# HEAT

A PROVIDER MANUAL FOR HEALTHCARE PROFESSIONALS ON ASSESSMENT AND MANAGEMENT OF PATIENTS WITH HEAT EXHAUSTION AND HEAT STROKE

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## About Heat Provider Manual

In the midst of June 2015, the city of Karachi was hit by a heat wave that resulted in 1200 - 2000 deaths and over 50,000 casualties. This burden caught the attention of various stakeholders ranging from government officials to medical responders to mobilize resources for planning a well-designed response.

The HEAT manual is among one such efforts to respond to such extreme climatic emergencies. It was designed as part of the Heat Emergency Awareness and Treatment (HEAT) cluster randomized trial, funded by Research for Health in Humanitarian Crisis that assessed the gap in assessment and management of patients who are presenting to the emergency departments (ED) with heat illnesses in low resource settings. This manual incorporates information that was gathered by a systematic review and suggestions from an expert panel comprising of clinicians and researchers from Pakistan and the United States of America. The HEAT Provider Manual was utilized by the investigators to train healthcare personnel in the hospitals that participated in the trial.

The material in this manual is intended to provide generic guidelines that can be tailored to the hospital resources and healthcare staff.

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# Contents

# Part 1

# Heat Provider Course

## 1 Course Introduction

The Heat Emergency Awareness and Treatment (HEAT) provider course is designed for healthcare providers who are involved in the assessment and management of patients presenting with heat emergencies (heat exhaustion and heat stroke) in emergency departments.

This course will enhance your knowledge and skills in the assessment and management of an adult patient with heat emergencies in the emergency department.

### 1.1 Course Objectives

1. To describe evidence-based cost-effective approaches in treating patients with heat emergencies
2. To describe a hospital emergency response plan to heat waves
3. Be able to perform effective and time sensitive resuscitation in patients with heat exhaustion/ heat stroke in the emergency department

### 1.2 Course Format

To achieve the aforementioned objectives, the HEAT provider course includes:

i- Lectures
ii- Skills stations (simulated case scenarios on heat exhaustion and heat stroke)
iii- A written exam (Pre & post-test)

### 1.3 Course Participants

Participants are health care professionals who are expected to provide emergency treatment to victims of heat related illnesses (heat stroke, heat exhaustion) as part of their clinical practice.

### 1.4 Pre-course Preparation

It is recommended that the participants attending the course will complete the pre-reading materials as well as activity sheets prior to attending the course. All participants are also expected to complete **pre- and post-course MCQs**.

### 1.5 Simulated heat emergency cases

During the course, the participants will actively participate in a series of simulated heat emergency cases. This will help the participant to translate knowledge gained during the lectures. You can make a decision based on your knowledge of the following:

a) Understanding of the physiological and pathophysiological response to physical compromise occurring in various types of heat emergencies
b) Application of a structured and comprehensive approach in identification and management of heat emergency victims
c) Use of the Airway, Breathing and Circulation for stabilizing the patient
d) Use of HEAT algorithms in Emergency medicine practice
e) Use core interventions for lowering body temperature

### 1.6 Course Materials

The HEAT provider course materials include the HEAT provider manual and HEAT algorithm cards.

### 1.6a HEAT Provider Manual

The manual contains systematic sequential assessment and management steps that the participants have to follow in the management of a patient affected by heat exhaustion or heat stroke in the emergency department.

### 1.7 Requirements for a successful course completion:

A final assessment of candidates at the end of the course entails the management of a heat emergency case simulation and a multiple-choice questionnaire (MCQ).

A pre- and post-test will be conducted to ascertain change in knowledge. Those scoring less than 70% on post-test will be offered a second 2-hour session. Candidates will receive a HEAT Provider course participation certificate at the end of session.

### 1.8 Suggested Readings


- Levitus S, Antonov JI, Boyer TP, et al. Global ocean heat content 1955–2008 in light of recently revealed instrumentation problems. *Geophysical Research Letters*. 2009;36(7).

- Bouchama A, Knochel JP. Heat stroke. *New England Journal of Medicine*. 2002;346(25):1978-88.

- Glazer JL. Management of heatstroke and heat exhaustion. American Family Physicians. 2005;71(11):2133-40.

# Part 2

# The Science behind Climate Change and Heat Waves

## 2.1 The Science behind Climate Change

Over the last century, climate change has presently increased the world's mean temperature by 0.75˚C which is further predicted to increase by the year 2100 [1]. Solar energy in the form of radiation is the main driver of climate change. However, since 1979, the data has not shown any long-term change in total solar energy, even though the earth has been warming. This change is driven largely by increased carbon dioxide production and its decreased utilization due to deforestation, increased industrialization and emission of toxic gases into the atmosphere due to burning of fossil fuels leading to a green-house effect [2]. The oceans have started to become warmer with the top 700 meters recording higher temperatures than below [3]. Increasing temperatures have also lead to the melting of the Arctic sea ice cap [3, 4] and the Northern hemisphere snow cover causing the global sea level to rise rapidly [5].

Data show rapid warming in the past few decades and that the last decade has been the warmest on record. The numbers of extreme high temperature events have been increasing on a global scale while the numbers of record low temperature events have been declining.

Many high income countries have recently developed public health management strategies to respond to heatwaves. A recent survey in Europe identified seven countries with comprehensive Heat Action Plans. These action plans have several key components: a leading body, an accurate and timely alert system, a communication campaign, reduction in indoor heat exposure, long-term urban planning, care of vulnerable population groups, the preparedness of health care system, and a surveillance system. While no conclusive evidence was found for the effectiveness of these approaches, observational studies have highlighted potential successes of these steps in averting deaths. Other observational studies in high income settings have shown single interventions such as early warning systems and urban greening to be effective and comply with common sense principles.

## 2.2 Heat Waves and Its Impact

Weather-related disasters during the last 20 years have resulted in over 606,000 deaths with over 4 billion people requiring emergency assistance globally [10]. Extreme temperatures, primarily in the form of heatwaves, cause the second highest number of deaths after those caused by storms, resulting in 160,000 deaths and 94 million people affected in [what year] [10]. One degree Celsius increase in temperature results in 2-5% increase in mortality among the elderly [1]. It is projected that the public health impact of extreme heat (EH) exposure will increase in the coming years as climate change becomes more pronounced [11].

It is projected that the public health impact of extreme heat (EH) exposure will increase in the coming years as climate change becomes more pronounced

Deaths caused by disasters are far higher in poor countries than in wealthy nations [13]. Health systems in low- and middle-income countries are burdened by finite resources, therefore it is necessary to investigate the public health impact of heat waves and devise effective management strategies for heat related illnesses which can later be used to design effective protocols for addressing these challenges.

This threat of extreme heat exposure disproportionately affects city dwellers. Cities on average have a 3.5-12˚c higher temperature than surrounding areas, a phenomenon known as the "urban heat island effect" [14]. Other groups at risk include those residing in lower socio-economic areas, the elderly, and those with concurrent medical conditions such as diabetes, respiratory or cardiac conditions [15].

Pakistan is among the top 10 countries for disaster deaths in the last 20 years [16]. In the last 50 years, the annual mean temperature in Pakistan has increased by roughly 0.5°C. The number of extreme hot days per year has increased nearly fivefold in the last 30 years. By the end of this century, the annual mean temperature in Pakistan is expected to rise by 4°C to 6°C. The occurrence of heat waves has increased in the province of Sindh since the 1960s. This coupled with the variability in annual average rainfall will potentially contribute to the increasing trend in annual mean temperatures until the end of the century [6, 7, 8]. Therefore, a concerted effort by the government and civil society at all levels is required to mitigate these threats [9]. A study by Ghazanfar et al reported a death toll exceeding 1200-2000 individuals within 3 days during the hottest summers in the city of Karachi in 2015 [34]. This further conforms to the notion that the phenomenon is widespread and will spread to most of the regions affecting both developed and developing nations.

# Part 3

# Heat Emergencies - Pathophysiology, Risk Factors and Vulnerable Population

### 3.1 Pathophysiology

Heat is generated in the body mainly by cellular metabolism and skeletal muscle activity.

In addition, heat is accumulated in the body by radiation from the sun and contact with hot objects. The body has several mechanisms to dissipate heat into the environment and these include:

a) Radiation – heat loss through electromagnetic waves from hot object to cold object.
b) Evaporation- heat loss by vaporization of water and sweat from the body
c) Conduction – heat loss from hot to cold object when two are in direct contact.
d) Convection- Heat loss by movement of air and water on the body's surface.

The body maintains normal core temperature between 36-38°C (96.8°F -100.4°F). The physiologic response to heat loss from body includes blood vessel dilatation especially in the skin, increased sweating, and behavioral heat control.

The body's physiological thermal regulation fails at temperatures above 40°C (104°F) resulting in heat illnesses. The vulnerable organs affected by heat illness are the brain and liver followed by kidneys and skeletal muscles and can progress to multi-organ failure and disseminated intravascular coagulation (DIC).

### 3.2 Vulnerable Populations

Heat-related illness represents a continuum of pathologic states and populations at risk include older persons, children, persons with prior comorbid like diabetes, patient with psychiatric illness and on antipsychotic medications, and persons who perform strenuous outdoor activities.

### 3.3 Risk Factors for Heat Illnesses

• Age: elderly are at risk because of higher rates of medication use, immobility, and volume depletion. They have diminished cardiovascular compensation and age-related loss of proteins due to heat shock adds further to the menace of heat intolerance [17].

• Children are particularly prone to heat-related illness because of their greater ratio of surface area to body mass resulting in more heat transfer from the environment to the body. They also have a diminished ability to dissipate heat because of slower sweat rates, a higher temperature threshold for the initiation of sweating, and production of a more diluted sweat.

Furthermore, children are slower to acclimatize to the heat and have less of a thirst response [19].

- Young, healthy persons who perform strenuous activity in hot and humid environments, such as laborers, military/police personnel, athletes and persons who work outdoors are at increased risk [20]. Persons who work outdoors have a 20-fold increased rate of heat-related death compared with persons in other forms of employment [22]

- Females are more vulnerable to suffer from heat emergencies due to the mechanisms termed as confinement hyperpyrexia. Women also have higher core body and skin temperature and may be less tolerant to heat than men [23]. In some countries cultural dress codes for women lead to less heat dissipation from the body.

- Individuals with comorbidities like diabetes, hypertension, ischemic heart disease, stroke, obesity, chronic respiratory conditions, hematologic/oncologic diseases, and/or psychiatric illnesses are also at high risk for heat illness.

Special circumstances that put people at risk of developing heat illness are

- Pregnancy
- State of fasting
- Water shortage
- Lack of shelter
- Lack of electricity (to operate fan or air conditioners/air coolers)
- Lack of ventilation/windows
- Congregational places/home or public places with overcrowding (like in traffic jam)

**Risk factors for heat illness**

- Age (less than 10 or greater than 50 years)
- Female gender
- Individuals working outdoors without shades
- People living in poorly ventilated areas
- People living in densely populated house
- Low socio-economic status
- Exertion in days when both the environmental temperature & humidity is high
- Individuals who have limited functional status or bed bound
- Comorbidities like diabetes, hypertension, ischemic heart disease, stroke, obesity, chronic respiratory conditions, hematologic/ oncologic diseases, psychiatric illnesses.
- Recent acute illness or exertion heat injury
- Lack of acclimatization

There is a significant association between heat related illnesses and the level of workload activity performed, mainly with activities qualifying as moderate and beyond (Table 2).

**Table 1: Categories of workload with examples**

| CATEGORIES | EXAMPLES OF ACTIVITIES |
|---|---|
| **RESTING** | • Sitting quietly<br>• Sitting with moderate arm movement |
| **LIGHT** | • Sitting with moderate arm and leg movements<br>• Standing with light work at machine<br>• Using a table saw<br>• Driving a tractor (at times can be moderate) |
| **MODERATE** | • Scrubbing in a standing position<br>• Walking<br>• Working in kitchen with gas stove<br>• Walking about with moderate lifting or pushing |
| **HEAVY** | • Carpenter sawing by hand<br>• Going up and down ladders<br>• Heavy assembly work on a non-continuous basis<br>• Intermittent heavy lifting with pushing or pulling (e.g. pick-and-shovel work) |
| **VERY HEAVY** | • Shoveling wet sand |

### 3.3 Heat illness predisposing medications:

Medications impart risks such as blunting cardiac output in times of stress, interfering with hydration, and inhibiting sweat [19, 24]. Table 3

**Table 2: Medications predisposing to heat emergencies**

| DRUG CLASS | EFFECTS | EXAMPLES |
|---|---|---|
| **Anticholinergics** | Can affect central thermoregulation, reduce cognitive alertness and prevent reduce sweating | Atropine, Ipratropium, Solifenacin, Benztropine, Trihexylphenidyl |
| **Antipsychotics** | Can inhibit the sweating mechanism and reduce systolic blood pressure, central thermoregulation, cognitive alertness and vasodilation | Haloperidol, Quetiapine, Risperidone, Clozapine, Olanzapine, Fluphenazine |
| **Antihistamines** | Can inhibit the sweating mechanism and reduce systolic blood pressure | Chlorphenaramine, Diphenhydramine, Cetrizine, Fexofenadine, Loratidine, |

| | | |
|---|---|---|
| | | Desloratidine |
| **Drugs used in Parkinson** | Can inhibit the sweating mechanism; reduce systolic blood pressure and cause dizziness and confusion. | Sinemet (carbidopa levodopa), Selegiline, Amantadine, Bromocriptine, Benztropine, Trihexylphenidyl |
| **Antidepressants** | Reduce sweating; some can decrease centrally induced thermoregulation and cognitive alertness | TCAs (Nortriptaline, Amitriptaline), SSRI(Fluoxetine, Sertraline), Bupropion, Venlafaxine |
| **Anxiolytics & muscle relaxants** | Reduce sweating and increase dizziness, decrease cardiac output and therefore reduce cooling by vasodilation, and worsen respiratory symptoms | Benzodiazepines (Diazepam, Alprazolam), Tizanidine, Cyclobenzaprine |
| **Sympatholytics** | Can worsen hypotension in vulnerable patients | Beta blockers (Metaprolol, Propanolol, Carvedilol) Alpha blockers (Prazosin, Doxazosin) |
| **Sympathomimetics** | Can prevent dilation of the blood vessels in the skin, reducing the capacity to dissipate heat by convection | Epinephrine, Norepinephrine, Dopamine, Dobutamine, Salbutamol, Albuterol |
| **Antihypertensives** | Can lead to dehydration and reduce blood pressure; hyponatremia is a common side effect and can be worsened by excess fluid intake | Calcium Channel blockers (Amlodipine, Nifedipine, Verapimil, Diltiazem), Angiotensin receptor blockers (Losartan, Irbesartan, Valsartan), Angiotensin converting enzyme inhibitors (Ramipril, Lisinopril), Diuretics (Furosemide, Hydrochlorothiazide, Spironolactone), Nitrates (Isosorbide mono/di-nitrates) Alpha blockers, Beta blockers |
| **Antiepileptics** | Can reduce cognitive alertness and increase dizziness | Phenytoin, Levetiracetam, Carbamazepine, Lacosamide, Lamotrigine, Oxycarbamazepine, Valproate, Phenobarbitone |

# Part 4

## Heat Illness Spectrum and Clinical Features

Heat illness encompasses a spectrum from sunburns and rash to heat cramps, exhaustion syncope and heat stroke. Physicians must be aware of the clinical features and diagnostic criteria for diagnosis of heat emergencies.

In heat emergencies, rectal route to measure core temperature is the most reliable method. However, if there are resource and cultural barriers, oral or axillary temperature measurements are suitable alternatives for monitoring temperature.

In heat emergencies, rectal temperature measurement is the most reliable method;

However, use oral or axillary temperature measurements if necessary.

This manual focuses on two heat emergencies - exhaustion and stroke which if not diagnosed timely and managed can result in poor patient outcomes.

### 4.1 Heat Cramps

Heat cramps are common when exercising in hot and humid environments. It is seen commonly in athletes or in people who are playing under the sun in hot and humid conditions. Excessive dehydration leads to loss of electrolytes which during days of heatwave are accelerated, especially in people who sweat profusely [25]. The cramps are appreciated mainly in calf muscles and abdomen.

Heat cramps are common when exercising in hot and humid environments and is commonly seen in athletes

### 4.2 Heat Syncope

It is a fainting episode that occurs in high environmental temperatures. It is commonly observed in individuals who are standing for long periods of time without movement or sudden rising from a sitting or lying position while in a hot environment [28].

### 4.3 Heat Exhaustion

It is a state of dehydration that is accompanied with/without electrolyte abnormalities. It usually occurs during or after periods of intense physical activity under high environmental temperature and is associated with profuse sweating.

The core temperature can be normal or can go above 38˚C (100.4˚F) but will be below 40˚C (104˚F) [28].

In heat exhaustion, the core temperature can be normal or can go above 38˚C (100.4˚F) but will be below 40˚C (104˚F)

While there is variability in literature in defining heat exhaustion, a patient is considered to be suffering from it if he/she has headache, weakness, dizziness, cool clammy skin, nausea, vomiting, and lethargy.

There may be tachycardia and/or hypotension. A main point for differentiation for heat exhaustion from heat stroke is the absence of neurologic symptoms [27].

Heat exhaustion can be differentiated from heat stroke by the absence of neurologic symptoms.

In recommendations that were gathered from the literature and with expert consensus we concluded that a health care provider should strongly consider the following to diagnose a victim of heat exhaustion:

a) History of exposure to an excessively hot environment or physical exertion in a hot environment.

b) Signs and symptoms representing volume and/or salt depletion (e.g. cool clammy skin, excessive sweating, delayed capillary refill tachycardia, hypotension, sunken eyes, nausea and headache)

Heat exhaustion is diagnosed from history of heat exposure and signs and symptoms of volume or salt depletion.

### 4.4 Heat Stroke

Heat stroke is an emergency which requires immediate recognition and treatment. There are many definitions of heatstroke in the literature. Disagreement remains about the exact temperature cutoff point, though most experts define heat stroke as a condition associated with a core temperature ≥ 104°F (≥40°C).

Exposure to heat stress (exertional or non-exertional) and altered mental status are essential clinical features. It should be remembered that not all patients may have this core temperature and still be suffering from heat stroke.

In order to diagnose hear stroke, the consensus agreement from the expert panel is as follows:

a) An associated history of exposure to an excessively hot environment or physical exertion in a hot environment

b) Elevated body temperature

c) Signs and symptoms of central nervous system dysfunction (e.g. confusion, delirium, altered mental status, convulsions, coma)

Heat stroke diagnosis

- History of exposure or physical exertion in hot environment
- Elevated body temperature
- Central nervous system dysfunction (Altered mental status, coma, delusions, convulsions)

The condition, if left untreated can progress to multi-organ failure.

There are two types of heat strokes - classic and exertional.

✓ ***Classical heat stroke***

This type often manifests in warm humid climates where patients get over heated without physical stress. Although anhidrosis is classically reported to occur in classic heat stroke, affected patients can continue to perspire [22].

The illness tends to progress alarmingly increasing the risk of systemic organ injury. It is strongly associated with heat waves [27, 29].

✓ ***Exertional Heat Stroke***

Mostly affects active laborers, athletes, military recruits or children playing under direct sun during heat waves.

Severe dehydration is commonly seen and is accompanied by high environmental heat stress, core body temperature ≥ 104°F (≥40°C), mitigating severe hyperthermia [27].

**4.5 Heat illness Prevention**

Physicians can work with community leaders/stakeholders and private/public agencies to identify people at risk and educate communities on the early signs of heat-related illness, hydration, and initial treatments.

Providing access to water, cooling measures or first aid facilities during heat waves in the form of emergency cell/heat camp have been practiced in many urban areas.

Evidence suggests that spending time in air-conditioned areas is among the strongest factors in preventing heat-related deaths. Fans do not provide the same benefit [30].

Laborers such as construction workers, agricultural workers, baggage handlers, electrical power transmission and control workers, and landscaping and yard maintenance workers must look after themselves and avoid prolonged or strenuous work during the hottest part of daytime generally lasting between 11 AM till 4 PM.

Employers should ensure to allow frequent breaks to workers especially those who are returning to their jobs after time away in order to build their tolerance. Older and at-risk laborers should be stationed elsewhere considering they are more prone to heat related effects. Ample amount of water should be made available and workers should be encouraged to keep themselves well hydrated with repeated fluid intake. Heavy protective clothing or impermeable suits should be discouraged.

Outdoor work including sports should be scheduled for cooler periods of the day as to avoid heat exposure. Proper hydration, lightweight and light-colored clothing, shaded rest areas, and rule adjustments to allow for frequent substitutions can help protect these individuals [20].

Risk of dehydration for nursing mothers exists. It is advisable for breast feeding women to avoid heat exposure and strenuous work along with improving their nutrition and fluid intake in order to avoid complications.

It is also necessary to choose appropriate diet to avoid risk of heat related-illnesses. Diets rich in sugar and caffeine which causes lose body fluids in abundance.

Local weather experts recommend using the heat index chart as a substitute for assessing the risk of heat-related illness on any given day [31]. The heat index is the relationship between air temperature plus relative humidity and how a person's body feels in that specific environment.

The general public should pay attention to local weather reports provided by the Pakistan Meteorological Department (PMD) and follow their provided instructions clearly.

# Part 5

## Management of Heat Emergencies

This section describes the steps that a health care provider needs to follow in managing a patient in a heat emergency.

First line of treatment in heat stroke management is to move the patient from the source to a cooler environment.

It is recommended to remove the clothes of the patient and to place him/her under a fan before the assessment is complete. However, it is important to follow the socio-cultural context and maintain the privacy of patient.

The body temperature should be measured using the mercury thermometer from the axillary or oral route, which ever feasible (literature recommends using core body temperature that is rectal temperature measurement which due to social, cultural and equipment deficiency is not recommended in low resource emergency departments).

Measure body temperature using axillary or oral route with mercury thermometers

Once the diagnosis of heat stroke is confirmed as per the definition mentioned above, the patient should be immediately evacuated towards the nearest hospital facility [19, 28, 30].

Stabilizing the patient's airway, breathing and circulation is crucial before initiating specific cooling therapy [33].

Assessment of the Airway, Breathing and Circulation is paramount before initiating specific cooling therapy

Body temperature should be monitored every 15-30 minutes [29].

A rise in body temperature with signs of altered mental status and a clear corroborative history of exposure to a hot environment should be treated for heat stroke.

Fever, Altered Mental Status and History of Exposure to hot environment in a patient should be treated as HEAT STROKE.

In heat stroke, morbidity and mortality depends upon the body temperature.

Pharmacologic interventions such as antipyretics are ineffective.

Antipyretics are ineffective in heat stroke.

Ice water cooling immersion continues to be one of the fastest ways of cooling techniques but can result in patient discomfort and hinder the continued monitoring of patient's condition.

Evaporative cooling by spraying and fanning the patient is recommended as it is effective, practical and comfortable for the patient as compared to other techniques.

Evaporative cooling by spraying and fanning is a recommended cooling technique for patients in heat emergencies

Ice packs can be applied to axilla, groin and neck as an adjunct [27].

Cooling should be started at body temperature above 38°C and should be stopped if temperature reaches 38°C or below.

There is paucity of data recommending the type or amount of fluid to be used but as per the consensus statement and literature review, 0.9% normal saline at room temperature in doses of 500 - 1000ml boluses for alleviating hypotension is most recommended(27). Physician discretion is essential in giving fluids above 500ml due to risk of pulmonary edema. As in most low resource settings, the availability of cold storage can be difficult. Additionally, cold saline can cause arrhythmia and is not recommended in patients with heat emergencies.

Benzodiazepine (diazepam 5-10mg) should be administered in case of seizures and uncontrolled shivering (28)

**Table 4: Specific management for different spectrum of heat emergencies**

| Heat spectrum | Management |
|---|---|
| Heat cramps | • Rapid relief is provided with oral rehydration solution (ORS)<br>• Severe cases should be treated with 0.9% IV normal saline |
| Heat syncope | • Rule out other causes of syncope (i.g, arrhythmias, pulmonary embolism, sepsis etc)<br>• Remove the victim from the hot environment<br>• Patient should rest in supine position<br>• Severe cases should be treated with 0.9% IV normal saline |
| Heat stroke and heat exhaustion | • Remove the victim from heat source<br>• Monitor vitals and blood sugar<br>• Start IV hydration<br>• Rapid cooling therapy should be instituted as early as possible with aim is to lower down the temperature below 40°C<br>• Oral fluids and ORS instituted in mild cases<br>• Blood Urea Nitrogen, Creatinine, and serum electrolytes should be measured.<br>• Electrolyte imbalances should be corrected, and water deficit should be replaced slowly as rapid reversal hyper/ hyponatremia can cause cerebral edema |

### 5.1 Diagnostic Investigations and Treatment Procedures [18, 19, 26, 27, 32]

In this manual we have touched on some of the diagnostic tests and their relevance with respect to heat emergencies. In the heat emergencies, the list of investigations and necessary procedures that are recommended in the literature and were advised by the consensus are as follows:

#### 5.1a Electrolytes

i- Sodium

Hypernatremia due to reduced fluid intake and dehydration are commonly observed early in the course of disease. Hyponatremia is observed in patients using hypotonic solutions, such as free water, and in patients on diuretics. It may also be due to excessive sweat sodium losses.

ii- Potassium

Hypokalemia is common in the early phases of heat stroke, and deficits of 500 mEq are not unusual. However, with increasing muscle damage, hyperkalemia may be observed.

**iii-** Other electrolytes

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

**5.1b Renal Function Tests**

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

**5.1c Urine analysis**

Urine dipstick analyses that are positive for blood must be followed by a microscopic urinalysis to determine the presence or absence of red blood cells. Proteinuria is also common.

*(TO NOTE: Urinary benzidine dipsticks do not differentiate between blood, hemoglobin, and myoglobin)*

**5.1d Complete Blood Cell Count**

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

**5.1e Hepatic function tests**

Hepatic injury is a consistent finding in patients with heat stroke.

Aminotransferase (aspartate aminotransferase [AST] and alanine aminotransferase [ALT]) levels commonly rise to tens of thousands during the early phase of heat stroke and peak at 48 hours, but they may also take as long as 2 weeks to peak.

**5.1f Muscle Function Test**

Creatinine kinase (CK), lactate dehydrogenase (LDH), aldolase, and myoglobin commonly are released from muscles when muscle necrosis occurs.

CK levels exceeding 100,000 IU/mL are common in such patients.

Elevations in myoglobin may not be noted despite muscle necrosis because myoglobin is metabolized rapidly by the liver and excreted rapidly by the kidneys.

**5.1g Coagulation Profile**

PT, INR and APTT may be deranged in extreme cases.

**5.1h Serum Glucose**

Hypoglycemia may occur in patients with heat emergencies and in patients with fulminant hepatic failure.

**5.1i 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.

**5.1j Myoglobin**

Myoglobin causes a reddish-brown discoloration of the urine but does not affect the color of plasma. This is in contrast to hemoglobin, which causes discoloration of both plasma and urine.

**5.1k Electrocardiography**

Sinus tachycardia of 130-140 beats per minute and nonspecific and ischemic ST-T wave abnormalities are common. In addition, a number of conduction abnormalities (e.g. right bundle branch block, prolonged QT interval) may be noted.

**5.1l Troponin**

An elevated prognostic value of cardiac troponin I (cTnI) can be observed in patients with heat-related illness.

**5.1m Chest radiographs**

Chest radiographs may show atelectasis, pneumonia, pulmonary infarction, or pulmonary edema.

**5.1n Computerized Tomography Brain Scans**

Computerized tomography scans may be helpful in ruling out CNS injury in patients with altered mental status.

**5.1o Arterial Blood Gases**

In the absence of arterial blood sample, venous blood gas analysis can be performed. Arterial/venous blood gas analysis may reveal respiratory alkalosis due to direct central nervous system (CNS) stimulation and metabolic acidosis due to lactic acidosis.

**5.1p Lactate**

Lactic acidosis commonly occurs following exertional heat stroke but may signal a poor prognosis in patients with classic heat stroke.

# Part 6

## Hospital Emergency Response Plan in Heat wave

It is advisable to have a hospital emergency response plan in the event of a heat wave. The plan will provide for an organized response of the hospital from the time of disaster notification until the situation comes to normal. This should be overseen by a planning group which includes planners, decision makers and employees for the execution of plan. The group should meet regularly to assess hazards, update plans accordingly, design exercises and conduct mock drills on the basis of experiences learned from real events.

In case of an emergency, we suggest following necessary steps to be taken, however, they can be modified to suit the available resources.

**6.1 Activate emergency response plan**

It is important to clarify the roles of the staff working in the Emergency Department (ED) or any other department who may have to respond to ED in the process.

Here are few essential roles as follows:

1. **Public safety**- ensuring hospital lockdown and restricted entry
2. **Facilities/ engineering**- for evaluation of any structural damage occurring in the process and advising stability of the facilities
3. **Logistic/ equipment supply**- providing supplies and equipment
4. **Pharmacy**- ensure availability of medications
5. **Transportation**- transportation of patients
6. **Clinical fields**- this includes Emergency Room (ER) physicians and other relevant specialties as per local resources such as; internal medicine, intensive care unit (ICU), pediatrics, anesthesia, etc.
7. **Public relations**- to communication with public and media
8. **Communication officer**- to coordinate with staff through paging, messages, phone calls and emails for keeping all relevant staff alert
9. **Non- clinical patient care**- housekeeping and food services
10. **Safety office**- ensuring that staff follow guidelines for safe practices (eg; usage of personal protective equipment)

The activation of plan should provide immediate mobilization of available supplies, equipment and personnel.

### 6.2 Establish emergency operations center

It is recommended to establish a hospital emergency incident command system in a predesignated location. The center should be able to communicate with the ED, triage and external authorities (e.g. law enforcing agencies, ambulance services and other healthcare facilities). The center should also be responsible for arranging extra space and beds, obtaining assistance from outside organization, assigning staff and terminating other less critical(??) operations if necessary.

### 6.3 Assess hospital capacity

A hospital safety office/ engineer should make a damage assessment of the hospital and its areas for ensuring safety of patients and staff. It is necessary to know the capabilities of the hospital, availability of beds and essential supplies, number of personnel available, and on-site damage e.g. blocked passages, inoperable elevators, failure of utilities, potential for fire, etc. This will help in estimating the capacity of the hospital to manage the patients.

### 6.4 Create surge capacity

This refers to increase in bed capacity of a hospital by various means, such as accommodating many patients in a room, converting an acute care ward to an intensive care level unit, opening previously closed wards/rooms, discharging/ mobilizing in-hospital patients to low acuity units and usage of non-clinical areas, e.g. cafeteria and other spaces for patient management.

### 6.5 Establish communications system

This is the most important step yet the most difficult to execute. Cellular services and telephone lines are overwhelmed in mass disasters. Planning should include intra-hospital (two-way radios, massagers/couriers) and inter-hospital (citizen band groups, cellular services, two-way radios, satellite phones) communications.

### 6.6 Supplies and equipment

Each hospital must make a reasonable estimate for the amount of supplies needed to be stocked. Necessary supplies and equipment should be ready for immediate distribution to appropriate location in hospital. A bold strategy may include a centralized supply stocking agency that should have a mechanism to determine hospitals in greatest need of supplies with arrangements for delivery, on site unpacking and replenishment. The suggested list of supplies and equipment is as follows:

- Thermometers
- Ice packs and other cooling adjuncts
- Water sponging/ spray
- IV fluids (e.g., saline)
- IV cannula
- Stand fans
- Air conditioning & cooling blankets (if possible)

- Fans
- Electricity/ Generators

### 6.7 Establish support area

A predesigned area for concerned family members should be established. A separate waiting or managing area for volunteers should be identified. Members of media should be assigned a specific room/office and a nominated hospital spokesperson should be tasked to convey information to them as and when required.

### 6.8 Triage and treatment

Restrict patient entry to one location only - the triage area.

This area should allow for rapid assessment of all ill patients, patients' registration and identification, assignment of priorities and distribution of patients to appropriate areas for treatment in the ED and hospital.

Generally, a team of ED physicians, ED nurse, and a medical records/admitting clerk should be present to receive patients. Place a tag on the victim with their name and destination in the hospital. If name is unavailable then age, gender and ethnicity can be used as an alternate source of identification. This information may also be entered in department's log book. Additional care may be recorded on a paper to be kept with patient at all times which at a later time can be kept as hard copy or uploaded to electronic record system depending on the local resources.

***Triage categories (color coding for ease of use)***

| Color | Priority | Urgency | Description | Example |
|---|---|---|---|---|
| Red | First | Most urgent | Life threatening condition and if immediate care provided the patient is likely to survive | Heat stroke victim with imminent airway danger or the actively seizing patient or heat exhaustion patient with hemodynamic compromise |
| Yellow | Second | Urgent | Patient is not yet in life threatening condition although systematic compromise may occur. They may withstand a 60-minutes wait without immediate risk | Heat exhaustion victim. |
| Green | Third | Non-urgent | Injuries are localized without systemic complications | Heat cramps<br>Heat rash |
| Black | Dead | - | Any unresponsive patient with no spontaneous breathing or circulation | |

### 6.9 Resuscitation

From triage, the most seriously ill patient will be sent to the resuscitation area. This area is physically located in ED and staffed by ED physicians and nurses.

### 6.10 Minor treatment area

Patients who are not seriously ill can be sent to this area. Physicians may institute necessary therapy and keep patients for observation until stable for discharge. The outpatient clinics may be used for this purpose.

### 6.11 Mental health

For agitated visitors and staff who may prove to be disruptive for hospital operations, consider a separate area to receive individuals in need for psychological intervention. Social workers and psychiatrists may be useful to provide support and stress briefing.

### 6.12 Morgue facilities

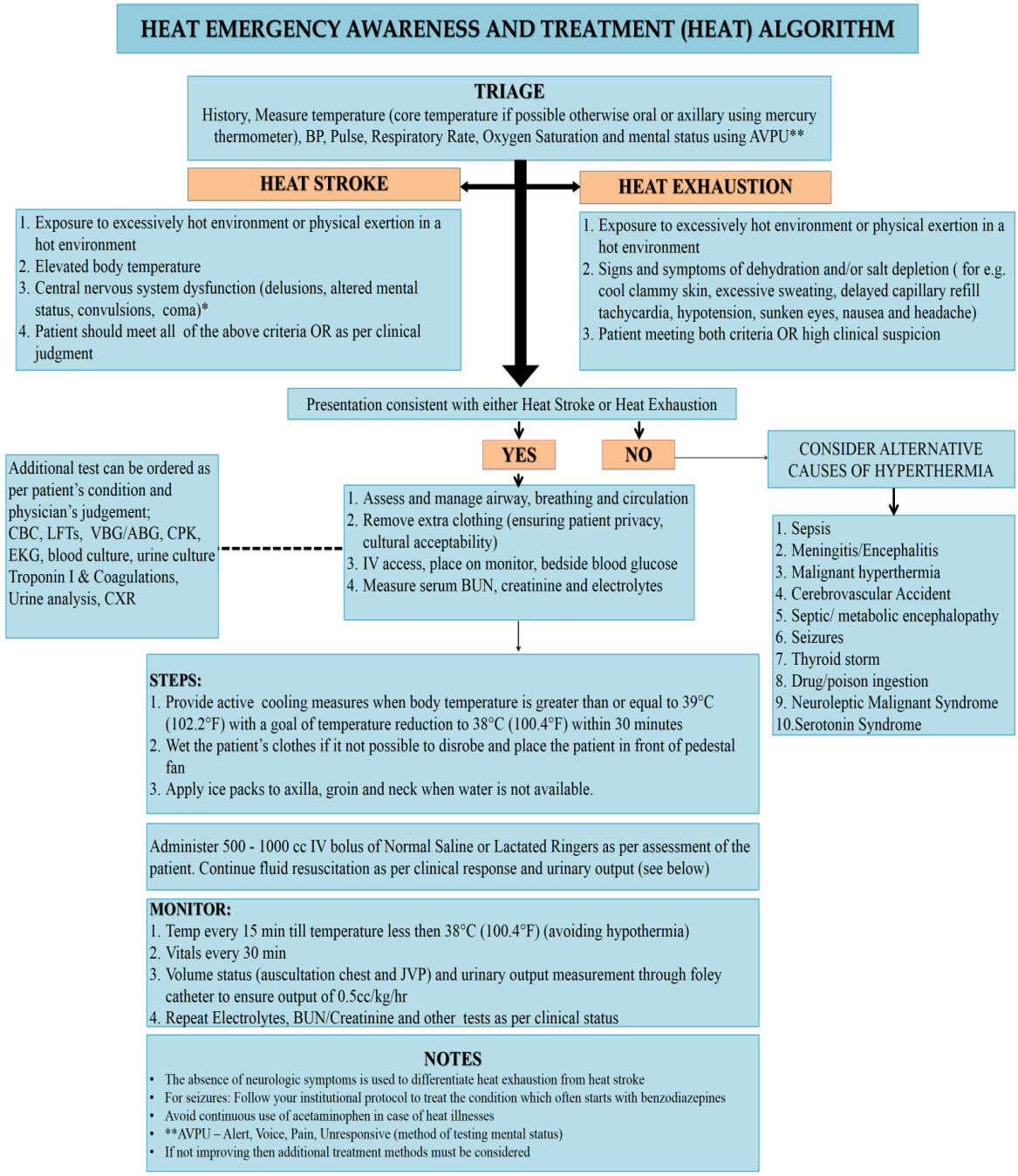
Morgue capacities may need to be expanded to other areas of the hospital, e.g. medical school, auditorium or as per local resources available. Viewing of the deceased patients should take place at these facilities instead of clinical/ treatment areas.

### 6.13 Terminating hospital emergency response plan

As appropriate, direct efforts towards returning the hospital to normal operations. Besides restocking and cleaning, a critical stress debriefing should be done for providing emotional support to healthcare workers. This also creates a moment to reflect on and record deficiencies in hospital emergency response plan and write an event report. Take necessary steps to plan better for future.

# Appendix

## Heat Algorithm




JOHNS HOPKINS UNIVERSITY

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r2hc Research for health in humanitarian crises | elrha

May 8, 2019

# HEAT EMERGENCY SKILL TESTING CHECKLISTS

Student name: _____ Test date: _____

| HEAT EXHAUSTION – Testing station checklist | | |
|---|---|---|
| Skill Set | **Action** | **If done correctly** |
| | Checks for patient's responsiveness | |
| | Measures the patient's temperature appropriately (Mercury thermometer) | |
| | Confirms patient's history of exposure to heated environment | |
| | Makes an accurate assumption of Heat exhaustion | |
| | Assesses patient's airway and manages accordingly | |
| | Assesses patient's breathing and manages accordingly | |
| | Assesses patient's circulation and manages accordingly. | |
| | States correctly required lab investigations, ECG and radiology (if required) | |
| | Makes a decision to initiate IV 0.9 % N/S OR IV bolus if hypotension | |
| | Assesses patient's disability and manages accordingly | |
| | Exposes the patient | |
| | Institutes fanning with wet cloths | |
| | Places ice packs (forehead, neck, axilla, groin) | |
| | Mentions the correct rate for IV fluids (250 – 500 ml bolus) | |
| | Mentions use of Foley catheter insertion for urine output monitoring (>0.5 ml/kg/hour) | |
| | Mentions to continue therapy with target temperature goal to 38 degree Celsius within 30 minutes | |
| | Mentions need for re-assessment of temperature and vitals every 15 minutes | |
| | Mentions to review labs and radiology (if required) | |
| | Correctly decides unit of admission (Ward/HDU/ICU) | |

**STOP TEST**

| **Circle one of below** | |
|---|---|
| **PASS** | **NR (Needs remediation)** |
| **Instructor name** | |
| **Instructor signature** | |
| **Date** | |

Student name: _____ Test date: _____

| HEAT STROKE – Testing station checklist | | |
|---|---|---|
| Skill Set | **Action** | **if done correctly** |
| | Checks for patient's responsiveness | |
| | Measures the patient's temperature appropriately (Mercury thermometer) | |
| | Confirms patient's history of exposure to heated environment | |
| | Makes an accurate assumption of Heat stroke | |
| | Assesses patient's airway and manages accordingly | |
| | Assesses patient's breathing and manages accordingly | |
| | Assesses patient's circulation and manages accordingly. | |
| | States correctly required lab investigations, ECG and radiology (if required) | |
| | Makes a decision to initiate cold IV 0.9 % N/S OR IV bolus if hypotension | |
| | Assesses patient's disability and manages accordingly | |
| | Exposes the patient | |
| | Institutes fanning with wet cloths | |
| | Places ice packs (forehead, neck, axilla, groin) | |
| | Mentions the correct rate for IV fluids (250 – 500 ml bolus) | |
| | Mentions use of Foley catheter insertion for urine output monitoring (>0.5 ml/kg/hour) | |
| | Mentions to continue therapy with target temperature goal to 38 degree Celsius within 30 minutes | |
| | Mentions need for re-assessment of temperature every 15 minutes and vitals every 15 minutes | |
| | Mentions to review labs and radiology (if required) | |
| | Correctly decides unit of admission (Ward/HDU/ICU) | |

**STOP TEST**

| Circle one of below | |
|---|---|
| PASS | **NR (Needs remediation)** |
| Instructor name | |
| Instructor signature | |
| Date | |

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