

# Heat Injury - Guidelines for Treatment and Prevention

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## Abstract

Pakistan lies in the tropical zone, where heat waves are a regular feature. Many precious lives are lost every summer, which can be easily saved. This loss of lives can be prevented by orientation for health care providers and general public along with quick set up of Heat Injury Management Units (HIMU) in time of need. Orientation should be spread through personal communication and effective use of media before and during hot months of country. Literature review was done to determine what efforts have been done and implicated globally to beat the heat. Simple measures are needed to reduce the mortality and morbidity. However it needs firm commitment from local government to provide basic amenities to clean and cool the country and dedication from the health care providers and media to spread the message to general public.

**Keywords:** Heat injury, spectrum, treatment, prevention.

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## Introduction

Pakistan lies in the hot tropical zone except Kashmir and northern areas, which are situated, in cold temperate zone Fig. 1,2. Heat waves are routine in the south and east provinces of country, especially Sindh and Punjab. Adjacent areas of Khyber Pakhtoonkhwa (KPK) and Baluchistan may be involved in case of intense heat waves. Karachi being a sea city has high level of humidity, making the situation worse than rest of the country, Fig. 3, 4. Karachi is the most populous city of Pakistan so the magnitude of the problem is also big; but as human and financial resources are also readily available, with a good management plan heat management plans secondary to climate it can be resolved.

The heat waves claim preventable mortality and morbidity. Actual facts and figures are not available, but cases brought to large hospitals, although tip of an iceberg, are still an eye opener.

There are multiple reasons for these tragedies like illiteracy, ignorance, poverty, malnutrition, electricity load shedding, poor water supply and pollution etc. However all of these problems are manageable through political will, health care dedication and media commitment.

Before the start of season, medical and paramedical staff of emergency, medical and paediatric wards should attend a mandatory Continuing medical education (CME) workshop. General practitioners and administrators of small hospitals should be encouraged to attend this credited course. Easy to follow charts should be available for wards and clinics (Table 2.).

Extensive literature review was done to find out the strategies applied all over the world to combat the hot weather related morbidity and mortality.

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Valuable guidelines were found from American and Saudi<sup>1-3</sup> literature review. These guidelines are translated in Pakistani prospect and applicable and easy to understand and apply recommendation are devised.

### Epidemiology

Precise data is not available as illness are usually under diagnosed and not always reported. Different studies<sup>1-3</sup> showed incidence of 22/100,000. In Kingdom of Saudi Arabia, incidence varies from 22-250/100,000, depending on season, with 50% mortality.

### Physiology

All metabolic processes and kinetic activities of the body generate heat<sup>2</sup>. Body has very fine thermoregulatory system to disseminate extra heat and maintain body temperature at 36-37.8°C/98.6°F Fig.5. This is the optimum temperature for normal metabolic activities. It is important to understand cooling mechanisms of the body, which are the bases of treatment protocols Fig.6.

1. Radiation: transfer of body heat to cool environment; ideal room temperature is 25°C.
2. Conduction: transfer of body heat to a cooler object in contact with body, like wet cloth
3. Convection: transfer of body heat by current of cooler air or water, like fan or water spray
4. Evaporation: body heat converts water into vapor and cools the core temperature, like sweating

**Behavior:** Loose light clothing reflects heat, umbrella or head cover protects from direct sunlight, and good water intake helps in maintaining the normal temperature through sweating and blood pressure as heat is disseminated from blood to skin and then environment. Trees and clean environment decrease pollution and humidity. When humidity exceeds 70%, air is fully saturated so its capacity to decrease the body temperature is diminished. Humidity increases Heat Index - how hot it feels<sup>4</sup>.

### Pathophysiology

Prolonged exposure to extremes of temperature (> 41 °C and < 34 °C) can decompensate or fail body's thermoregulatory mechanisms leading to increased morbidity and mortality<sup>5-10</sup>.

Vulnerability is increased in conditions such as extremes of age, co-morbidities like cardiac failure, health orientation i.e. poor knowledge and commitment of people and health care providers respectively. Lack of facilities at home or hospital, like water and electricity supply

Children are more vulnerable because they have blunt thirst response, produce more heat per kilogram of body weight, sweat at a lower rate, need higher temperature to sweat acclimatize slowly to warm and humid climate.

Spectrum of heat illness varies from mild to severe Fig. 7.

**Prickly heat:** is a common mild illness. Sweat gland ducts are blocked due to poor personal hygiene in hot and humid environment. Patient suffers from itchy red rash.

**Heat edema:** is a rare and mild illness. There is edema of hands and feet due to vasodilation in an effort to disseminate heat. Reason being poor acclimatization to hot weather.

**Heat cramps:** is a common mild illness. Reason is mild dehydration and salt depletion. Patient presents after physical activity in hot weather with cramps especially in arms and legs muscles.

**Heat tetany:** is a mild disease caused by heat related hyperventilation. Patient presents with carpo-pedal tingling or spasm.

**Heat syncope:** this is a moderate disease. Patient faints after prolonged physical exercise in hot weather. Reason is depletion of fluid and electrolytes and poor vasomotor tone leading to hypovolemic hypotension.

**Heat exhaustion:** is also a moderate illness. Characteristic features include core body tempera-

ture, 100-103°F/37.7-39.4°C, heavy sweating, nausea, vomiting, headache, dizziness, fainting, fast and weak pulse, dilated pupil, poor performance, none or mild CNS dysfunction

**Heat stroke:** is the severe disease. It is a medical emergency. Elderly people, children and chronically ill patients are more vulnerable due to poor regulatory mechanisms of the body. Characteristic features include core body temperature > 104°F/40°C, hot, red and dry skin, no sweating CNS dysfunction and poor performance, constricted pupils, end organ damage affects heart, brain, kidneys and muscles rapid and strong pulse and fatal if not treated promptly, mortality may reach up to 50%.

#### **Differential diagnosis and justified investigations for heat stroke.**

Good history and quick physical examination is warranted to rule out common simulating diseases, which need different management. Differential diagnosis include meningitis, cerebral malaria, sepsis and thyroid storm. Investigations include complete blood count, malaria parasite, prothrombin time, activated partial thromboplastin time, creatinine phosphokinase, cerebrospinal fluid, liver function test, urea creatinine electrolytes, arterial blood gas, chest X ray and electrocardiogram.

#### **Management**

Early recognition and categorization of the severity is important because management depends on it. Table 2, gives salient features of guidelines<sup>11-19</sup>.

#### **Special paediatric situations**

There are two special situations, regarding children, worth mentioning in the scenario of hot waves in Pakistan i.e. child locked in car and Ramzan fasting.

Car in a summer month can get dangerously hot within 10 minutes. Car temperature can rise 20°F above the environment even if windows are

open and it is parked in the shade. This can lead to permanent disability like blindness or death.

Fasting is a common practice in Pakistan and other Muslim countries especially during the month of Ramadan. It has proven medical benefits in terms of re-conditioning and acclimatizing of the body. Children should be allowed to fast when they are physically and mentally mature. However they need supervision for their diet, fluid intake and rest. Points to remember while preparing Ramadan meals for children is shown in (Table 1). Children have a small stomach, so they should eat energy rich food, especially at sehri. Their thirst response is blunt, so they should be encouraged to drink enough at sehri, iftari and after iftari. Good urine output is a simple indicator of hydration. Children should take rest especially during hot noon hours. Gentle exercise in cool hours, like taraweeh (During the month of Ramadan, Muslims conduct special prayers each night, called taraweeh prayers, during which long portions of the Qur'an are recited), improves the stamina.

#### **Discussion**

Most of the Pakistan lies in the hot tropical zone, where heat waves are common occurrences. Unfortunately it claims loss of many precious lives. Statistics available may be a tip of iceberg and actual figures may be much high. Prevention and treatment do not need much in term of medication or equipment. Dissemination of knowledge is the most important strategy, which needs firm commitment and dedication from government and health care providers.

High mortality is due to many factors including general malnutrition, due to poor body stores and resistance, body cannot acclimatize itself with harsh weather, both hot and cold, illiteracy-especially low female literacy rate-makes implementation of even simple health care measures difficult, power poverty periodic electricity failures and shortages are responsible for poor cooling strategies like water, fan and air conditioners. Water deprivation leads to a high mortality in the summer months.

Water is the most important factor for cooling. It is daily used for drinking, cooking, washing, cleaning and plantation etc. Pollution adds to humidity and spread of diseases. Co-morbidities and high humidity increase heat related mortality<sup>3-5,7</sup>. Poor health facilities due to lack of health care providers and hospitals not ready to deal with upcoming expected climatic disaster lead to increased morbidity and mortality of both children and adults during the hot summer months.

Reasons for these confounding factors include poor political priority, government has resources and authorities which if utilized can achieve the required goal. Government is responsible for providing basic necessities of life like water, gas, electricity, food, education, health and security etc. Insufficient health care facilities such as public and private health care provider should get appropriate short courses and drills regarding prevention and management of heat illnesses before the hot season. Similarly clinics and hospitals should have dedicated 'Heat stroke units'. Inappropriate media coverage especially electronic media is stirring panic rather than focusing on facilities available in the city and public education.

**Heat Injury Management Unit (HIMU):** All large public and private hospitals should have facility to set up HIMU at short notice. Trained staff can triage patients quickly - patients can go home with advice, if need be, can have a short stay in observation or can be admitted in Heat Stroke Unit (HSU). HSU consists of two rooms, one is the cooling room, Fig. 9,10. Room temperature is maintained around 25°C. Two oscillatory wall fans are used to supply a horizontal current of air directed towards the bed at 30-40. One exhaust or suction fan at a higher level on the wall is used to remove humid air. There is a steel bed without mattress with a drain pipe. A source of tap water is used to spray the water on patient. The second is the observation room. Once patient's temperature is down to 101-102°F, patient is shifted in observation room. Patient is monitored for vital signs and complications. If patient develops any complication he or she is shifted to Intensive Care

Unit (ICU). Otherwise patient is kept for 24 hours and the discharged.

### Prevention and Recommendation

In Pakistan heat waves are expected in summer months. Health care providers should emphasize on the prevention. Messages should start going aerial at the beginning of season. Alerts and recommendations should be broadcasted at prime time. Easy to understand picture charts should be pasted in all health care facilities.

Comfortable temperature is 25°C. Try to maintain this temperature at home, school and work. Physical work should be re-scheduled for lesser hours and in morning and evening; avoid physical exertion from 10 am till 3 pm. Take frequent breaks for rest and water drinking. There should be free access to clean drinking water. Children should be encouraged to drink water and other healthy drinks. Home-made, freshly prepared lemonade, salt-sweet lassi and juicy fruit cuts help to restore fluid, electrolyte and mineral balance, which are heavily lost in sweat. These are good rescue fluids, which help to repair damage as well. Yoghurt, lassi, lemonade, cucumber and melon are easily available in hot weather. Use light and loose cotton clothing; light colors reflect heat away from the body; naked body absorbs heat so body should be covered properly. Use fans to move the air. Water bed can be used instead of foam mattress; it is cooler and comfortable. Exhaust fan can actively remove hot and humid air from the room. Similarly umbrella, head cover, hat or sunglasses should be used for protection.

Pollution not only spreads diseases but also increases humidity. High humidity interferes with sweat related cooling mechanism of the body. Hence, encourage leafy trees near the house; they provide fresh air and shade. Grape, olive, marrow and kiwi plants can cool the walls. Room windows can be tinted like car; they should be closed during day and opened at night. Try to have a 'Patio' - a sitting open but shaded place away from direct sun light - north or south open. Always switch off un-necessary lights, televi-



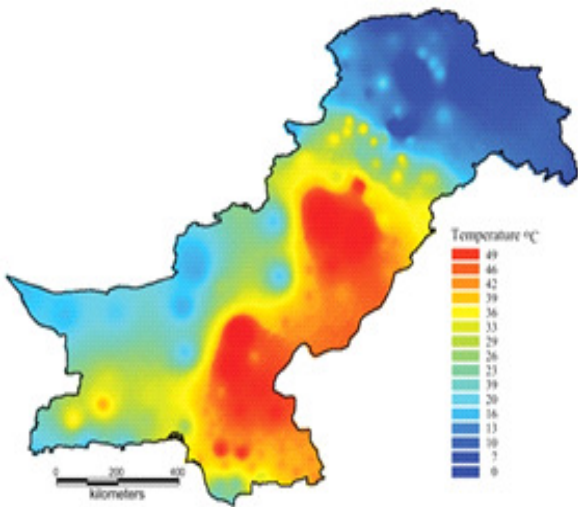


Fig. 1. Climatology of Pakistan<sup>16</sup>

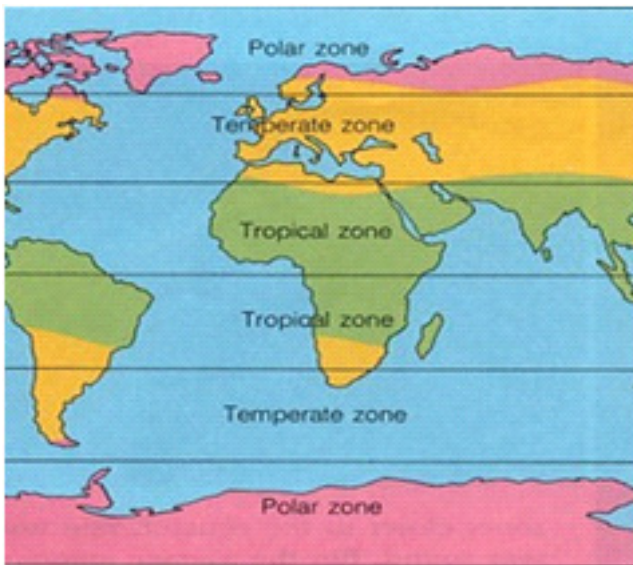
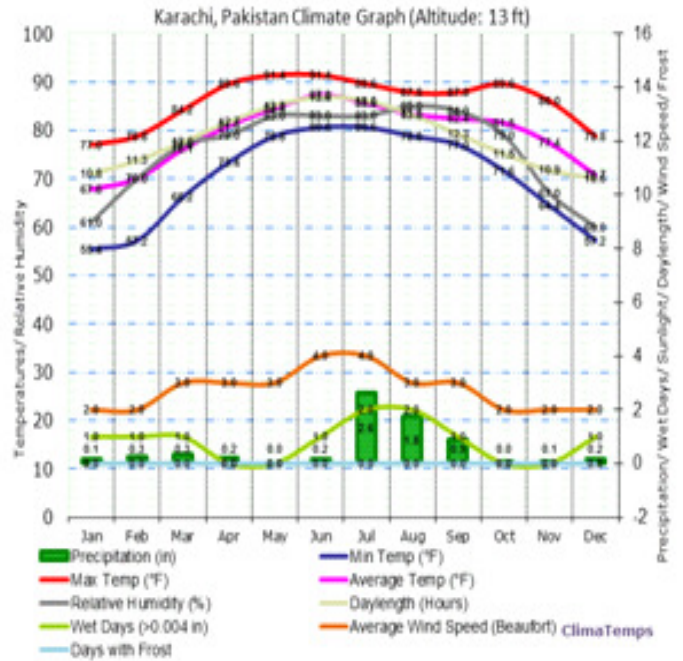
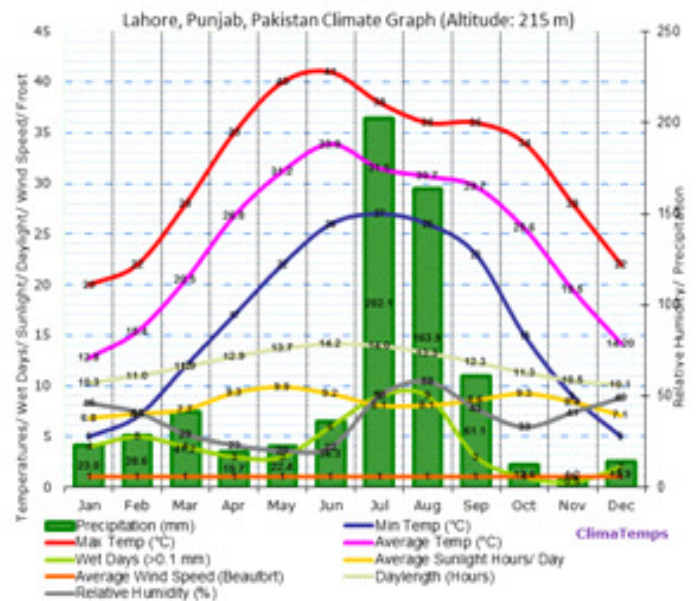


Fig. 2. World climate zones<sup>17</sup>



Note: high humidity

Fig. 3. Climate of Karachi<sup>18</sup>



Note: low humidity

Fig. 4. Climate of Lahore<sup>19</sup>

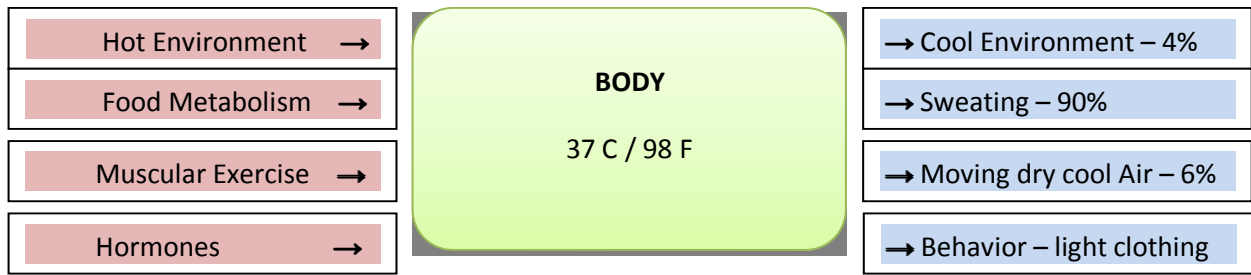


Fig. 5. Body's heat dynamics<sup>2</sup>

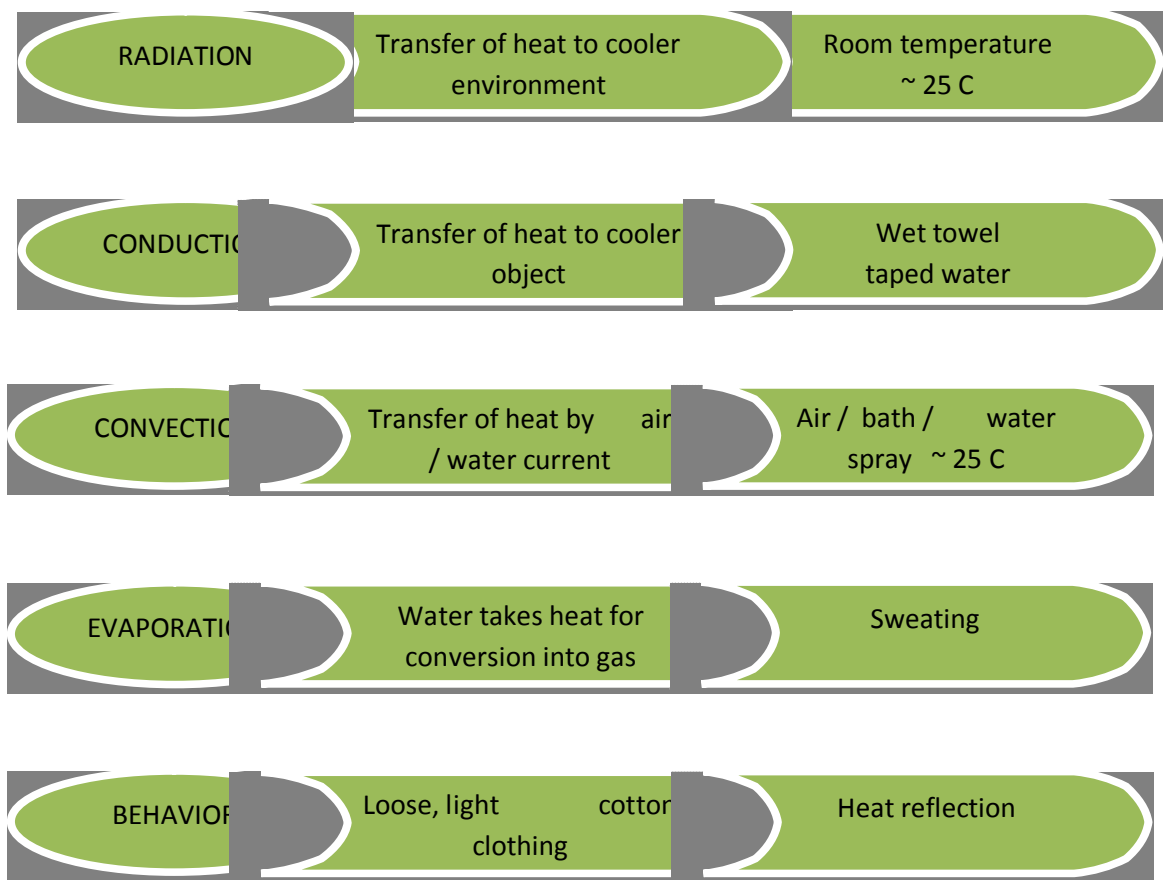


Fig. 6. Cooling strategies<sup>2</sup>

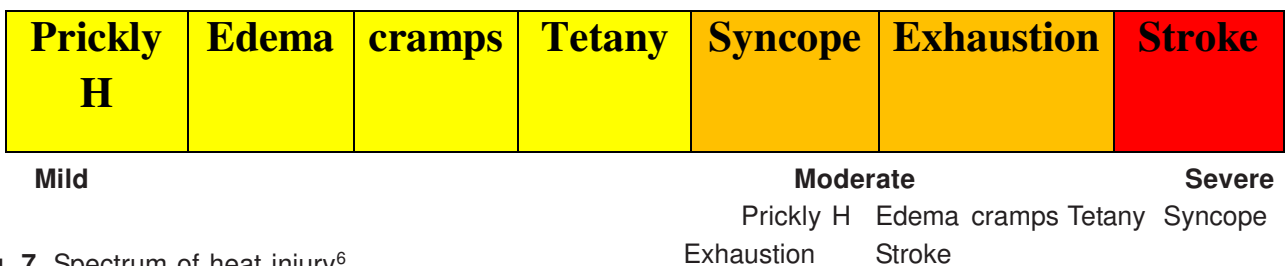


Fig. 7. Spectrum of heat injury<sup>6</sup>

Temperature	85 F / 29.4 C	95 F / 35 C
Humidity	30%	60%



Fig. 8. Heat Equation<sup>6,20</sup>

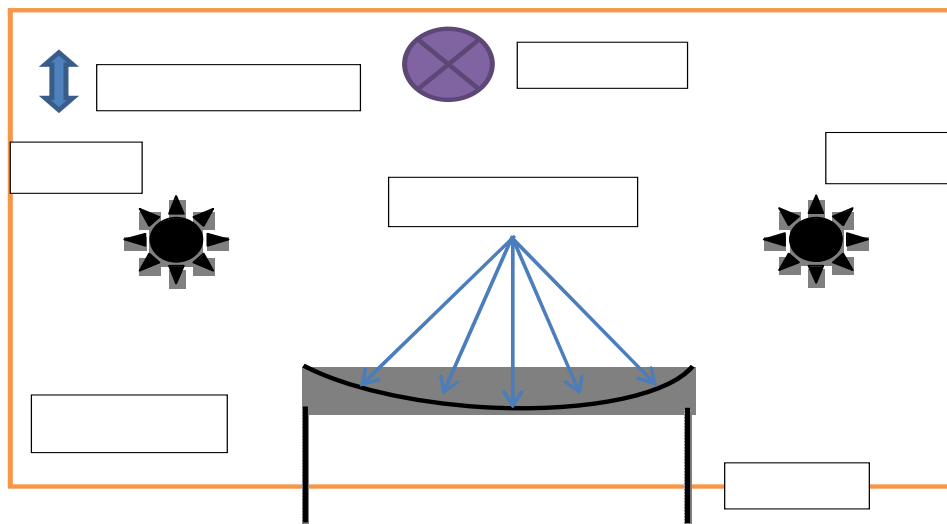
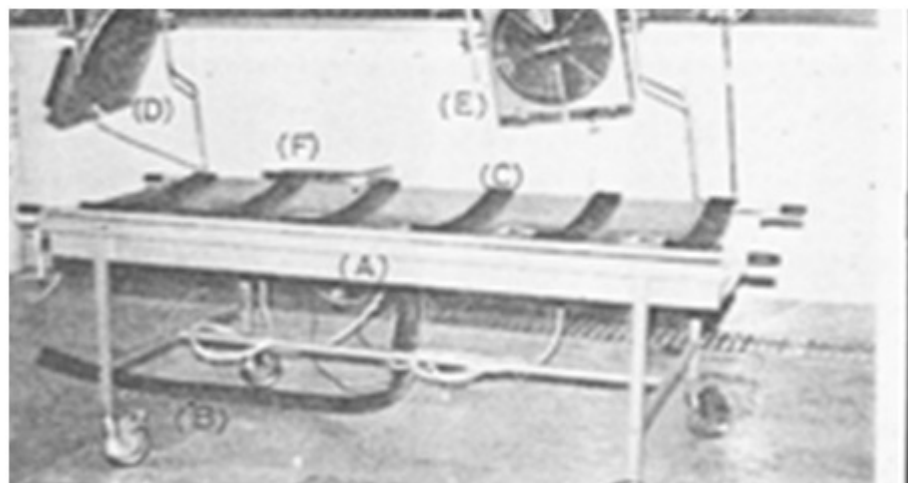


Fig. 9. Cooling unit blue print<sup>17</sup>



King Saud University cooling bed

(A) Stainless steel pan (B) drain pipe (C) rubber stripes fixed on steel stretcher (D, E) electric fans adjustable in three directions (F) panel for aperture probes, and single electricity outlet for whole unit.

Fig. 10. Cooling bed used at King Saud University Hospital, KSA<sup>17</sup>

Hospitals should be ready to deal with heat emergency. Staff should be well rehearsed and alert. All hospitals should have a two room unit 'Heat stroke unit' ; a cooling room with cooling facilities and an observation room Fig 9, 10. If child is in the car: look before locking the car; if a child is missing never forget to check the car. During fasting: one should take care of food, fluid and rest (Table1).

## Summary

Hot day rules include that each person should be well hydrated; encourage liberal use of water, lemonade, lassi and fresh juicy fruits. Put on loose, light coloured cotton cloths; use umbrella and head cover. Stay in cool, shaded and arid place. Avoid physical work in peak hot hours i.e. 10 am to 3 pm. One should Exercise regularly to acclimatize oneself. During and after exercise sample amount of fluid should be taken,

Medical advice is to be sought at the first sign of sickness like cramps, light headedness etc. Fasting should only be encouraged when child is physically and mentally mature. Ramadan conditions and acclimatizes body for all seasons as it rotates through the year. Care of children's eating manual and rest. Before locking the car check the number of children sitting inside. Firm commitment is needed from all the stakeholders - government, health care providers and general public.

This review article is written to re-orientate health care providers so they can educate the general public and save lives through simple measures.

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