ka Amrit Mahotsav

EMERGENCY COOLING
FOR
SEVERE HEAT RELATED ILLNESSES

National Programme on Climate Change and Human Health

National Centre for Disease Control
Government of India

Acknowledgement

These guidelines on Emergency Cooling for Severe Heat-Related Illnesses are prepared under National Programme on Climate Change and Human Health (NPCCHH), National Centre for Disease Control (NCDC), MoHFW. Aligned with the programme's goal, the guidelines emphasize the significance of rapid and active cooling in addressing severe heat-related illnesses. With a specific focus on various body cooling methods, the guidelines are envisioned to support the incorporation of this approach into emergency care throughout the healthcare system, adapting to the increasing climate change and extreme heat events.

These guidelines supplement earlier publications, i.e., National Action Plan on Heat Related Illnesses (2021) and Strengthening Health Systems Preparedness for Heat Related Illnesses in India (2023). NPCCHH Programme Implementation Plan (PIP) provides procurement guidance for emergency cooling measures.

These guidelines were conceptualized under the vision and leadership of Prof (Dr) Atul Goel, DGHS and Director, NCDC. The expert committees of clinicians from internal medicine and paediatrics contributed to their development. We thank Prof (Dr) Ajay Chauhan, Atal Bihari Vajpayee Institute of Medical Sciences & Dr. Ram Manohar Lohia Hospital, New Delhi, for technical guidance and detailed review.

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Legend

Symbols represent preference of usage of a cooling method in;
(from left to right) 1. Type of heat stroke, 2. institutional and/ 3. field setting

1.Heat Stroke

Heat and Human Body

- Human body temperature is maintained in a narrow range of 36.5–37.5°C (97.7–99.5°F) by balancing heat load (originating from environmental heat exposure and metabolic processes), with heat dissipation.
- Body temperature is regulated by physiological and behavioural mechanisms.
- Increasing core body temperature leads to activation of autonomic nervous system through activation of preoptic nucleus of the anterior hypothalamus causing increased sweating and cutaneous vasodilation to allow for dissipation of body heat.
- Body heat dissipates through following heat transfer mechanisms
    1. Conduction: Direct transfer of heat through contact with a cooler object or cold water
    2. Convection: Direct transfer of heat to convective, cooler air currents
    3. Evaporation: Transfer of heat to evaporating sweat or water on the skin
    4. Radiation: Simple loss of heat across the skin barrier to the ambient air
- The first three mechanisms fail to transfer heat effectively when environmental temperature exceeds skin temperature (typically 35°C or 95°F).
- Evaporation is the principal mechanism the body uses to cool in the hot environment. However, it becomes ineffective beyond relative humidity of 75%.
- Heat stress depends on ambient temperature and humidity.
- *Rising global warming increases ambient temperature and humidity both. With each degree of warming, atmospheric water vapor grows approximately by 6 to 7%, potentially pushing heat stress exposure to beyond human tolerance at many places.*[1]

Pathophysiological Changes

Core body temperature of ≥40°C leads to

- Acute central nervous system dysfunction with pulmonary, cardiovascular, hepatic, and/ renal dysfunctions, and disrupted coagulation.
- Damage to hepatocytes, vascular endothelium, and neural tissue which are the most sensitive to high heat.
- Cellular changes through changes in cellular proteins, enzymes and membranes leading to capillary leakage, systemic inflammation and multiorgan failure.

Clinical Management and Heatstroke Workup

Detail clinical management protocols (Adults and Paediatrics) and heatstroke workup guidelines are available in National Action Plan on Heat-Related Illnesses (2021)

Types of Heat Stroke

Feature	Exertional Heat Stroke	Classic Heat Stroke
Occurrence	Sporadic (any time of year)	Epidemic (heat waves)
Exposure	A. Athletic event B. Working in high heat stress conditions	A. High environmental heat with/without high humidity
Acute risk factors	• Dehydration • Concurrent illness • Obesity • Wearing too much clothing • Poor cardiovascular fitness	• Lack of adequate ventilation/cooling • Confined places* • Physical exertion not a pre-requisite
Heat equilibrium	Overwhelmed: heat gain > heat loss • Heat gain from environment with/without increase internal heat production	Impaired: ↓ heat lose capacity • Internal heat loss mechanism impaired • Restricted/inadequate ventilation
Heat injury development	Quick rise in core body temperature (over minutes-hours)	Slow rise in core body temperature (over hours or days)
Sweating	Usually present (wet skin)	May be absent (dry skin)
CNS dysfunction	Common	Common
Pathophysiological changes	• Metabolic acidosis • Hypoglycaemia • Rhabdomyolysis: frequent • Liver dysfunction: marked-severe • Renal failure: common • DIC: marked-severe • Hypocalcaemia, Hyperkalaemia	• Respiratory alkalosis • Rhabdomyolysis: unusual • Liver dysfunction: mild • Renal failure: uncommon • DIC: mild • Volume, electrolyte abnormality is common
Risk factors		
Physiological	• Active adult • Generally healthy	• Elderly, Children • Pregnancy • Obesity • Chronic illness • Poor physical health • Psychological, Physiological impairment
Medication/ drug use	Amphetamines and amphetamine-like agents (e.g., ephedra), MDMA, cocaine, PCP and LSD, synthetic stimulants of the cathinone class (e.g., α-PHP), alcohol	Antihypertensives, laxatives, anticholinergic drugs, salicylates, thyroid agonists, benztropine, trifluoperazine, butyrophenones, α-agonists, monoamine oxidase inhibitors, sympathomimetic medications, tricyclic antidepressants, SSRIs
Socio-economic (individual/institutional)	Occupation/physical exertion linked: work time, duration, adequate time to rest, lack of cooling and hydration facilities	• Social isolation • Living on top floor • Unventilated and non–air-conditioned living space • Inability to care for oneself

Key Steps in Heat Stroke Management

Step	Action
1. Early Recognition	• Maintain high clinical suspicion • Weather awareness • Measure core body temperature
2. Rapid cooling	• Initiate immediate external cooling • Early decision regarding invasive cooling
3. Supportive care	• Maintain on airway, breathing, circulation • Monitor for and correct metabolic derangements

Key Points: Severe Heat-Related Illnesses (HRI)

- The critical thermal maximum (CTM) is defined as the degree of elevated body temperature and duration of heat exposure that can be tolerated before cell damage occurs.[2]
- Human thermal maximum is estimated as a core body temperature of 42°C (107.6°F) lasting between 45 minutes and 8 hours. Children sustain serious heat-related injury when the CTM is exceeded.[3]
- Exposure to elevated ambient temperatures coupled with increased metabolic activity may result in heat illness if the individual has exhausted physiological compensatory mechanisms and is unable to take behavioral steps to cool down.[4] **Heat stress can progress to heat stroke even after the patient is removed from the hot environment.**
- **Heat stroke is a life-threatening, time-sensitive condition.**
- If untreated, heat exhaustion may progress to heat stroke.
- Clinical diagnosis of heat stroke is largely a diagnosis of exclusion. Hence, diagnostic investigations are directed toward detecting end organ damage and excluding other diseases.
- The definitive treatment for heat-related illness is total body cooling.

Guiding Principles: Rapid Cooling in Severe Heat-Related Illnesses

- Rapid cooling is the most effective strategy for minimizing morbidity and mortality from heat stroke and should be initiated as soon as possible, and **within 30 minutes of presentation.**
- It requires creating a gradient for heat loss from skin to environment by conduction, convection or evaporation.
- Apply cooling method that has high effective cooling rate. (*See page 6*)
- In field setting, cooling should be initiated immediately at time of collapse and should be based on feasible field measures including ice or tepid water (1-16°C).
- In emergency department, management should be matched to the patient's age and medical background and include immersion in ice water (1-5°C) or evaporative cooling.
- In emergency situation, the distinction between exertional and classic (non-exertional) heat stroke is less relevant for initiation of the treatment, because immediate cooling and support of organ system function is the therapeutic goal for both.

Primary goal

1. **Cool First, Transport Second**
   Immediate, rapid cooling: recognize, begin effective cooling in field/pre-hospital setting continue during transport to nearest emergency department
2. **Aggressive supportive care in** emergency department to maintain organ function

End point: Core body temperature between 38-39°C, approximate cooling times **9-40min**

Rectal temperature measurement:

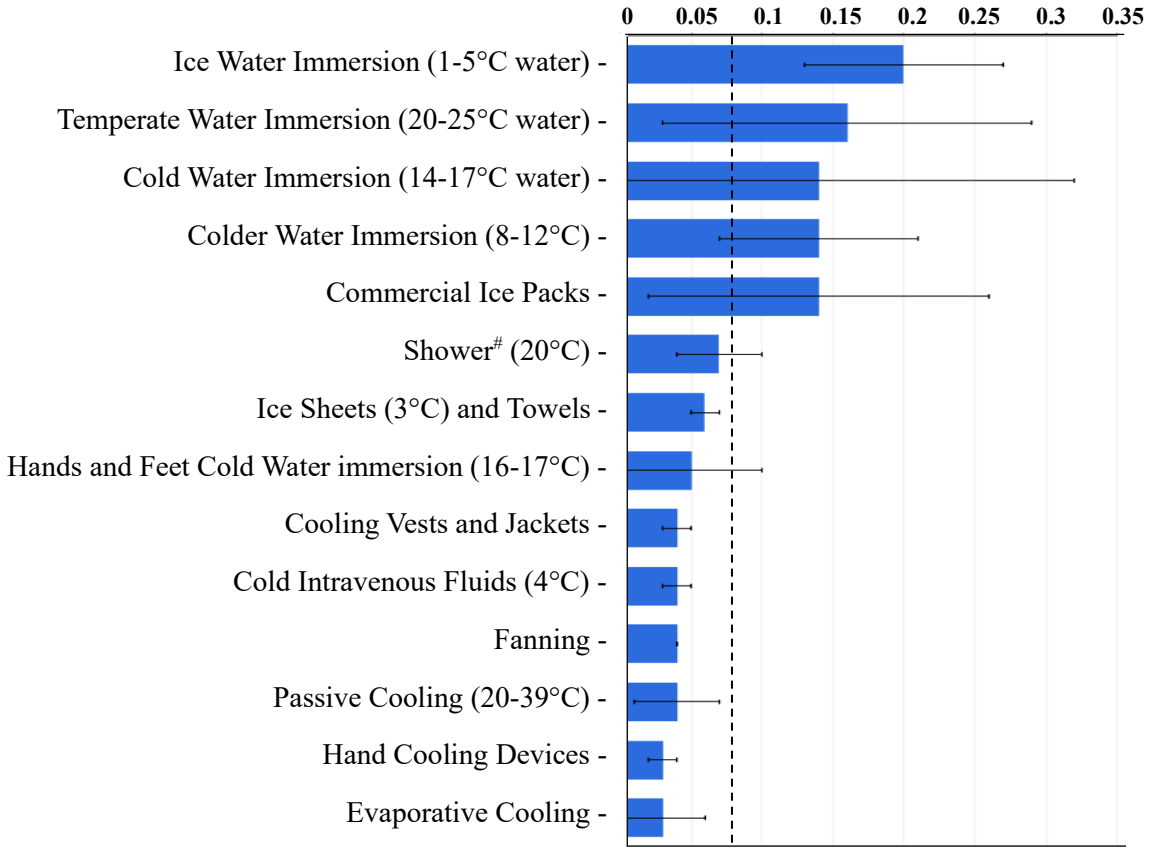
A rectal thermometer with flexible, disposable probe (2 m length) is recommended for patient comfort and ease of continuous monitoring throughout the treatment. The thermometer should be inserted through the anal sphincter for at least 10 cm. It is recommended to mark the probe at the insertion length so that the thermometer is fully inserted to the required length.[5]

- The only absolute contraindication to cooling is normal or low body temperature
- Delay in cooling is directly associated with adverse outcomes including high mortality.
- Cooling should not be delayed to remove all clothing, uniforms, or equipment. The cooling process should be initiated as quickly as possible; clothing and equipment can be removed while cooling is initiated, or when practical
- Evidence is lacking to support the use of cooling blankets or ice packs placed strategically to the neck, axilla, and groin as primary cooling methods.[6] This method of cooling should be applied to whole body for effective cooling and should be used as supplementary method.
- Monitor vital signs (rectal temperature, heart rate, respiratory rate, blood pressure) and mental status continually. Always maintain patient safety.
- Colder water temperature produce faster cooling. water's high thermal conductivity, which is 24 times greater than air's
- Avoid using warm water whenever possible
- Prognosis of heat stroke in patients is directly related to the degree of hyperthermia and its duration. In extreme cases these may progress to multi-organ failure and death. Heat stroke has a mortality rate of 40% to 64%.[7]
- Regardless of the cooling method used, mortality and morbidity remains higher in older patients with heatstroke due to pre-existing conditions and population characteristics[6]
- A single episode of hyperthermia may cause short-term neurological and cognitive dysfunction, which may be prolonged or become permanent. The cerebellum is most frequently affected in such instances.[7]
- There is insufficient evidence to recommend invasive cooling methods like intravascular cooling device, noninvasive external cooling system, body cavity lavage.[6]
- Antipyretic agents (Paracetamol, Acetaminophen, Aspirin etc) are not effective.
- Dantrolene is not recommended in the treatment of heat stroke.

Cooling rates

Weighted Mean Cooling Rates (°C/min) by Cooling Method as First aid cooling techniques For heat stroke and exertional hyperthermia

Standard deviations based on the mean cooling rate of study participants



*Dotted line represents minimum ideal rate of cooling (0.15**°C/min**) for EHS.*

Adapted from: McDermott BP, Casa DJ, Ganio MS, et al. Acute Whole-Body Cooling for Exercise-Induced Hyperthermia: A Systematic Review. Accessed December 28, 2023

- Minimum ideal rate of cooling is 0.155°C/min (0.28 °F/min) for EHS[8]
- Cooling rates of 0.078°C to 0.154°C/min are acceptable and <0.078°C/min are unacceptable for EHS[9]
- Air-conditioned or temperature-controlled rooms have cooling rates of 0.03–0.06°C/min, which as a standalone cooling method are unacceptable for heat stroke management[6]

Challenges with Rapid Cooling

a. Shivering:

Ice or cold water immersion cooling may lead to shivering and the accompanying reflex peripheral vasoconstriction which may delay the cooling theoretically.

- Practically, immersive cooling can effectively cool patients as it uses high thermal conductivity gradient between ice water and hyperthermic skin. Water has 24 times greater thermal conductivity than that of air which may effectively counter small amount of heat generate by shivering.
- Also, thermoregulatory response is driven mainly by core body temperature and not by skin temperature change, high core temperature would prevent shivering even in case of rapid skin cooling.

Preventing shivering

- Conduct evaporative cooling in elderly, children, co-morbid, classic heat stroke patients over immersive cooling as it is better tolerated physiologically and prevents shivering.[10]
- Use warm water (40°C) or expose the patient to hot air (45°C) with the fan.[11,12]

Pharmacological treatment of shivering is primarily short-acting benzodiazepines and secondarily phenothiazines.[13] Phenothiazines may lower the seizure threshold and cause hypotension, and their anticholinergic properties impair sweating.

b. Inability to adhere cardiac electrodes to the skin

Immersive cooling is not preferred in classic heat stroke and patient with existing comorbidity as it may hamper cardiac monitoring and resuscitation. In this patients other conductive or evaporative measures of cooling should be used.[6] *(see page 18-19)*

Follow-up of Heat Stroke Treatment

- Schedule a follow-up visit 7 days after hospital discharge for a physical examination and repeat laboratory testing of affected organ systems during hospital stay if warranted.

Patient education post-heatstroke

- Patient should abstain from exercise for at least 7 days after hospital discharge.
- **Acclimatize**: once cleared to return to routine activity, the patient should remain in a cool environment and slowly increase the duration, intensity, and heat exposure over 2-4 weeks to acclimatize.
- **Evaluate:** If heatstroke symptoms return or if vigorous activity is not tolerated, the patient of exertional heat stroke may be considered for a heat tolerance test as per sports or occupational requirements
- **Prevent exposure and adapt:**
  - Try to schedule activities during cooler times of the day and wear light-coloured, loose-fitting clothing.
  - Avoid dehydration by drinking ample amounts of isotonic fluids (taking concurrent medical condition into consideration) being sure to avoid fluids containing alcohol and caffeine if the individual is at risk for heat-related injury.
  - Never leave an adult or child in a car unattended.
  - Be aware of medication side effects such as medications that cause bradycardia, diuresis, or reduce sweating.

EXERTIONAL HEAT STROKE (EHS)

Guiding principles for cooling a exertional heat stroke case

- Rapid, active cooling (within 30 minutes) is the most effective strategy for minimizing morbidity and mortality.

- Key principles for external cooling of an EHS patient:
    1. provide a modality of adequate cooling capacity
    2. apply this modality to a sufficient body surface area

- Recommended minimum rate of cooling for treating an EHS patient is at least 0.15°C/minute

- Conductive cooling (i.e. with ice/water) methods are the best way to rapidly cool in EHS
    - Ice/cold water immersion (CWI): the most effective (gold standard) method regardless of the patient's location
    - If CWI is not available or feasible, alternative yet effective cooling methods must be used for rapidly cool the patient *(See Conductive Cooling, page 11)*

- Cooling must be initiated in the field following brief, rapid evaluation, till
    - Core body temperature reduces to 38.3-39°C *or*

  if rectal thermometer not available
    - Until the patient begins to shiver *or*
    - If treating with CWI, cool for 15 to 20 minutes. It cools most patients 3-4°C (5-7°F), which would make their removal from an ice tub sensible in most cases.

- Once cooling to a reasonable temperature (e.g., ~39°C) is achieved, the patient is rapidly transported to the closest emergency department.

- If adequate cooling not achieved in field, it should be continued in the best way possible during transport and in the hospital.

- Studies on EHS often report 100% survival rate when immediate cooling (via CWI or aggressive whole-body cold-water dousing) was initiated within 10 minutes of collapse.

- Cooling should not be delayed in order to remove all clothing, uniforms, or equipment. The cooling process should be initiated as quickly as possible; clothing and equipment can be removed while cooling is initiated, or when practical.

Onset of heatstroke and selection of cooling method

- Clinical presentations indicative of CNS dysfunction may be delayed (eg, disorientation, confusion, aggressiveness, hysteria, delirium, altered level of consciousness and irrational behaviour).

- Collapsed athletes with confirmed hyperthermia below 40.5°C (*104.9°F*) should still be cooled using the whole-body rotating ice-wet towel procedure where wet towels soaked in iced water are applied to the athlete and exchanged every 1–2 min.[5]

- Athletes who are suspected of EHS from their symptoms but have a rectal temperature measured at below 40.5°C (*104.9°F)* should continue to have their rectal temperature monitored continuously and undergo a blood sodium and blood glucose point-of-care analysis for the differential diagnosis of their medical condition.

CLASSIC (NON-EXERTIONAL) HEAT STROKE (CHS)

Guiding principles for cooling a non-exertional heat stroke case

- Rapid cooling should be initiated as soon as possible to minimize mortality from CHS as it arises due to diminished thermoregulatory function.[14]

- Elderly are more vulnerable to CHS due to various combination of their intrinsic vulnerabilities and extrinsic factors.

- In CHS, evaporative cooling is preferred over conductive cooling, as it
  - Provides a practical alternative to immersion in ice/cold water which may restrict cardiac monitoring and resuscitation efforts in elderly or patients with existing comorbidities[1]
  - Well tolerated physiologically and has low mortality rate[10]
  - Less shivering and vasoconstriction compared to ice water cooling[9]

Type of cooling

- Evaporative + convective cooling together (i.e. large quantities of water + strong directed air current) is more effective to rapidly cool a patient of CHS.

- Evaporative + convective + conductive cooling combination (i.e. large quantities of water + strong directed air current + ice) may speed up overall cooling and improve outcomes.

- Evaporative cooling in elderly patients may offer several practical advantages, such as greater patient comfort and less agitation.

Salient points

- Cool the entire surface of a patient.[9]

- Cooling only the anterior surface of a patient[9] on a bed is significantly less effective than cooling both anterior and posterior surfaces.

- Misting the patient with lukewarm water with forced, directed airflow of 20-40°C is effective.

- Cooling rate for a vasodilated patient cooled with an air speed of 1 m/s^{-1} is twice the cooling rate of a vasoconstricted patient with an air speed of 0.5 m/s^{-1}

- Strategic placement of ice packs to axilla, neck, and groin only marginally contributes to cooling.[1]

- Prognosis of heat stroke in patients is directly related to the degree of hyperthermia and its duration.[11]

- Rapid cooling (within 1 hr) may reduce length of hospital stay in CHS patients.[14]

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2. Cooling Methods

A. Conductive cooling

ICE/COLD WATER IMMERSION (CWI)

EHS

- ***Gold standard*** *cooling method for* ***exertional heat stroke***
- Highly effective in generally healthy or athletic adult
- Suitable at health facilities, pre-hospital and field setting with planned resources and setup
- Useful during sport, military, outdoor events (field setting) year around especially during high temperature
- May not be suitable for elderly, children or if patients have medical conditions which require advance cardiac monitoring.
- Ice slurry or cold water of ***Temperature of 2–10°C (35.6–50°F)*** should be used.
- Multiple research report very low to zero mortality in EHS treated timely with CWI
- Resource intensive, multiple assistants required

Recommended equipment list for CWI using tub/portable pool

- Rectal thermistor, lubricating gel
- Tub or portable pool
- Tarp when tub is not feasible *(see pg 15)*
- 3-4 ice coolers/box with ice
- Water source
- 3-4 towels
- Bed sheet or large towel (to hold patient)
- Tent/tarp for shade (if needed, outdoors)

If being set up for a planned sport or outdoor event, additional preparation for patients' safety and privacy should be ensured and reliable arrangements for ice and cold water should also be considered.

Personnel

CWI requires at least three-four trained medical providers per patient for following tasks

1. Maintaining airway and patient
2. Body (rectal) temperature monitoring
3. Continuously stirring and managing cold water immersion bath
4. Documentation of medical records

Additional assistance may also require in case the patient becomes combative or must be lifted or rolled because of vomiting.

Preparation

The tub/portable pool should be set up as following

1. Fill with water and ice (1/2–2/3 full)
2. Volume should be enough to submerge a most of body area
3. Prioritize submersion on torso
4. Temperature of water must remain between 5°C and 15°C (lower the better)
5. 3-4 ice/cooler boxes full of ice next to the tub
6. In shaded area (e.g. under a tree, bleachers, or tent)
7. Safety and protection of providers should be considered

Process of CWI

After diagnosis of confirmed exertional heat stroke and initial rapid clinical assessment and rapid removal of additional clothes[5]

- **Start point**

With assistance, place the patient/athlete in the ice/cold water immersion tub/pool up to mid-chest or neck with appropriate support

a. Keep patient/athlete's head and neck above water by holding the patient under the axillae
b. with a towel or sheet wrapped across the chest and under the arms.
c. Cover as much of the body especially torso as possible with ice water
d. Place an ice/wet towel over the head and neck while body is cooling
e. Keep water temperature <15°C (60°F).
f. Keep stirring water aggressive throughout the cooling process
g. Keep maintaining airway, breathing and circulation and monitoring of vitals including core body temperature

When water is not stirred, it decreases the efficacy and cooling rate due to decreasing in temperature gradient between water and skin, which is a primary factor in rate of cooling.

- **End point**

h. Continue cooling until patient's rectal temperature lowers to ***<39ºC (102ºF)***
i. If rectal temperature cannot be measured and cold-water immersion is indicated, cool for ***10-15 minutes***
j. Approximate estimate of cooling via cold water immersion: ***1ºC for every 5 minutes*** and 1ºF every 3 minutes (if the water is aggressively stirred).[1]

Cooling rate will be slower initially and increase the longer the person is in the tub.
If immersed for **15 minutes,** core body temperature may reduce to **3ºC** or 5ºF. (1)

k. Once cooled, patient is transferred to a bed
l. Dispose the water content carefully.

Cold water immersion process

Image source: US football, Internet (adapted)

COLD-WATER DOUSING WITH ICE MASSAGE

Also referred as **Water ice therapy (WIT)**

- Close alternative method to CWI, utilizes same set up as CWI
- Suitable at health facilities, pre-hospital and field setting with planned resources and setup
- Cooling rates comparable to CWI with warmer water but not as effective as CWI with cold water[15]
- Initial cooling remains slow (first 6 minutes) but subsequent cooling (minutes 6 to 12) is comparable across similar experimental or clinical case studies[3].

Recommended equipment list (same as CWI) + a porous stretcher.
Patients were treated while lying supine on a porous stretcher that rested on a tub filled with cold water (10-12.8°C).

Personnel
Six to eight personnel are required

1. Maintaining airway and patient
2. Core body temperature monitoring
3. To continually douse the entire patient
4. Documentation of medical records

Preparation

1. The tub should be set up as mentioned in CWI *(See page 11)*
2. Put and stably arrange a porous stretcher on the tub filled with cold water (10-18°C)

Process

➢ **Start point**

a. Place the patient in supine position on a meshed/porous stretcher that is stably resting on the tub filled with cold water
b. Six to eight personnel continuously douse the entire patient (except the head) with water from the tub
c. Use ice packs/bags to massage major muscle groups (pectorals, abdominals, quadriceps, gastrocnemii)
d. Head should be covered in an ice towel
e. Measure core body temperature every 3 minute during the treatment via indwelling rectal thermometer
f. Aggressive cooling should be continued through out

➢ **End point**

g. Continue cooling until patient's rectal temperature lowers to ***<39°C (102°F)***
h. Approximate cooling time: ***12 and 24 min.***

BODY BAG COOLING (BBC)

- Alternative of CWI for rapid cooling in EHS patients/athletes in low resource setting
- Supports similar cooling rates as of gold standard CWI in EHS[16]
- Suitable for CHS (*emerging evidence*)[16,17] with proper assessment of patient's condition and clinical judgement. BBC allows placement of monitoring equipments/ resuscitation, if needed, as patient's chest can be kept dry while the body is surrounded by ice/cold water[18]
- Suitable for emergency department and field setting
- Utilizes a body/cadaver bag which are strong, waterproof with leak proof zip and have lifting handles (6)
- May not be suitable for children
- Cost effective, convenient, efficient method of CWI

Recommended equipment list for Body Bag Cooling

- Rectal thermistor, lubricating gel
- Body bag/Cadaver bag
- Cold water source
- Ice: 3-4 ice coolers/box with ice
- Tent/tarp for shade (if needed, outdoors)
- 3-4 towels

Personnel

BBC may require 2-3 trained medical providers per patient

Preparation

1. Body bag prepared on the bed/flat comfortable surface in the field settings with
2. Buckets of ice and/ cold water

Process of BBC

After diagnosis of suspected exertional or classic heat stroke and initial rapid clinical assessment and rapid removal of additional clothes

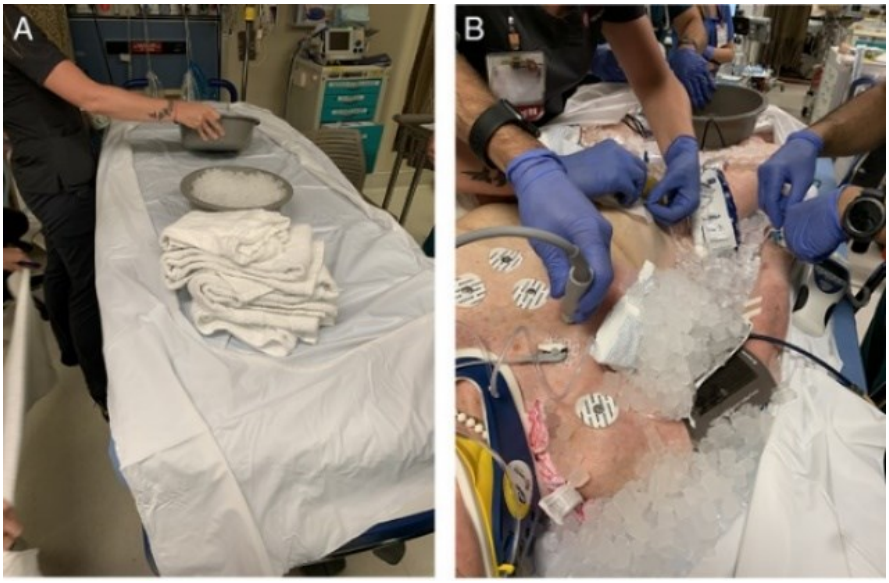
➢ **Start point**

With assistance, place the patient/athlete in

a. Patient is transferred from the stretcher/field directly into the body bag,
b. Apply monitors and a temperature-probe
c. Buckets of ice and cold water are poured into the body bag to initiate cooling.
d. After initial resuscitative measures are completed, the body bag is loosely closed (up to the patient's neck) until the patient is cooled to ***38˚C-39˚C***
e. Keep maintaining airway, breathing and circulation and monitoring of vitals including core body temperature

➢ **End point**

f. Continue cooling until patient's rectal temperature lowers to ***<39ºC (102ºF)***
g. Once cooled, patient is transferred from the bag to another bed.
h. Dispose the body bag and water content carefully.



Cold water immersive cooling using a body bag in emergency department for a patient with classic heat stroke[17]

a. *Preparing a disposable body bag on a bed with buckets of ice*

b. *. the patient placed directly into the body bag with monitors including core body temperature monitor and buckets of ice and tap water are poured into the body bag to initiate cooling.*

Image source: Kim D. A. et al

Cold water immersive cooling using a body bag on field/scene for a patient with classic heat stroke[19]

a. *Cool water is sourced through a hydrant with 2.5-inch hose.*

b. *Patient's core body temperature measured through rectal probe*

Image source: Jacobsen et. R. C. et al

TARPAULIN ASSISTED COOLING WITH OSCILLATION (TACO)

- Alternative of CWI for rapid cooling in EHS patients/athletes in low resource setting
- Provides cooling rates within the minimally acceptable rate of cooling[8]
- Suitable for emergency department and field setting
- Not suitable for CHS (*limited evidence*) due to hemodynamic instability, chronic illness or other risk factors that warrant continuous monitoring and possibly resuscitation
- May be used in absence of any another effective cooling methods with necessary clinical judgement
- Utilizes a large, waterproof tarpaulin sheet
- Cost effective, efficient method of CWI, multiple assistants required

Recommended equipment list for Tarpaulin (trap)-Assisted Cooling with Oscillation

- Rectal thermistor, lubricating gel
- Tarpaulin sheet (large, waterproof)
- Cold water source
- Ice: 3-4 ice coolers/box with ice
- Tent/tarp for shade (if needed, outdoors)
- 3-4 Towels

Personnel

TACO with oscillation may require six or more individuals to implement it.

Preparation

1. Large waterproof tarp
2. Buckets of ice and cold water (80-150litter of ice and cold water)[6]

Process of TACO

After diagnosis of exertional heat stroke and initial rapid clinical assessment and rapid removal of additional clothes

➢ **Start point**

a. With assistance place the patient/athlete in the middle of a tarp on floor/comfortably elevated surface, which will serve as the makeshift tub.
b. Have assistants to pick-up each corner of the tarp to form a sling (or "tacoshape").
c. Pour cool water and ice up to the chest level of the patient/athlete.
d. **Slowly** move the tarp back and forth to oscillate the mixture and initiate cooling
e. Keep maintaining of airway, breathing and circulation and monitoring of vitals including core body temperature

Standing close to the patient helps to maintain the water level and allows the tarp to be oscillated efficiently to maintain water circulation.

Additional assistance may be needed to hold the heavy tarp or replace tired providers

➢ **End point**

f. Continue cooling until patient's rectal temperature lowers to ***<39°C (102°F)***
g. Dispose the water content carefully especially if contaminated.

Tarpaulin assisted rapid cooling method for exertional heat stroke in field setting

Image source: University of Missouri Health

WHOLE-BODY ROTATING ICE-TOWEL APPLICATION

EHS

- Alternative of CWI for rapid cooling in EHS in low resource setting
- Suitable in CHS and can be combined with evaporative and convective cooling

Equipment list

- 12 towels/4-5 bedsheets
- ice box/cooler full of 1/3 cold water and 2/3 ice

Personnel: possible with one-two trained personnel

Preparation: *Fill a cooler with ice, water, and 12 towels.*

Process

After diagnosis of heat stroke and initial rapid clinical assessment and rapid removal of additional clothes

- Six towels soaked in ice water should be applied on the whole body
- Towels should be exchanged every 1-2 min to maintain cooling capacity

➢ **End point:** Continue cooling until patient's rectal temperature lowers to ***<39°C (102°F)***

Whole-body rotating ice-wet towel application

Image source: Hosokawa Y, et al[5].

DIFFUSE ICE PACK OR CRUSHED ICE APPLICATION

- Alternative of CWI for rapid cooling in EHS in low resource setting
- Suitable for cooling in CHS[6] and can be combined with evaporative and convective cooling
- Cost effective, less effective than CWI in rapid cooling

Equipment list: crush ice/ frozen ice boxes/packs
Personnel: possible with one-two trained personnel
Process

After diagnosis of suspected exertional or classic heat stroke and initial rapid clinical Assessment and rapid removal of additional clothes

- Keep patient in the bed/stretcher/flat surface with elevated legs
- Apply crushed ice or ice packs all over on the body especially torso

Strategic placement of ice packs to axilla, neck, and groin only marginally contribute to cooling[6]

➢ **End point:** Continue cooling until patient's rectal temperature lowers to ***<39°C (102°F)***

Crushed ice/ cold water application for rapid cooling.
Image source: Internet

B. Evaporative and Convective Cooling

COLD WATER DOUSING OR COLD SHOWER:

- Used in EHS in field setting where water source is easily accessible.

Process:

1. **Cold water dousing** (pouring) the patient/athlete with cold water from a hose/pipe in case of non-availability of cooling implements.
2. **Cold shower** can be used if available e,g, in training area

WATER SPRAY + DIRECTED FAN

CHS

- Suitable for older adults and pre-pubertal children
- To prevent shivering and over cooling, it is recommended to use tepid water (40°C/*104°F*) or exposing the patient to hot air(45°C/*113°F*) with the fan.[12]

Equipment list: spray bottle/garden sprayer, electric fan
Preparation: large quantities of water (slightly cold/lukewarm)
Process:

- Place patient in the flat, shaded surface.
- Remove patient clothing and spray cool water (~15*C) on most of the patient's body surface.

WATER-SOAKED BEDSHEETS + DIRECTED FAN

CHS

Equipment list: Bedsheets/gauze sheets, electric fan
Preparation: large quantities of water (slightly cold/lukewarm)
Process:

- Place patient in the flat, shaded surface.
- Remove patient clothing and cover maximum body surface with wet bedsheets or gauze sheets surface
- Direct a fan over the patient allow high air current to pass over the patient body

C. Evaporative + Convective + Conductive Cooling

- Combine or adjunct cooling method utilizes additional cooling power of cold water/ice.

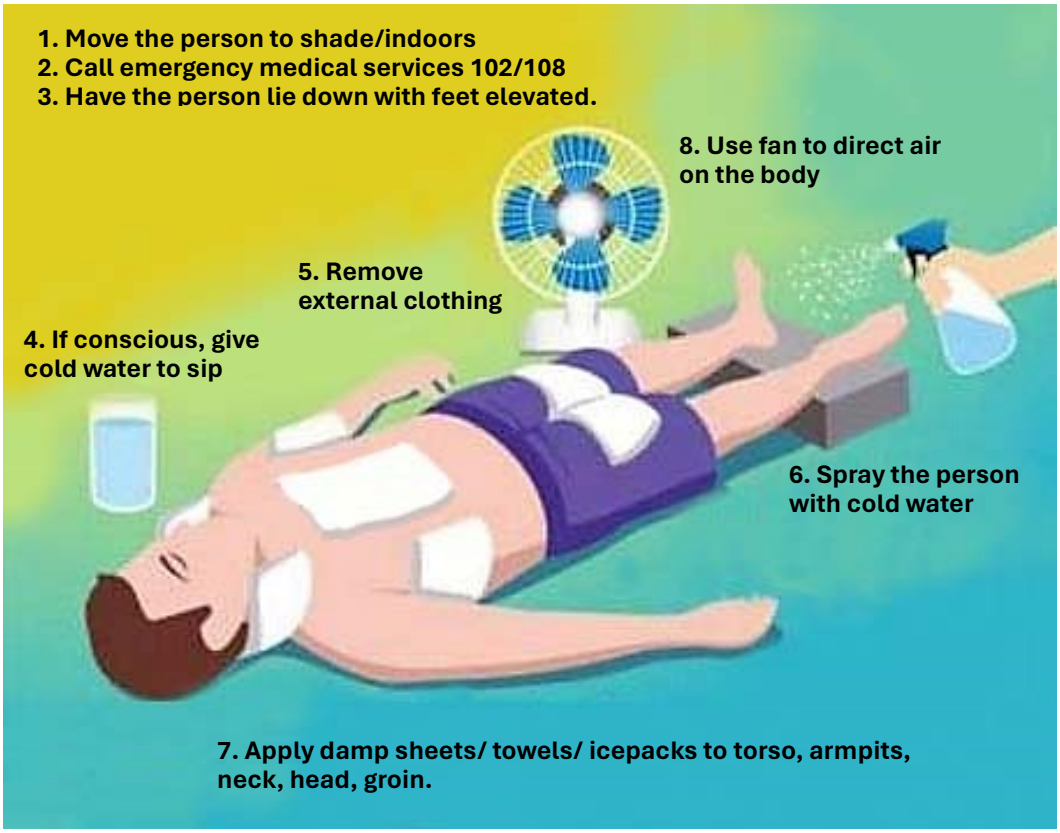
ICE PACK/CRUSHED ICE + WATER SPRAY +DIRECTED FAN

- Apply crushed ice or ice packs all over on the body especially torso

Equipment list: spray bottle/garden sprayer, electric fan, Ice packs/crushed ice
Preparation: large quantities of water (slightly cold/lukewarm), ice
Process:

- Place patient in the flat, shaded surface.
- Remove patient clothing and spray maximum body surface with water
- Direct a fan over the patient allow high air current to pass over the patient body
- Apply crushed ice or ice packs all over on the body especially torso

Strategic placement of ice packs to axilla, neck, and groin only marginally contribute to cooling[6]



Combined cooling methods for rapid, active cooling

Image source: Internet

D. Invasive Cooling Measures

- **Chilled/cold intravenous fluids** are insufficient as primary method of cooling, they may provide supplemental cooling.
- **Cold saline** may be beneficial when added to evaporative or conductive cooling
- **Intravascular or external cooling devices** should not be considered primary cooling methods in heat stroke.
- **Body cavity lavage** with cold isotonic fluid have been reported, but not adequately studied

E. Other cooling methods

- **Ice-filled rubber bottles** do not provide effective cooling
- **Body cooling unit** or other **novel portable/wearable cooling arrangements** are not widely available or adequately tested.

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3. Emergency Cooling in Children

Guiding Principles: Rapid Cooling in Children

- Heat stroke should be suspected in any child brought to a healthcare facility with altered consciousness, confusion or seizures in a heatwave or high temperature conditions especially in summer season.
- Core body temperature can be measured from esophagus, oral cavity, rectum.
- Usually, axillary temperatures are less precise than the rectal temperature.
- Axillary temperature is usually 0.5-0.8°C lower than rectal temperature.
- **Classic heat stroke**: more common in younger children who are unable to escape from hot environments (e.g. closed vehicles) and those with underlying chronic medical conditions that impair thermoregulation (
- **Exertional heat stroke:** generally seen in young, healthy individuals who engage in heavy exercise during periods of high ambient temperature and humidity (e.g. athletes, football players, military personnel)
- **In absence of a rectal thermometer,** proceed with the temperature recording from the armpit; if it exceeds 40°C, a presumptive diagnosis of heat stroke should be made.
- Apply rapid, active cooling measures in the heat stroke case as early as possible till the temperatures are reduced to below 39°C. Recommended cooling **rate is 1°C every 10 minutes.**
- As a first aid, affected child should be moved to a cooler place/ shade / room under fan, preferably in the air-conditioned room if available.

Effective cooling methods

- **Adolescent patient:** cold-water immersion is the most effective method for rapidly cooling in adolescent[20]
- **Infants and prepubertal children:** evaporative with convective cooling is the most effective for rapid external cooling because of the large surface area to body mass and can be used in field [20]
- Emergency cooling rooms, TACO method, bladder irrigation with cold saline, cold water lavage of the stomach/peritoneum and bladder are not feasible. These methods are not well studied in children and not required most of the times.

Prevent/treat shivering

- IV benzodiazepines (eg, midazolam or lorazepam) may be given
- Avoid meperidine, clonidine, or dexmedetomidine (significant adverse side effects in children)

Post-cooling management

All children with heat stroke should be admitted to a pediatric critical care unit in order to maintain appropriate monitoring and to treat ongoing and delayed end-organ dysfunction.

Prognosis

- The prognosis in children with heat stroke is not well studied.
- All children that recover from heat stroke may show some degree of heat intolerance (a disorder in temperature homeostasis) which may increase the risk for repeated heat illness.
- Children and their families/primary caregivers should be educated to avoid heat exposure until repeat evaluation establishes that they have fully recovered and a period of acclimatization has occurred [20]
- Children with severe heat stroke may have ongoing impaired physiologic response to exertion in hot environments

Cooling methods in Paediatric Patients

Cooling Method	Advantage	Disadvantage
ICE/COLD WATER IMMERSION (CWI)		
(See Conductive Cooling, page 11)	• May provide effective cooling to adolescent athletes in field settings	• Discomfort, shivering, agitation,combativeness • Not preferred in hospital setting
BODY COOLING WITH GARDEN SPRAYER/SPRAY BOTTLE + FAN		
Spraying with tepid water (to minimize shivering) while fanning with high-flow fans to maximize air circulation	• Faster, effective cooling method for infants and prepubertal children • Comfortable • Easily available	• Requires maintenance and storage
WET SHEET + DIRECTED FAN		
Patients are covered with wet sheet, water is sprayed over the sheet, and fans are used to blow over the wet sheet	• Heat loss comparable to the body cooling unit, using a garden sprayer • Easy to maintain	
ICE PACKS		
Ice packs are placed over large body surface area, groin, neck and axilla	• Simple • Readily available • Shorter cooling time when combined with evaporative technique	• Longer cooling time compared to evaporative technique
COLD I.V FLUIDS		
Cold iv fluid administration	• May be used as supplementary to external evaporative cooling methods	• Needs maintenance
COLD WATER IRRIGATION		
Gastric, bladder, peritoneal lavage, extracorporeal	• Not well studied	• Invasive
TACO METHOD		
	• Not studied in children	

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4. Public Health Aspects

Heat stroke is primarily an out-of-hospital health issue and a true time-critical emergency.
A paradigm shift to **"cool first, transport second"** recommends active, on-scene cooling.
Therefore, preparedness for on-scene/field or community level/pre-hospital management should be focused.

For clinical protocols, surveillance, general health facility preparedness and equipment acquisition to manage heat-related illnesses, please also refer to following guidelines by National Programme on Climate Change and Human Health, NCDC

1. National Action Plan on Heat-Related Illnesses (2021)
2. NPCCHH PIP Guidelines FY 24-25, 25-26

Health sector preparedness for emergency cooling of severe HRI

Aim	Measures
Ambulance and first aid	
1. On-scene rapid, active, sufficient cooling following quick assessment 2. Active cooling during transport 3. Transfer to nearest health facility able to provide cooling and supportive care 4. Advance communication to health facility to prepare for active cooling	1. Identifying cooling method that ambulance can provide 2. Equipping and maintaining cooling equipments 3. Training of first-aid providers
Primary level health facilities	
1. Rapid, active, sufficient cooling following quick assessment 2. Supportive care to stabilize the patient (dedicated beds) and referral to higher level for advance care	1. Identifying cooling method that facility can manage 2. Equipping and maintaining cooling equipments 3. Preparing cooling areas and internal protocols 4. Training of Medical officers and allied staffs first-aid providers in case identification, clinical management and reporting 5. Ensure basic water, cooling facilities in general and treatment areas
Secondary and tertiary level health facilities	
• Rapid, active, sufficient cooling following quick assessment • Advance, critical care (heatstroke bed/room)	1. Identifying cooling method that facility can manage 2. Equipping and maintaining cooling equipments 3. Preparing areas and internal protocols 4. Training of health care professionals in case identification, clinical management and reporting 5. Ensure basic water, cooling facilities in general and treatment areas

Community level preparedness for rapid cooling of severe HRI

Community level preparedness and response for heat stroke should be driven by the facts: 1. heat stroke is preventable and 2. when manifested it is a acutely life-threatening condition. Globally, with climate change, heat heat-related deaths of people older than 65 years is increased by 85% in 2018-2022 compared to 2000-2004.[21] As global temperature continue to rise, India may experience significant increase in mortality by mid-century.

General community

- Awareness among panchayat raj members, various occupational setting, community
- Training of various community service providers (traffic police, municipal workers, fire fighters) in identifying and responding to severe HRI (in community and in their own occupational setting)

Occupational settings

Miners, bakers, smelters, workers restricted in closed-places, construction, and agricultural workers are reported to be prone to heat exposure due to their occupation.

- Awareness among employers and workers
- Ensuring provision of preventive measures (See Public Health Advisory: Extreme Heat/Heatwave)
- Ensuring basic on-field body cooling measures in organized and unorganized occupational settings with potential for high heat exposure, exertion, closed/overcrowded place

Mass participation sports events/ mass gathering events

Preparedness to manage emergency cooling at mass participation sports events or mass gathering events should be focused when combination of ambient heat, physical exertion and/ overcrowding is expected to occur.

Population at Risk of EHS

- **Events with a high risk of EHS** (eg, athletics, cycling, football, hockey, marathon, swimming, modern pentathlon, rowing, tennis and triathlon), when scheduled under stressful environmental conditions must prepare a designated, well-marked heat stroke assessment and management area (i.e. heat deck) within or adjacent to the main athlete medical tent.
- **Sports events with a high metabolic** demand (eg, marathon running), a heat deck set-up is still advised whether environmental condition is mild or cool.

Cold-water immersion setup for EHS patient treatment.

Population at Risk of CHS

- **Pilgrimage, parades, outdoor ceremonies, spectators of sports events:** invariably contains population of various age groups, physical (acclimatization), medical vulnerabilities and risk awareness

Heat desk setup [5]

Location

- must have access to a water source and water drainage
- easily accessible from the expected site of collapse (such as the alongside the field of play in team sports or near the finish line for individual sports)
- has direct ambulance access/egress
- ideally, housed in an indoor facility with air conditioning and/or a fan
- protected from unnecessary attention from spectators and media
- If above criteria not met, appropriate location for portable tent setup should be identified by in-charge health officer

Access

- restricted entry from the athlete's team staff and family members

Equipment list to provide on-site rapid cooling[5]

□ Rectal thermometer with disposable probes or disposable probe cover	□ Oral sodium
□ Thermometer for water temperature monitoring	□ Oral glucose
□ Medical gloves	□ 3% saline injection
□ Partitions for rectal temperature assessment area	□ 50% glucose injection
□ Cold water immersion tub	□ 1 mg glucagon injection
□ Pole-less/soft stretcher for patient transfer in and out of cold water immersion tub	□ Intravenous infusion kit
□ Ice	□ Towels for drying
□ Ice cooler boxes	□ Cots or beds for postcooling observation
□ Water	□ Chair
□ Hose to supply and drain water	□ Blankets for rewarming
□ Towels for cooling	□ Emesis basin/kidney tray
□ Sheets to maintain patient posture	□ Medical waste container
□ Medical record keeping	□ Change of clothes (for after cooling)
□ Clock	□ Wheelchair
□ Cold water immersion tub cleaning equipment	□ Wheeled stretcher
□ Point-of-care blood electrolyte and glucose analysing kit	□ Cardiac defibrillator
	□ Cardiopulmonary resuscitation equipment
	□ Air conditioning unit/fan
	□ Personal protective equipment

The quantity of each item depends on the total number of participants and the relative risk of heat stroke at the event, such as environmental conditions, exercise duration, and exercise intensity. To make an informed estimate of the amount of resources needed, a thorough evaluation of local environmental conditions and exertional heat illness records from previous international and national competitions of a similar setup should be reviewed.

Heat deck patient management areas

1. **Temperature assessment area** should have partitions to limit any unnecessary exposure of an athlete during rectal temperature measurement.
2. **Cold water immersion (CWI) area**
3. **Observation area** should have cots set up for athletes to rest until all their vital signs are within a predetermined normal range.

Immersion tab management during cooling

- During the time of active/sports event, cold water immersion tubs do not need to be drained and cleaned after each use if not obviously contaminated.
- Contaminated cold water immersion tubs (ie, vomiting, diarrhoea and open wound) should be well labelled and not be reused for other athletes. Such contaminated tubs must not be used until they have been fully cleaned and disinfected.
- For multiday event, all tubs, including tubs without obvious contamination, must be fully cleaned, disinfected and dried at the end of each day of competition.

Cold water immersion provider arrangement

A medical officer familiar with event medical services and proficient in prehospital management should be appointed with additional trained support staff

The CWI treatment requires at least four trained medical providers (Provider A–D) per athlete.

- **Provider A:** maintains the airway and upright posture of the patient;
- **Provider B:** in charge of monitoring the core temperature;
- **Provider C:** responsible for continuously stirring the cold water immersion bath; and
- **Provider D:** ensures all medical records are properly documented

Post-cooling outcome scenarios

- **On-site**

The patient's rectal temperature must continue to be monitored to ensure that the fall in core temperature has been maintained.

If the core temperature starts to rise again then the individual should be returned to the cold-water bath and the cooling procedure repeated until a constant temperature <39°C is maintained.

If the core temperature starts to show a rapid drop toward 36°C after removal from cold water immersion during the 15-minute postcooling recovery period, the patient should be dried, their wet clothing removed, and insulated blankets used until they can be transported to the designated hospital for rewarming and advanced care. If privacy can be maintained, moving the athlete into direct sunlight may assist with rewarming while waiting for the ambulance.

- **Transportation**

In the case of the patient being transported to the hospital, emergency service dispatch and/or on-site medical officials should notify the hospital medical team in advance to allow staff to prepare for treatment to begin immediately upon patient arrival.

- **Emergency department**

Diagnostic difficulty may occur, as the patient may present with a temperature less than 40.5°C either due to active or passive cooling that has already occurred

Alternative to CWI

If patient collapses at remote locations from the heat deck or immersion tubs are not available, organisers should also consider preparing a

- Tarp-assisted cooling (TACo)
- Ice/wet towel rotation
- High-flow cold water dousing/shower (requires mapping/provision of portable water resources at event location)

Annexure 1: Heat Stroke Management Algorithm in Emergency Department

1. Heat Alert Triggered

- Summer season=high risk season based on local climate patterns, active heat advisory or high heat index
- Patient temperature >40°C
- Chief complaint includes: Altered Mental Status OR Confusion OR Unresponsive OR Seizure.

2. Triage Clinician Evaluation

Activate heat alert if clinical suspicion is high based on:

- Recent history of environmental (indoor or outdoor) heat exposure OR strenuous physical activity.
- Central Nervous system dysfunction
- Tachycardia, tachypnea, +/- hypotension
- Flushed or warm skin +/- sweating
- Lower suspicion for sepsis, medicine/drug overuse, or metabolic abnormality (e.g. hypoglycemia)

3. Begin Treatment Algorithm

- This guide does not replace clinician judgment; actions should be initiated simultaneously if feasible.
- More aggressive interventions may be provided if available and professionals are trained to deliver those.

TRIAGE

Bedside evaluation | Move to resuscitation | ICU consultation

TREATMENT GOALS

Clinical Management Key Steps

Tasks

5 minutes
- Recognition
- Initiate treatment

Recognition
- Assess airway, breathing, and circulation
- Document core temperature
- Consider alternative / concomitant diagnoses of
  - Neuroleptic Malignant syndrome, Malignant Hyperthermia, Serotonin Syndrome, Hyperthyroidism, Sepsis

Recognition
- Obtain core temperature
- Place patient on the monitor
- Establish large bore IVs
- Send for lab test, ECG, and chest x-ray

10 minutes
- Initiate rapid cooling

Rapid cooling
- Begin external cooling and consider internal cooling
- Consider deep sedation followed by neuromuscular blockade to reduce metabolic heat production
- Use benzodiazepines to treat intense shivering

Rapid cooling

Gather supplied as per cooling method selected: Ice, Ice packs, Tub, Tarpaulin, Ice bag, Mist bottle, Fan, Foley catheter, IV Fluids

Begin external cooling
(in order of preference based on cooling rates)
1. Perform cold water immersion *or* body bag cooling *or*
2. Place ice packs/chilled bed sheets/towels *or*
3. Mist water + direct fan

Consider internal cooling
(supplementary to external cooling)
- Infuse chilled IV fluids
- Place 3-way Foley catheter bladder irrigation
- Sedate and paralyze
- Body cavity lavage (rare)
- Cardiopulmonary bypass (rare)
- ECMO/ transfer for liver transplant if very severity illness (rare)

30 minutes
- Cool to 39°C
- Avoid re-exposure

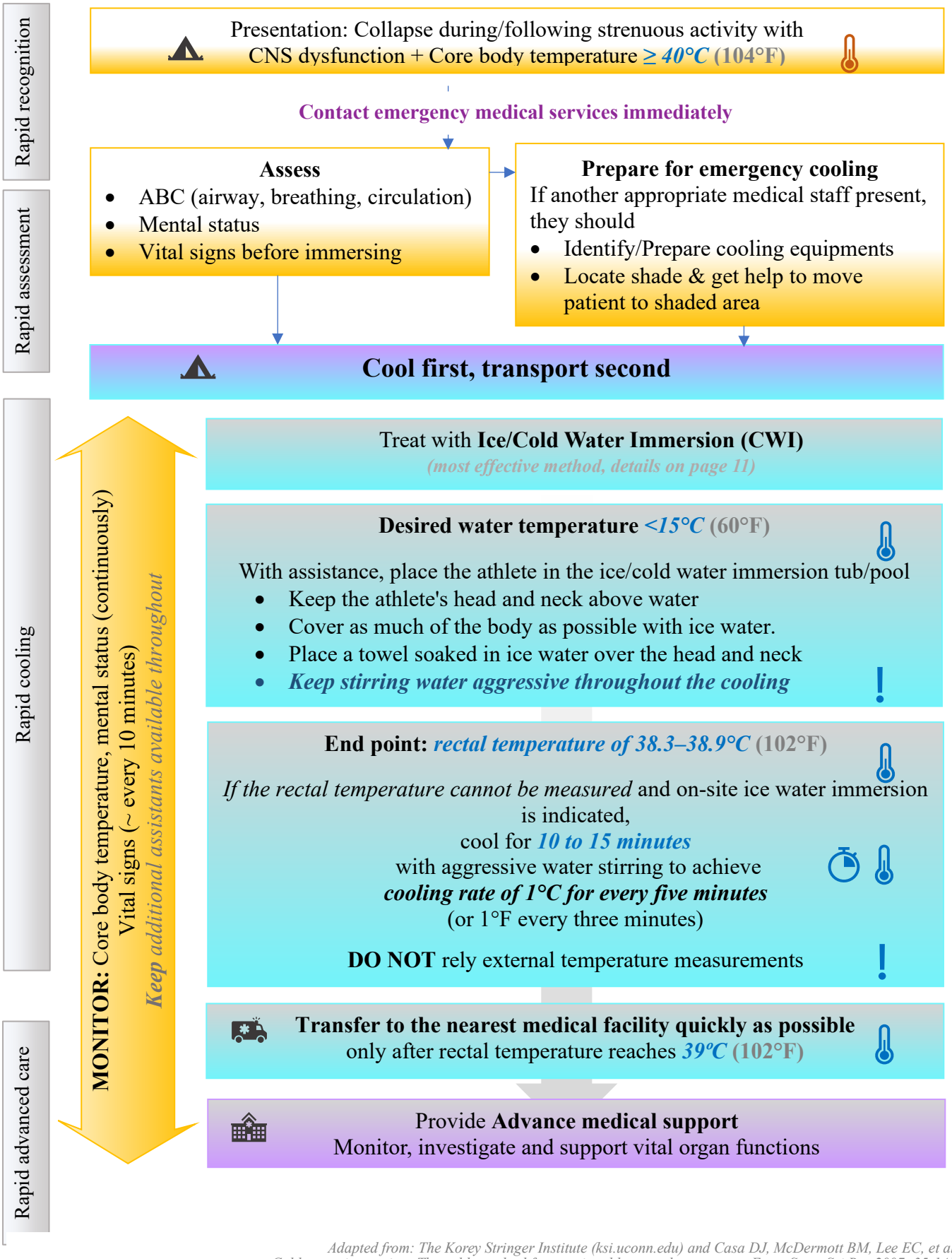
Supportive care
- Continuous temperature monitoring
- Correct electrolyte abnormalities
- Arrange for admission (likely ICU)
  - Consider transplantation if acute liver failure

Supportive care
- Serial neurologic and hemodynamic reassessments
- Keep defibrillator and pads at bedside
- Resupply ice as needed

Adapted from Rublee C, Dresser C, Giudice C, Lemery J, Sorensen C. Evidence-based heatstroke management in the emergency department. West J Emerg Med. 2021;22(2):186-195. doi:10.5811/WESTJEM.2020.11.49007

Annexure 2: Ice/Cold Water Immersion for Exertional Heat Stroke

Pre-hospital/Field setting



Adapted from: The Korey Stringer Institute (ksi.uconn.edu) and Casa DJ, McDermott BM, Lee EC, et al. Cold-water immersion: The gold standard for exertional heat stroke treatment. Exerc Sport Sci Rev 2007; 35:141.

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