Guidelines on Prevention and Management
of

Heat Related Illnesses

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Emergency Medical Relief
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Guidelines on Prevention and Management of Heat Related Illnesses

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Definitions

Heat Cramps: A condition that is marked by sudden development of cramps in skeletal muscles and that results from prolonged work or exercise in high temperatures accompanied by profuse perspiration with loss of sodium chloride from the body.

Heat Exhaustion: A clinical syndrome caused by heat stress, such as over-exertion in a hot environment or excessive exposure to sun. It is characterized by sweating, water (volume) depletion, salt depletion, cool, clammy skin, nausea, and headache.

Heat exhaustion (Anhydrotic) : Heat prostration due to water depletion.

Heat exhaustion due to salt depletion: Heat prostration due to salt (and water) depletion.

Heat Stroke: A condition caused by the failure of body to dissipate heat in an excessively hot environment or during physical exertion in a hot environment. *In* contrast to heat exhaustion, the body temperature in heat stroke patient is dangerously high with red, hot skin accompanied by delusions; convulsions; or coma. It can be a life-threatening emergency and is most common in infants and the elderly.

Heat Wave . The Indian Meteorological Department (IMD) has given the following criteria for Heat Waves :

- Heat Wave need not be considered till maximum temperature of a station reaches at least 40*C for Plains and at least 30^{0}_{C} for Hilly regions
- When normal maximum temperature of a station is less than or equal to 40^{0}C Heat Wave Departure from normal is 5^{0}C to 6^{0}C, Severe Heat Wave Departure from normal is 7^{0}C or more
- When normal maximum temperature of a station is more than 40*C Heat Wave Departure from normal is 4^{0}C to 5^{0}C Severe Heat Wave Departure from normal is 6^{0}C or more
- When actual maximum temperature remains 45^{0}C or more irrespective of normal maximum temperature, heat waves should be declared. Higher daily peak temperatures and longer, more intense heat waves are becomingly increasingly frequent globally due to climate change. India too is feeling the impact of climate change in terms of increased instances of heat waves which are more intense in nature with each passing year, and have a devastating impact on human health thereby increasing the number of heat wave casualties.

All above definitions are from ICD 10, WHO except that of Heat Wave (IMD) and Heat Cramps (Merriam Webster (medical) Dictionary)

Acknowledgement

This document is a compilation of information available in Standard medical texts and web based free resources. It has also drawn its strength from the Euro Heat Project (2003), the guidance on Heat Action Plan provided for by the WHO Regional Office, Europe. The materials made available by Centre for Disease Control, Atlanta, has been consulted. A Panel of Experts has edited this information.

1.1. Introduction

Global climate change is inevitable. We are already witnessing extreme weather events. Among them, heat-waves are projected to increase in number, intensity and duration over most land areas in the 21st century.

In India, significant number of deaths takes place every year due to heat related illnesses. The data is not captured under the existing surveillance system, hence its magnitude / public health burden is not known. Taking cue from the global climate change, India is also likely to experience increase in number, intensity and duration of heat waves over most of our land areas.

It is important to note that these are preventable deaths. Informing the public on the preventive actions to be taken, reporting early to health facility, timely diagnosis and treatment, would reduce the deaths attributable to heat waves.

These guidelines intent to provide insight into the patho- physiology of heat related illnesses, at risk groups, prevention, clinical management and the administrative action that needs to be taken by the concerned State Governments.

Basics Physiology of Heat Gain and Loss

The normal body temperature is about 37^0C (36.1–37.8 ºC). This is maintained by the Thermo Regulatory Centre in the Hypothalamus of the Brain. Essentially it needs to balance the heat produced by the body through metabolic activities as also that gained from external sources (for example solar radiation) with that lost by the body to the environment. The main modality for heat loss is sweat evaporation (75%). Other modalities are convection (10%), respiration (5%), external work(10%) and conduction (1%).

When the air temperature approaches skin temperature or exceeds it, loss of heat through convection (air passing over exposed parts of skin) becomes minimal or negative. Then the only modality of heat loss is by sweat evaporation which is dependent on the humidity. High environmental vapour pressure affects sweating.

If heat gain exceeds heat loss, then the body temperature would rise. Increase in core body temperature stimulates the Hypothalmic thermo regulatory mechanism which activates physiological response such as sweating, peripheral vasodilatation and increased cardiac activity to bring down the body temperature by moving blood from core of the body to skin.

Acclimatization to hot environment could be achieved over a period of time by graded exposure to such environment.

Etiology and Patho Physiology of Heat Related Illnesses

Extremes of temperature and humidity make heat dissipation less efficient. Physical effort generates intrinsic heat and can rapidly lead to heat gain when combined with environmental factors. Other intrinsic factors, including chronic volume depletion, inability to increase cardiovascular output and lack of acclimatization can all inhibit the body's ability to respond to heat challenges. Certain drugs (Beta blockers, vasoconstrictors, sedatives etc) also contribute to failure of the thermoregulatory responses. Heat related illness occurs when thermal loads overwhelm the body's thermoregulatory responses and homoeostasis is altered. This could be more pronounced in the chronically ill, especially where the cardio vascular functions are compromised and those at extremes of age.

Conditions of extreme heat and excessive sweating results in salt and water depletion. Inadequate replacement of fluid and salt causes dehydration and hyponatremia (sodium depletion) resulting in heat cramps and may progress to heat exhaustion, if not treated. Further failure of thermo regulatory mechanism results in rise of core body temperature.

The term thermal maximum was developed to measure the magnitude and duration of heat that cells can endure before becoming damaged. Human thermal maximum has been established as a core body

temperature of approximately 42°C (107.6°F) for between 45 minutes and eight hours[3]. Extreme body temperature (above 40.5 °C) leads to damage to cellular structures. Inflammatory factors are released and gastrointestinal permeability increases, which may allow endotoxins into the circulation. Patient develops multi organ failure (kidney failure, liver failure), Acute Respiratory Distress Syndrome, and disseminated intravascular coagulation. Body temperature higher than 41.1°C (106°F) is associated with neurologic dysfunction. The increased cardiovascular load in heat (vasodilation and dehydration) exacerbates other health problems such as cardio-vascular disease.

Death from heat stroke may be under reported because heat stroke is similar to other more familiar causes of death, especially coronary or cerebral thrombosis, once the body is no longer hot itself. Further, post mortem findings are also not definitive to establish death by Heat Related illness.

Risk factors for Heat Related Illnesses

1. **Environmental**

Environment that is hot and humid.

2. Age :

People aged 65 and older

People aged 65 years or older are less likely to sense and respond to changes in temperature. People in this category must be reminded often by family members (or friends, neighbors, care providers etc) for remaining in a cooler environment and for taking adequate quantity of fluids and be informed about seeking medical care if showing signs and symptoms of Heat Related Illness.

Infants and young children

Infants and young children are sensitive to the effects of extreme heat, and must rely on parents, teachers and other people to keep them cool and hydrated.

3. Physical

Obesity, dehydration, being un- acclimatised, unusual exertion, inappropriate clothing, sleep deprivation, sunburn, sweat gland dysfunction.

4. Pregnant Women

Pregnant women are more susceptible to heat stroke and exhaustion because fluid Volume depletion and electrolyte imbalance also affects

fetus. There are also references in literature that raise in maternal core body temperature affect development of fetus (neural tube defects).

4. People with chronic medical conditions

People with a chronic medical condition are less likely to sense and respond to changes in temperature. Those with (i) poorly controlled diabetes mellitus (ii) compromised cardio-vascular functions (cardiac disease, Peripheral vascular disease) are at higher risk. Other chronic medical conditions are alcoholism, anorexia, cystic fibrosis, dehydration, delirium tremens, dermatological conditions with decreased sweating, diabetes insipidus, epilepsy, febrile illness, gastroenteritis, previous heat-related illness, hypokalaemia, Parkinson's disease, spinal injuries, and thyrotoxicosis.

5. **Medications**

Medications can worsen the impact of extreme heat important ones being Beta blockers, diuretics, alcohol, anticholinergics, alpha-adrenergics, antihistamines, tricyclic antidepressants, selective serotonin reuptake inhibitors (SSRIs), phenothiazines, calcium-channel blockers, lysergic acid diethylamide (LSD), phencyclidine (PCP), cocaine, amphetamines, ecstasy, aspirin, and lithium.

6. **Outdoor workers**

People who work outdoors, especially migrant laborers, brought in to work in hot humid climate are at risk of getting dehydrated and more likely to get heat-related illness.

7. Destitute and other low income population

Shelter less population in urban settings, ignorant of the preventive steps is prone to get heat related illnesses.

8. People who exert in hot environment

Athletes or people who exercise vigorously in hot environment

Clinical Manifestations of Heat Related Illnesses

The effects of exposure to heat can be directly heat-related (heat related illnesses) or can contribute to a worsening of respiratory and cardiovascular diseases, electrolyte disorders and kidney problems. Heat-related illnesses occur on a continuum from mild symptoms to fatalities. Different type of heat related illness includes:

1. Minor heat related Illnesses [1,2]:
    - Heat rash
    - Heat edema
    - Heat tetany
    - Heat cramps
    - Heat syncope
2. Major heat related Illnesses:
    - Exertion associated collapse
    - Heat Exhaustion
    - Heat Stroke

1. Minor Heat Related Illnesses

1.1. Heat rash [1,2]:

Heat rash , also known as "prickly heat" and *miliaria rubra*, is a pruritic, maculopapular, erythematous rash, normally seen on the skin in normally clothed areas. It is an acute inflammation of the sweat ducts caused by blockage of the sweat pores. The ducts dilate under pressure and eventually rupture, leading to vesicle formation on a red base. Itching is the predominant feature.

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1. Pre-hospital Trauma Life Support, seventh edition, NAEMT & American college of Surgeons, Committee on Trauma.
2. www.TintinalliEm.com/environmental injuries/Heat Emergencies

1.2 Heat Edema:

This is a mild edema of dependent areas like hands, feet and ankles , seen during early heat acclimatization. It occurs due to cutaneous vasodilatation and orthostatic pooling of interstitial fluid in gravity dependent extremities.It does not restrict or interfere with normal activities and resolves spontaneously in a few days or weeks. Systemic causes of edema like congestive heart failure, renal or hepatic dysfunction and deep vein thrombosis should be ruled out in the susceptible population.

1.3. Heat Tetany:

This is a rare and self limiting condition seen in patients exposed to short ,intense heat conditions, resulting in hyperventilation which causes respiratory alkalosis, paresthesia of extremities, circumoral paresthesia and carpopedal spasm. Heat tetany can be differentiated from heat cramps by the fact that there is very little pain or cramps in the muscle.

1.4. Heat cramps

Heat cramps are painful, involuntary, spasmodic contractions of skeletal muscles, usually those of the calves, but may involve the thigh and shoulder muscles too. Sweating evaporation in high heat causes dehydration and sodium depletion resulting in painful muscle cramps and spasms that occur during or after intense physical exertion. It presents with:

- Body temperature, often elevated, usually <40°C.
- Intense thirst with painful muscle cramps and tachycardia.
- Sweating and heat dissipation mechanisms preserved.
- Normal alertness and higher functions with no neurological problems.

1.5. Heat Syncope:

Heat syncope is seen with prolonged standing in hot environments that causes vasodilatation and a fall in blood pressure due to venous pooling in the legs (which causes a decrease in venous return to the heart causing a fall in cardiac output) resulting in fainting or feeling light headed.

2. Major Heat Related Illnesses:

2.1. Exertion associated collapse

This occurs when an individual collapses after strenuous exercise. During exercise contraction of muscles of the legs assists in augmenting return of venous blood to the heart. When exercise is discontinued, venous return to the heart decreases, due to the muscle pump not working, resulting in decreased blood flow to the brain.

Signs and symptoms include nausea, lightheadedness, Collapse or syncope; Patients feel better lying down but become lightheaded when they try to sit up or stand (orthostatic hypotension); Profuse sweating may be present. There may be tachycardia and tachypnea (rapid respirations). Core temperature could be normal or elevated.

2.2. Heat Exhaustion

Heat exhaustion is the most common heat related illness which can develop over days of exposure as in elderly living in hot and poorly ventilated spaces, or acutely as in athletes. It occurs due to a low cardiac output which is insufficient to support the increased circulatory demand required for heat dissipation. The hypovolemia is caused by water and/or sodium depletion, vasodilation and increased skin blood flow.

In Heat Exhaustion, profound CNS disturbance is absent, which is the main distinguishing factor from Heat Stroke. Core temperature is

elevated (37°C to 40°C [98.6°F to 104°F]) but not to the extent seen in heat stroke. Key features are:

- Central nervous system (CNS) function is usually largely preserved, but those experiencing heat exhaustion may experience mild confusion, irritability and poor co-ordination.
- Heat dissipation is still functioning and temperature is usually <41°C.
- Patients may experience headache, nausea, vomiting, malaise, dizziness, muscle cramps, oliguria, weakness, thirst, occasionally syncope, sinus tachycardia, and orthostatic hypotension.
- They often complain of being hot and appear flushed and sweaty.

Heat Exhaustion presents in two variants:

2.2.1 Heat exhaustion (Anhydrotic)

Heat prostration is due to water depletion. Presents mainly signs of hypovolumia as described above (thirst, oliguria, weakness, occasionally syncope, sinus tachycardia, and hypotension).

2.2.2. Heat exhaustion due to salt depletion:

Heat prostration due to salt (and/ or water) depletion: Signs and symptoms of Hyponatremia prominent (nausea and vomiting, headache, confusion, Restlessness and irritability, Muscle weakness, spasms or cramps, loss of energy and fatigue. Severe deficiency of sodium may result in Seizures and coma).

If left untreated, Heat Exhaustion might progress to heatstroke.

2.3. Heatstroke

This is a combination of hyperthermia (classically defined as a core body temperature of at least 40.6°C [typically ranges from 40°C to 44°C (104°F to 111.2°F), although higher core temperatures have been reported], often with loss of the capacity to dissipate heat, and

CNS impairment, ranging in severity from confusion to coma. Typically, patients present with confusion and agitation, ataxia and irritability may also be manifest.

- Loss of ability to sweat is often a late and ominous sign.
- Hyperventilation is almost invariable, with hypotension and shock occurring commonly.
- If the condition progresses to a more severe form (core temperature >41.5°C) it can cause widespread damage, in particular to the brain, liver, kidney and muscle.
- The thermoregulatory centre may fail so that the patient actually feels cold with dry, vasoconstricted skin, leading to a vicious cycle.
- Heatstroke involves coagulopathies and cytokines, and can result in systemic inflammatory response syndrome and multiple organ dysfunction.

There are 2 forms of heat stroke:

a) **Classic (non-exertional) heat stroke (NEHS)** – Classic heat stroke commonly affects sedentary elderly individuals, persons who are chronically ill and are on treatment (these conditions include cardiovascular disease, neurologic or psychiatric disorders, obesity, anhidrosis, physical disability, extremes of age, and the use of recreational drugs, such as alcohol or cocaine, and certain prescription drugs, such as anticholinergic agents or diuretics.) or those who are very young.
Classic NEHS occurs during environmental heat waves and is more common in areas that do not typically experience periods of prolonged hot weather.

b) **Exertional heat stroke** – Exertional heat stroke generally occurs in young, otherwise healthy individuals who engage in heavy exercise during periods of high ambient temperature and humidity and the body's cooling mechanism cannot get rid of

the excessive heat. Typical patients are athletes, military recruits in basic training, laborers etc.

Both types of heatstroke are associated with high morbidity and mortality, especially when cooling therapy is delayed.

Key diagnostic features of Heat Stroke are

- **Presence of risk factors** (common)

- **Hyperthermia** (common)

  - Core temperature readings may be obtained with rectal or oesophageal thermometers and in heat stroke core temperature is classically >40°C (>104°F).Elevated core temperature in the setting of CNS dysfunction should trigger a presumptive diagnosis of heat stroke, and cooling should begin immediately.
  - However, it should be noted that even patients with normal temperature can have heat stroke, either because of inaccurate measuring techniques or from effects of prior cooling.
  - Repeat readings are necessary to track temperature.

- **Profound CNS disturbance**: confusion and agitation, irritability, ataxia, seizures and coma.

- **Other diagnostic features are:**

Headache , nausea and vomiting ; anxiety , dizziness , fainting, tachycardia , jaundice , Muscle tenderness, hypotension , gastrointestinal bleeding (uncommon) , bruising and skin bleeding (uncommon).

Differential diagnosis

- The history of exposure to an adverse environment ± physical exertion usually clinches the diagnosis, but sepsis and alternative causes of fever (particularly malaria if relevant area/travel history) should be considered as a cause or precipitant.
- In patients taking phenothiazines or other antipsychotics, consider neuroleptic malignant syndrome. Those on SSRIs (Selective Serotinin Reuptake Inhibitor) or other serotonergic medication may be suffering from serotonin syndrome.
- If there is a history of recent inhalational anaesthetic, consider malignant hyperpyrexia (In such case Dantrolene is the drug of choice 2-3mg/kg IV repeated every 5-10 minutes upto a maximum dose of 10mg/kg.)[1.]
- Recreational drug toxicity, particularly involving cocaine, amphetamines and ecstasy, is an increasingly common cause of hyperthermia.
- Other rare causes are Thyroid Storm, Pheochromocytoma and Anti cholinergic Poisoning.

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1. Stoelting's Anesthesia and Co-Existing Disease, Roberta L. Hines MD, 5 edition, Elsevier Publishing, USA.

Management of Heat Related Illness

1. On-site Management

1.1 **Minor Heat Illnesses** : The minor heat illnesses can be managed at domestic / Out Patient Department settings.

1.1.1. Heat Rash

Wearing clean, light cotton and loose fitting clothes can prevent prickly heat from occurring. It can be treated by cooling and drying the affected area, and with antihistaminics and chlorhexidine in a light cream or lotion base. Prevention of sweat generating situations and staying in cool environment can prevent aggravation of prickly heat.

1.1.2. Heat Edema

It does not restrict or interfere with normal activities and resolves spontaneously in a few days or weeks. Systemic causes of edema like congestive heart failure, renal or hepatic dysfunction and deep vein thrombosis should be ruled out in the susceptible population.

Treatment consists of loosening any constricting clothing and elevating the legs. Diuretics are NOT effective and can predispose to volume depletion, electrolyte abnormalities and increased risk of heat illness.

1.1.3. Heat Tetany

Heat tetany can be differentiated from heat cramps by the fact that there is very little pain or cramps in the muscle. Treatment consists of removing the patient from the hot environment and controlling hyperventilation.

1.1.4. Heat Cramps

- Move to a cool place (e.g. cool shady area, air conditioned environment if feasible).
- Make the patient lie down with legs supported and slightly elevated

- Remove excess clothing and place wet clothes on skin; fan skin.
- Give drinks containing salt and sugar, such as lime water
- Stretch cramped muscles slowly and gently.

1.1.5. Heat Syncope

Exclusion of metabolic, cardiovascular and neurological causes of syncope is required. Treatment consists of removal of patient from the heat source and rest in a cool place in the recumbent position . Provide oral fluids (Water, fruit juice, lime water etc) if complaining of thirst.

1.2. Onsite Management of Major Heat Related Illnesses

1.2.1. Exertion associated collapse

- Remove patient to a cool place and rest in recumbent position with legs elevated.
- Encourage oral fluid intake , if patient is conscious.
- Transport to the identified health facility.

1.2.2. Heat Exhaustion

- Follow the above measures as suggested for heat cramps.
- Record body temperature (Oral temperature assessments reflect inaccurate core body temperatures, which may delay the diagnosis and ultimate treatment of patients with heat exhaustion/ heat stroke)
- If no improvement, call Emergency Services (102/108); Patient may have to be started immediately on Intravenous fluids (Saline) while transferring to hospital.
- If Pre Hospital Emergency Medical Services are not available within the State/ district, arrange transport to health facility through local ambulance/ local transport).

1.2.3. Heat Stroke

- Move patient to a cool place. Call 102/108 or your local emergency medical service.

- Till such time as the ambulance arrives:

    - Remove clothing and drench skin with cool water; fan skin.
    - Place ice packs on the armpits and groin areas.
    - Offer cool fluids if alert and able to drink (do not give sips of cold water to semi or unconscious patients).
    - If person is unconscious, check person's airway, breathing and pulse.
    - Immediately transfer the patient to the nearest health care facility for emergency care.
    - While transferring, the above measures to bring down core temperature needs to be continued. Patient is started on intravenous fluids. The Emergency Medical Technician would give constant attention to airway, breathing and circulation.

2. Management at health care facility

The accurate diagnosis of heat stroke in adults rests on correctly quantifying the core temperature. Patients with suspected heat stroke should be rapidly assessed using Advanced Trauma and Life Support (ATLS) protocols. Their **temperature assessed with rectal or oesophageal thermometers**. An elevated core temperature in the setting of CNS dysfunction should trigger a presumptive diagnosis of heat stroke, and cooling should begin immediately. A lower core temperature should not rule out heat related illness as the patient body temperature might have been brought down by the first aid given during transportation.

2.1 Treatment approach:

2.1.1. Heat Cramps

Prolonged and severe muscle cramps not responding to on-site management requires hospitalization. It can be treated rapidly with with intravenous administration of normal saline solution (0.9%)

2.1.2. Heat Syncope

Cases of Heat Syncope not responding to onsite management may require hospitalization and treatment with Intra venous rehydration with fluids and exclusion of metabolic, cardiovascular and neurological causes of syncope are required.

2.1.3. Exertion Associated Collapse

Cases of **Exertion Associated Collapse** in a hot environment and not responding to onsite management may require hospitalization and treatment with Intra venous rehydration with fluids and evaluation to rule out other causes of exercise related collapse especially exercise related hyponatremia. Vitals needs to be monitored including ECG.

2.1.4. Heat Exhaustion

- Patient should be placed in airconditioned or air cooled room.
- Augment heat dispersal mechanisms such as removing clothing, wetting the skin to aid in evaporative cooling,
- Start intravenous fluids. Ensure that sweating is not compromised by volume depletion.
- Assess and manage volume depletion (Mild volume depletion is generally defined as either <5% of extracellular fluid volume or <3% of total body weight. Significant volume depletion exceeds 10% of extracellular fluid volume or 9% of total body weight).

- Assess electrolyte levels to rule out Hyponatraemia. Manage hyponatremia, if present.
- Heat exhaustion can be managed at primary/ secondary health care level. All such patients showing signs of significant volume depletion or hyponatremia, or significant CNS disturbance, should be transferred to a higher medical facility for further assessment and management

2.1.5. Heat Stroke

2.1.5.1. Lowering of core body Temperature

The basic premise of rapidly lowering the core temperature to about 39°C (to avoid overshooting and rebound hyperthermia) remains the primary goal. Some studies have shown that promptly reducing the exposure time to excessive heat can dramatically improve long-term outcomes and decrease irreversible injury. If treatment is initiated within this so-called golden hour and is aggressive enough to rapidly reduce the core body temperature, complications (including multisystem organ failure) may be averted and the patient may have a much better prognosis.

The goal of treatment is to reduce the temperature by at least 0.2°C/min to approximately 39°C. Active external cooling generally is halted at 39°C to prevent overshooting, which can result in iatrogenic hypothermia.

A flexible indwelling thermistor rectally or an esophageal probe can be placed to monitor core body temperature during treatment; alternatively, a more modern method is to use a temperature-sensing Foley catheter. Because thermal instability may persist for a few days after the onset of heatstroke, the temperature must be monitored continuously until it is stable.

2.1.5.1.1. External cooling

External methods include immersion and evaporative cooling.

- **Immersion cooling**
    - Immersion in an ice bath, or cooling blankets used in conjunction with ice packs to the axilla, groin, neck, and head, may be the most rapid methods of cooling.

- Patients cooled in an ice bath frequently suffer afterdrop, so that their core temperature continues to decline even after they are removed from the bath. Ice-water immersion or an equivalent method has the advantage of rapidly reducing core body temperature. Because of its high thermal conductivity, ice water can reduce core body temperature to less than 39°C in approximately 20-40 minutes.
- The disadvantages of ice-water immersion include the fact that it may be extremely uncomfortable for patients who are awake. In addition, in theory it can cause subcutaneous vasoconstriction, preventing the transfer of heat via conduction.
- Recent guidelines recommend ice-water immersion as the superior method for rapidly lowering core body temperature below the critical levels normally found for those with exertional heatstroke.

- **Evaporative cooling**

  - The patient's skin is exposed to warm air at 40°C (104°F) passing over the body while a mist of cool water at 15°C (59°F) speeds heat dissipation. Cooling rates with this technique have been measured at 0.31°C/minute (0.5°F/minute). The following procedure is followed:
    - Remove all of the patient's clothing.
    - Insert a rectal thermometer for continuous monitoring.
    - Mist over patient constantly, using spray bottles filled with tepid (15°C) water.
    - Place large fans to circulate warm room air (ideally 40°C) directed at the patient.

  Evaporative and convective cooling using a combination of cool water spray with continual airflow over the body can be undertaken for classic heatstroke.

2.1.5.1.2. Internal cooling

Internal cooling methods are effective in rapidly decreasing temperature. Gastric, bladder, and rectal cold water lavage can all be readily performed. Peritoneal and thoracic lavage may also be used, but are more invasive and so are used only in extreme cases. Although rarely required, cardiopulmonary bypass or plasma exchange is also effective as a cooling method in this setting. No data exist to help practitioners determine when internal cooling methods might be superior to external ones. As such, internal cooling methods should be regarded as an approach for use when external cooling may not be feasible or is ineffective.

2.1.5.2 Emergency Life Support

All patients should be assessed using Advanced Trauma Life Support (ATLS) protocols and managed as appropriate. Special attention to airway protection, adequate ventilation and fluid resuscitation are essential to treating heat injuries, as pulmonary aspiration and hypoxia are important causes of death[1]. "*Prompt correction of hyperthermia by immediate cooling and support of organ system function are the two main therapeutic objectives in patients with heat stroke"*[1]

- All patients should be administered oxygen along with cooling.
- Patients with an altered level of consciousness, significant hypercapnia, or persistent hypoxia should be intubated and mechanically ventilated. Avoid using suxamethonium during intubation.
- **C**irculatory support is usually given with IV fluids as 0.9% Na Cl or 5% dextrose:
    - Avoid K+ containing fluids.
    - Gradually reduce concentration of Na+ if hypernatraemic.
    - If inotropes are required, try to use those with less alpha-adrenergic activity eg, dopamine.

1. Advanced Trauma Life Support student course manual, ninth edition ,American college of surgeons,ACS Committee on Trauma.

2.1.5.3. Management of Volume Depletion and Electrolyte imbalance

Intravenous infusion of normal saline should be given. Infusions may require 1 to 1.5 L/hour. Central Venous Pressure (CVP) monitoring may be of help in appropriate fluid resuscitation. Catheterization should be done to monitor urine output.

2.1.5.4. Medications

Patients who are awake and responsive should receive supplemental oxygen.

Hypoglycemia is a common occurrence in patients with Heat Stroke and infusion of dextrose 50% in water solution (D50W) should be considered in all patients with heatstroke.

Benzodiazepines and anticonvulsants should be used to control shivering and fits. Neuroleptics may be used to treat excessive shivering associated with cooling. In patients not controlled by the above medications, thiopentone infusion 1% and even non depolarizing muscle relaxants may be required with patient requiring intubation and positive pressure ventilation. Hence these drugs should ONLY be administered by doctors trained in their use and having expertise in airway management and use of ventilators for providing assisted ventilation. Equipment for airway management, source of oxygen and an ICU ventilator with an ICU setup is required with multiparameter monitor for monitoring of these patients' vitals.

Medicines, including **antipyretics and dantrolene are not effective in treating heat stroke and should not be used.**

2.1.5.5 Monitoring

In adults, admitted to hospital, with heat stroke hepatic, renal, and clotting function should be monitored for 48 hours after admission and treatment. The following laboratory studies need to be done:

(i). Arterial blood gas testing

Arterial blood gas analysis may reveal respiratory alkalosis due to direct central nervous system (CNS) stimulation leading to hyperventilation and metabolic acidosis and metabolic acidosis due to lactic acidosis. Lactic acidosis commonly occurs following exertional heatstroke (EHS) but may signal a poor prognosis in patients with classic heatstroke.

(ii). Blood Glucose

Hypoglycaemia may occur in patients with Heat Stroke and in patients with fulminent hepatic failure.

(iii). Serum Electrolytes

Sodium*:* Hypernatremia may be seen due to reduced fluid intake and dehydration. It is commonly observed early in the course of disease. Hyponatremia may be due to excessive loss in sweat. It is observed in patients receiving hypotonic solutions, such as free water, or those who are using diuretics for some underlying illness.

Potassium: Hypokalemia is common in the early phases of heatstroke. However, with increasing muscle damage, hyperkalemia may be observed.

Other: Hypophosphatemia secondary to phosphaturia and hyperphosphatemia secondary to rhabdomyolysis, hypocalcemia secondary to increased calcium binding in damaged muscle, and hypomagnesemia also are observed commonly.

(iv). Hepatic function tests

Hepatic injury is a consistent finding in patients with heatstroke.

Aspartate aminotransferase [AST] and alanine aminotransferase [ALT]) levels commonly rise to thousands during the early phases of heatstroke and peak at 48 hours, but they may take as long as 2 weeks to peak. Jaundice may be striking and may be noted 36-72 hours after the onset of liver failure.

(v). Serum Uric Acid

Urates may predict acute renal failure.

(vi). Muscle function tests

Creatinine kinase (CK), lactate dehydrogenase (LDH), aldolase, and myoglobin are commonly released from muscles when muscle necrosis occurs. CK levels exceeding 100,000 IU/mL are common in patients with EHS. Elevations in myoglobin may not be noted despite muscle necrosis because myoglobin is metabolized rapidly by the liver and excreted rapidly by the kidneys.

(vii). Complete blood cell count

Elevated white blood cell counts commonly are observed in patients with heat stroke, and levels as high as 40,000/μ L have been reported. Platelet levels may be low.

(viii). Renal function tests

Elevations in serum uric acid levels, blood urea nitrogen, and serum creatinine are common in patients whose course is complicated by renal failure.

(ix). Cerebrospinal fluid analysis

Cerebrospinal fluid (CSF) cell counts may show a nonspecific pleocytosis, and CSF protein levels may be elevated as high as 150 mg/dL. This test may be considered in patients in whom CNS infections has been kept as a possibility.

(x) Imaging in the form of X-ray chest and CT head should be done based on the judgement of the treating physician to rule out other disorders mimicking heat related illnesses.

2.1.5.6 Complications

- Hyperkalaemia.

- Hypocalcaemia.
- Acidosis.
- Rhabdomyolysis.
- Disseminated intravascular coagulation.
- Hepatic failure.
- Acute kidney injury.
- Ventricular fibrillation (often fatal).

2.1.5.7 Prognosis

With rapid cooling, sufficient rehydration and careful management of complications survival rates for heatstroke approach 85-90% in most Tertiary care facilities. However, many patients experience permanent neurological impairments or death despite these efforts. Poor prognostic indicators include:

- Coagulopathy.
- Lactic acidosis (in the absence of severe physical exertion).
- Core temperature >42.2°C.
- Coma lasting >4 hours.
- Acute kidney injury.
- Hyperkalaemia.
- Very high transaminase level.
- Prolonged period of hyperthermia.

Prevention of Heat Related Illness

Because heat-related illness is largely avoidable, the most crucial point of intervention concerns the use of appropriate prevention strategies by susceptible individuals and their care givers. Knowledge of effective prevention and first-aid treatment, besides an awareness of potential side-effects of prescription drugs during hot weather, is crucial for physicians and pharmacists.

The preventive steps include:

- **Drink plenty of fluids**: Drink water to the point where your urine is light yellow colour. Rehydration is best with water and not carbonated drinks. Avoid alcohol and caffeinated drinks during exercise as it increases your risk of hyperthermia.
- **Avoiding exercising/ strenuous outdoor activities** in the heat.
- **Acclimatization**: It takes weeks to acclimatize to a hotter climate. The process of repeated or increasing exposure (for example, over 1-2 weeks and with daily exercise in heat) of initially 30-60 minutes increasing to about 100 minutes at a time. During acclimatization the body becomes more efficient in work production as well as heat dissipation through various mechanisms, including a number of changes to sweat rate, volume and composition.
- **Light Clothing**: To help evaporation of sweat, wear lightweight, light-coloured, loose, porous clothes and a wide-brimmed hat/ umbrella.
- **Protect yourself outside**: Use strong sunscreen as sunburn limits the body's ability to cope with heat.
- **Keep cool indoors**: Keep your home cool with curtains, shutters, or awnings on the sunny sides and leave windows open at night.
- **Schedule outdoor activities carefully**: Try to restrict your outdoor activities to cooler parts of the day (in the mornings and evenings)

- **Do not Leave Children alone in parked cars.** Indoor temperature. in car can rapidly rise.
- **Pre-cooling** either by cold water immersion and the application of cooling garments or by ingesting cooled drinks has become a popular strategy for those who are going to exercise in hot environments. It has been shown to be effective for lowering pre-exercise core temperature, increasing heat storage capacity and improving exercise performance in the heat.

Administrative and Work Practice Controls for Employers

To prevent Heat Related Illness among employees, performing out-door work the employer should:

- Assess the demands of all jobs and have monitoring and control strategies in place for hot days and hot work places.
- Consider cut-off temperature about 44^0C to stop all non essential outdoor activities.
- Morning shifts should be considered in offices where ever feasible.
- Increase the frequency and length of rest breaks.
- Schedule strenuous jobs to cooler times of the day.
- Provide cool drinking water near workers and remind them to drink a cup about every 20 minutes or more frequently to stay hydrated.
- Caution workers to avoid direct sunlight.
- Assign additional worker or slow down the pace of work.
- Make sure everyone is properly acclimatized.
- Train workers to recognize factors which may increase the risk of developing a heat related illness and the signs and symptoms of heat stress and start a "buddy system" since people are not likely to notice their own symptoms.
- Trained First Aid providers should be available and an emergency response plan should be in place in the event of a heat related illness. Pregnant workers and workers with a

medical condition or those taking certain medications should discuss with their physicians about working in the heat.

- Protective clothing: Light summer clothing should be worn to allow free air movement and sweat evaporation.
- If working outdoors wear light coloured clothing preferably long sleeve shirt and pants, and cover the head to prevent exposure to direct sunlight.
- Awareness campaigns should be organized for employees.

Public Health Action Plan for Managing Heat Related Illnesses

Recent scientific assessments indicate that, as global temperatures continue to increase because of climate change, the number and intensity of extreme events are likely to increase (WMO). Heat-waves usually occur in synoptic situations with pronounced slow air mass movement, leading to intensive and prolonged heat stress.

Heat-waves characterized by long duration and high intensity have the highest impact on morbidity and mortality. The impact of extreme summer heat on human health may be exacerbated by increases in humidity. There is growing evidence that the effects of heat-wave days on mortality are greater on days with high levels of ozone and fine particulate matter. Global climate change is projected to further increase the frequency, intensity and duration of heat-waves and attributable death (WHO).

The adverse health effects of heat-waves are largely preventable through the development and implementation of Heat Action Plans at National, State and district levels. Microplans, which are location specific (eg Heat Action plan for a City) needs to be developed.

Components of Heat Action Plan for Health Sector

1. Surveillance

Integrated Disease Surveillance Programme (IDSP) in NCDC having pan India presence would be the backbone of the Surveillance network. IDSP platform would be used by the affected states for gathering data on Heat related illnesses (both morbidity and mortality)

through community based and hospital based data gathering mechanism. Real-time data systems can be used to describe rapidly what is happening during a heat-wave during the summer months. Real-time data systems can inform health decision-makers during the summer about abnormal outbreaks or clusters of health impacts.

IDSP units of the vulnerable States will work with the State units of Meterological Departments to evolve heat health warning systems that use weather forecasts to predict heat-related effects on human health. The essential components of such systems are identifying weather situations that adversely affect human health, monitoring weather forecasts, implementing mechanisms for issuing warnings when a weather situation that could adversely affect health is forecast and promoting public health activities to prevent heat-related illness and death. Models are available in India that can be considered for replication (Ahmedabad Heat Action Plan, Indian Institute of Public Health, Gandhi Nagar, Gujarat).

2. Rapid Response Teams

Existing Rapid Response Teams (RRTs) Centre, State and District levels of the vulnerable States shall be trained to investigate Heat related health events. Each team would comprise of an epidemiologist / public health specialist, medical / paediatric specialist and other experts as deemed appropriate. At the central level, the teams would be constituted, notified and deputed by the EMR division of MOHFW. At State / District level, the existing Rapid Response Teams under IDSP would be reinforced.

3. Heat Health Event Investigation

National Centre for Disease Control (NCDC), Delhi would be the nodal agency for investigation of heat related health events.

4 Pre Hospital and Hospital care

The primary responsibility of treatment of heat related events would vest with the State/ UT Governments. The identified health care facilities at PHC/ CHC/ District / Medical College level would have necessary treatment facilities for treatment of Heat related Illnesses. The Ambulances services (108/102) in these vulnerable hotspots would also be equipped to cool the patient and rehydrate the patient.

A referral system from any of the primary / secondary Health care facilities to identified tertiary care facility would be established for managing severe cases.

5. Logistics

The State Govt / District authorities / local bodies would ensure that all the health facilities in vulnerable cities/ rural districts have required medicines, ice packs, functional refrigerators, air cooled or air conditioned rooms for care of such cases.

6 Trained Human Resource.

The doctors and nurses of the emergency departments and the ambulance paramedics of the concerned cities/ rural districts in the vulnerable States would be trained in identification of early warning signs and clinical management of heat related illnesses.

7. Communication

There should be a risk communication plan. Awareness among public about the do's and 34on't's regarding heat related health event would be created through the print and audio-visual media at the beginning of the summer season. There should be outreach programmes to

create awareness and sensitize on specific actions that needs to be taken by identified risk groups (out door construction workers, street vendors, school children, Police Personnel, Resident Welfare Associations etc). Key messages and Do's and Don't's are given in the Appendix I&II.

8 Co-ordination

There are multiple stake holders contributing to the Heat Action Plan. State Department of Health and health functionaries at District / Local Authorities are one such stake holder. State Disaster Management Authority and District Disaster Management Authority should be the co-ordinating agency at State level. Similar co-ordination mechanism needs to be identified for Municipal Corporations/ Municipalities .

9. Heat Action Plan for Specific Cities / Rural Districts

City/ district specific heat health action plans needs to be developed bringing together the above core-components.

10. Particular care for vulnerable population groups

The health action plan should address the concern of the vulnerable groups (out door construction workers, street vendors, school children, Police Personnel, Resident Welfare Associations etc.)

11. Role of NGO

Within the District/ City Heat Action plan Non-Governmental organizations such as District Medical Association, Professional bodies and their associations, philanthropic organizations need to be roped in for spreading awareness on heat related illnesses.

Key Messages

Keep your home cool

- During the day, close windows and shutters (if available) especially those facing the sun. Open windows and shutters at night when the outside temperature is lower, if safe to do so.
- If your residence is air conditioned, close the doors and windows.
- Electric fans may provide relief, but when the temperature is above 35 °C, fans may not prevent heat-related illness. It is important to drink fluids.

Keep out of the heat

- Move to the coolest room in the home, especially at night.
- If it is not possible to keep your home cool, spend 2–3 hours of the day in a cool place (e.g. air-conditioned public building).
- Avoid going outside during the hottest time of the day.
- Avoid strenuous physical activity.
- Stay in the shade.
- Do not leave children or animals in a parked vehicle.

Keep the body cool and hydrated

- Take cool showers or baths.
- Alternatives include cold packs and wraps, towels, sponging, foot baths, etc.
- Wear light, loose fitting clothes of natural materials. If you go outside wear a wide brimmed hat or cap and sunglasses.
- Drink water regularly and avoid beverages with alcohol.

Help others

- If anyone you know is at risk, help them to get advice and support. Elderly or sick people living alone should be visited at least daily.
- If the person is taking medication, check with the treating doctor how they can influence the thermoregulation and the fluid balance.

If you have a health problem:

- Keep medicines below 25 °C or in the fridge (read the storage instructions on the packaging);
- Seek medical advice if you are suffering from a chronic medical condition or taking multiple medications.

If you or others feel unwell:

- Try to get help if you feel dizzy, weak, anxious or have intense thirst and headache; move to a cool place as soon as possible and measure your body temperature;
- Drink some water or fruit juice to rehydrate;
- Rest immediately in a cool place if you have painful muscular spasms, most often in the legs, arms or abdomen, in many cases after sustained exercise during very hot weather, and drink oral rehydration solutions containing electrolytes;
- Medical attention is needed if heat cramps are sustained for more than one hour;
- Consult your medical doctor if you feel unusual symptoms or if symptoms persist.
- If one of your family members or people you assist presents hot dry skin and delirium, convulsions and/or unconsciousness, call the doctor/ambulance immediately.
- While waiting for the doctor/ambulance move him/her to a cool place and put him/her in a horizontal position and elevate legs and hips, remove clothing and initiate external cooling, such
- Along with cold packs on the neck, axillae and groin, continuous fanning and spraying the skin with water at 25–30 ^{o}C.
- Measure the body temperature. Do not give acetylsalicylic acid or paracetamol.
- Position unconscious person on their side.

For service providers:

- Information on helpline, ambulances, cool spaces and transport should be provided on the information material!!
- Provide access to cool spaces and ensure active assistance for those most at risk.

Source: Franziska Matthies (2008): Guidance; Heat Health Action Plans, WHO Regional Office for Europe, Denmark.

Do's and Dont's

Heat Wave conditions can result in physiological strain, which could even result in death.

To minimise the impact during the heat wave and to prevent serious ailment or death because of heat stroke, you can take the following measures:

- Avoid going out in the sun, especially between 12.00 noon and 3.00 p.m.
- Drink sufficient water and as often as possible, even if not thirsty
- Wear lightweight, light-coloured, loose, and porous cotton clothes. Use protective goggles, umbrella/hat, shoes or chappals while going out in sun.
- Avoid strenuous activities when the outside temperature is high. Avoid working outside between 12 noon and 3 p.m.
- While travelling, carry water with you.
- Avoid alcohol, tea, coffee and carbonated soft drinks, which dehydrates the body.
- Avoid high-protein food and do not eat stale food.
- If you work outside, use a hat or an umbrella and also use a damp cloth on your head, neck, face and limbs
- Do not leave children or pets in parked vehicles
- If you feel faint or ill, see a doctor immediately.
- Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. which helps to re-hydrate the body.
- Keep animals in shade and give them plenty of water to drink.
- Keep your home cool, use curtains, shutters or sunshade and open windows at night.
- Use fans, damp clothing and take bath in cold water frequently.

Source: National Disaster Management Authority