Heat Stroke and Heat Exhaustion Seminar

Edited Report from F4, A10, and B10 submissions

Community Medicine course (COMM 311)
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Objective 1: Define and classify heat stress and its types (heatstroke, heat exhaustion)

Heat stress is an illness that can be caused by exposure to extreme heat. It occurs when the body is unable to maintain a healthy temperature in response to a hot environment[1].

Types of heat stress[2]:

- Heat rash and heat cramps are mild types of heat illness.
    - Heat rash is a mild skin irritation caused by heavy sweating.
    - Heat cramps usually develop in muscles being used during the activity. Cramps are caused by the loss of body salts and fluid through heavy sweating and high effort. When a muscle has a low salt level, it cramps.

- **Heat exhaustion and heat stroke are serious types of heat illness.**
    - **Heat exhaustion** is the body's general reaction to losing salt and fluid through heavy sweating.
    - **Heat stroke** usually occurs in very high heat, high humidity conditions. However, heat stroke can also occur in mild to moderately hot temperature if the humidity is high (in other words if the heat index – the "feels like" temperature – is high). Sweat cannot evaporate as quickly as usual, so the body cannot release heat to cool itself. Sweating stops and the body temperature goes up quickly.

There are two types of heatstroke: exertional and non-exertional[3].
Non-exertional heatstroke occurs in those who cannot adapt well to increasingly hot temperatures. Older adults, people with chronic illnesses, and infants are often affected. Exertional heatstroke occurs in people whose bodies can no longer adapt to rising temperatures while exercising or working. This condition can develop within a few hours, and it usually affects people who are spending time outdoors.

Objective 2: Define the clinical presentation of each (symptoms, signs, complications, and investigations)

Heat exhaustion is caused by exposure to high temperatures, particularly when combined with high humidity, and strenuous physical activity. Symptoms may include heavy sweating and a rapid pulse as a result of body overheating. Without prompt treatment, heat exhaustion can lead to heatstroke, a life-threatening condition. Fortunately, heat exhaustion is preventable[4].

Signs and symptoms of heat exhaustion[4]:

- Cool, moist skin with goosebumps when in the heat
- Heavy sweating
- Faintness
- Dizziness
- Fatigue
- Weak, rapid pulse
- Low blood pressure upon standing
- Muscle cramps
- Nausea
- Headache

Complications[5] :

- Heatstroke

Investigations[6]:

- Blood tests: Hypokalemia and hypophosphatemia
- Urine test: ↑ Creatinine

Heatstroke is defined as hyperthermia exceeding 40°C associated with an altered sensorium. The temperature criterion relative because when a patient is allowed to cool down before measurement of the temperature like in a cool ambulance or evaluation in an emergency department, the measured temperature may be lower than 41°C. A high index of suspicion is needed to avoid delays in diagnosis and treatment since there's variable presentations[7].

Signs and symptoms of heat stroke[8]:

- High body temperature. A core body temperature of 104 F (40 C) or higher, obtained with a rectal thermometer, is the main sign of heatstroke
- Altered mental state or behavior. Confusion, agitation, slurred speech, irritability, delirium, seizures, and coma can all result from heatstroke
- Alteration in sweating. In heat strokes brought on by hot weather, the skin will feel hot and dry to the touch. However, in a heatstroke brought on by strenuous exercise, the skin may feel dry or slightly moist
- Racing heart rate, because heat stress places a tremendous burden on your heart to help cool your body
- Flushed skin
- Nausea and vomiting
- Rapid shallow breathing
- Throbbing headache

Complications[9]:

- Acute renal failure
- Rhabdomyolysis
- Arrhythmia
- Acute Respiratory Distress Syndrome (ARDS)
- Coagulation disturbances: thrombocytopenia, DIC
- Coma

Investigations[9, 10]:

- Core temperature measurement (≥40°C)
- Blood tests: Hypokalemia, hypophosphatemia, ↑CK, prolonged PT, respiratory alkalosis and lactic acidosis
- Urine test: Myoglobinuria
- Imaging: Acute pulmonary edema

Objective 3: Describe the public health importance of heatstroke and heat exhaustion (morbidity, mortality, and cost-effectiveness)

Epidemiology (morbidity, mortality, economic loss):

The trends of the disaster between 1998 and 2017, was summarized and graded by The Center for Research on the Epidemiology of Disasters (CRED). Extreme heat was found to be the fourth most common disaster to occur. The number of people affected was 97 million, and 166,346 of those had died because of it. This resulted in an economic loss which was estimated to be 61 billion dollars[11].

The climate change trends were observed by the Intergovernmental Panel on Climate Change (IPCC). It was predicted that the annual increase in temperature would be around 4°C, on average, and with an increase in the number, duration, and intensity of heat waves[12].

Direct and Indirect Impact of excessive heat on public health[13]:

This results in cumulative physiological stress on human body mechanisms that regulate its temperature. This also would lead to an exacerbation in the top causes of morbidity and mortality, including cardiovascular and respiratory diseases, diabetes mellitus, and renal diseases in the vulnerable population (the elderly, infant and children, pregnant women, outdoor and manual workers, athletes, and the poor).

The other important indirect effects of heat conditions are that it can alter human behavior (increase the risk of accidents), the transmission of diseases, health service delivery (increase ambulance call-outs and hospital administrations), air quality, and critical social infrastructures such as energy, transport, and water.

According to International Labour Organization[14.1], an increase in heat stress at work linked to climate change is set to have a massive impact on global productivity and economic losses, notably in agriculture and construction sectors. The agriculture sector will be the worst affected globally. Moreover, the construction sector will also be severely impacted with an estimated 19% of global working hours lost by 2030. The impact will be unequally distributed around the world. The regions losing the most working hours are expected to be southern Asia and western Africa. The economic losses due to heat stress at work were estimated at US$280 billion in 1995 and estimated to increase to US$2,400 billion in 2030.

Objective 4: Explain the distribution (place, person, time) in the global, regional, and local contexts, including the incidence rate during Hajj.

Global (place, person, time):

Climate change is causing increased temperatures around the globe. Extreme heat-related events are observed to be increasing in their frequency, duration, and magnitude, as a result, the number of people exposed to heat waves has gone up by approximately 125 million between the years 2000 and 2016[14.2].

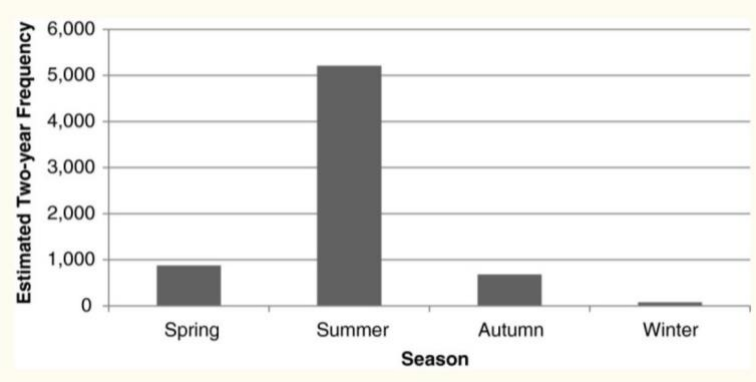
Regarding the global distribution of heat strokes, they are uncommon in subtropical climates. As a result, they are rare in countries such as Japan but common in Saudi Arabia, commonly affecting people who perform pilgrimage in Mecca[15].

According to a study done in the US which involved findings from 20 states, from 2001 to 2010, about 28,000 hospitalizations due to heat-related conditions were recorded, with an annual rate of 1.8 cases per 100,000 people[16].

With the same risk factors and under the same environmental conditions, heatstroke affects both sexes and all races equally. However, because of lifestyle and social disparities, the annual incidence rate from heatstroke is higher in men than in women (1.99 per 100,000)[17] (because males are more likely to work outside and in hot conditions), and it is higher among blacks than in whites due to social advantages such as the availability of central air conditioning and cooler public spaces[18].

Infants, children, and elderly persons have a higher incidence of heatstroke than young, healthy adults. In a nationwide US study that analyzed ED visits for heat strokes in 2009-2010, adults aged 80+ proved to have the highest incidence (4.45 per 100,000 population) compared to younger demographics, for example, 20-29-year-olds had an incidence of 1.15 per 100,000 population study [17]. In terms of location, it was found that higher incidence rates for heat strokes was in residents living in the southern region (1.61 per 100,000). [17]

Heatstroke and deaths from excessive heat exposure are most common during summers with prolonged heat waves. In the United States, the table below summarizes the occurrence of heat-related illness in 2009-2010. It shows that the majority (63.1%) of ED visits occurred in the summer months of June, July, and August [17].



Saudi Arabia (place, person, time):

The graph below shows the expected temperatures in Makkah during Hajj from 2009-2028, which are predicted to range between 45 - 55 degrees celsius[19].

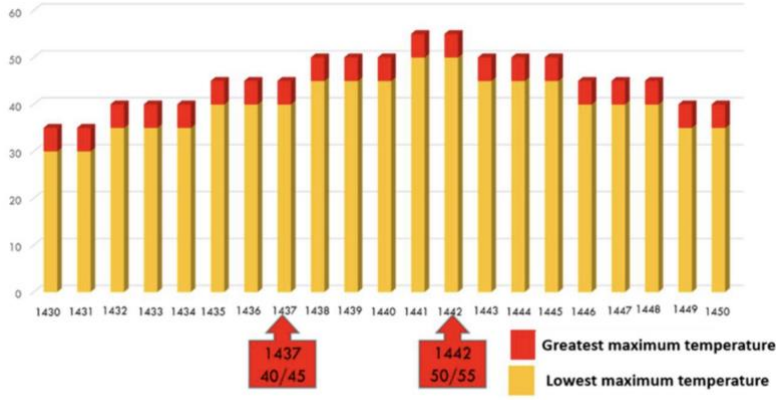


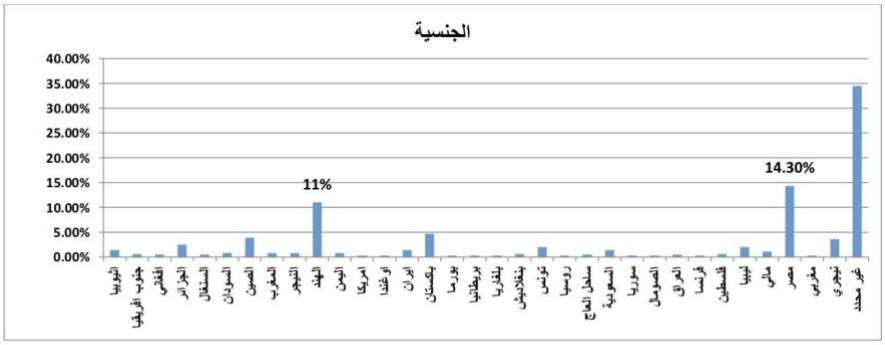
Figure 1: The expected maximum temperature in Makkah during Hajj from 1430 to 1450

Heat-related illnesses during Hajj are not uncommon. In the 2015 Hajj season, heat strokes and heat exhaustion contributed to 24% of hospital admissions[19]. The table below also summarizes the rates of heat strokes and exhaustion during Hajj 1980-1985, in which the incidence increases progressively each year from 22 (in 1980) to 250 (in 1985) cases per 100,000[20].

Year	Date†	No. of pilgrims	Heat stroke		Heat exhaustion	
			Cases	Rate/100,000	Cases	Rate/100,000
1400H (1980)	19 October	813,000	176	22	NA	---
1401H (1981)	8 October	479,000	258	54	NA	---
1402H (1982)	27 September	854,000	1,119	131	5,595	655
1403H (1983)	16 September	1,005,000	1,365	136	5,950	592
1404H (1984)	5 September	920,000	1,058	115	4,337	472
1405H (1985)	25 August	852,000	2,134	251	15,560	1,826

* Source: Haj Report, 1985. General Directorate of Health Affairs, Western Region, Ministry of Health, Kingdom of Saudi Arabia.
† Gregorian date corresponding to 10 Dhu Al-Hijah, on which the main event of Haj occurs.

In contrast to the US study mentioned above, Saudi registries found that among pilgrims of different races and nationalities, Egyptians and Indians were the two most affected by heat strokes[21].



شكل (١١) : الإصابات الحرارية بين الجنسيات.

The table below depicts the direct correlation between rising temperatures and the number of cases of heat strokes and heat exhaustion in the years 2005 - 2015[21].

الموسم	إجهاد الحراري	ضربات الشمس	الإصابات الحرارية	أعلى قيمة درجة حرارة	أعلى متوسط رطوبة	أعلى قيمة سرعة رياح كم/س
١٤٢٥هـ	٤	-	٤	٣٠.٦٢	٩٨.٩	١٥.٩٥٨٨
١٤٢٦هـ	٧٦	-	٧٦	٣٢.٥٩	٩٢	١٢.٧٥٨٤
١٤٢٧هـ	٨	-	٨	٣١.٢	٨٠.٩	١٣.٠٠٣٢
١٤٢٨هـ	٢٨	-	٢٨	٣٢.١٩	٨٣.٩	١٠.٨
١٤٢٩هـ	٢٦	-	٢٦	٣٤.٥٣	٨٥.٩	١٣.٣٠٢
١٤٣٠هـ	٥	-	٥	٣٣.٥١	١٠٠	١٣.٩٦٨
١٤٣١هـ	٨٠	٥	٨٥	٣٧.٣٥	٨٦.٤	١٠.٢٠٩٦
١٤٣٢هـ	١	-	١	٣٥.٧٩	٨٠.٧	١٢.٨٦٢٨
١٤٣٣هـ	٣١	-	٣١	٣٩.٠٤	٨٤.٧	١٠.٠٣٦٨
١٤٣٤هـ	١٢٧	-	١٢٧	٤١.١٥	٧٦.١	١٤.٠٤
١٤٣٥هـ	٢٢٥	٦	٢٣١	٤١.٥٨	٧٦.٤٢	١٢.٣٥٥٢
١٤٣٦هـ	١٠١٤	٧٢٣	١٧٣٧	٤٦.٤٧	٢٥.١٦	١٢.٦٢٥٢

Objective 5: Explain the determinants (risk factors) of heat stress and its types

Although anyone at any time can suffer from heat-related illness, some people are at greater risk than others[22]:

- **Infants and young children** cannot sweat, which is the body's way of cooling itself off, thus they can often suffer heatstroke much quicker than an older child or adult.
- **People 65 years of age or older** because the aging body decreases its capacity to adapt to changes in body temperature.
- **People who are overweight** are carrying an excess weight which can affect your body's ability to regulate its temperature and cause your body to retain more heat.
- **People who overexert during work or exercise**
- **People who are physically ill** especially with heart disease, high blood pressure, or who take certain medications, such as diuretics (which cause dehydration and electrolyte depletion), beta-blockers (which reduce skin blood flow), and antidepressants (which increase heat production).
- **People with disability**
- **Outside workers** in hot environments such as firefighters, farmers, construction workers, miners, boiler room workers, factory workers.
- **Pilgrim at hajj** particularly in summer.
- **People who live in urban areas** considering the combined effect of urban growth and climate change.
- **People who have sunburn** causing significantly slow skin ability to release excess heat.

Types of heat stroke[23]:

- **Classic heatstroke (non-exertional)**: is more commonly seen in infants, children, and the elderly. It develops over days during the environmental heat waves and is more common in areas that do not typically experience periods of prolonged hot weather.
- **Exertional heat stroke:** usually develops rapidly in a young, vigorously exercising individual who has not acclimatized to a hot environment. A dramatic presentation is seen with central nervous system changes ranging from severe headache to seizures and collapse. Rhabdomyolysis and disseminated intravascular coagulation are often prominent.

Objective 6: Explain preventive (1ry, 2ry, 3ry) and control (treatment) measures, including the MOH device for Hajjis with heat stroke

Primary prevention[24]:

- **Drink plenty of fluids:** rehydration is best with water and not carbonated drinks. Avoid alcohol and caffeinated drinks during exercise as it increases your risk of hyperthermia.
- **Replace Salt and Minerals:** Heavy sweating removes salt and minerals from the body that need to be replaced. A sports drink can replace the salt and minerals you lose in sweat.
- **Avoiding exercising/ strenuous outdoor activities** in the heat and schedule outdoor activities carefully, try to restrict your outdoor activities to cooler parts of the day (in the mornings and evenings).
- **Acclimatization:** it takes weeks to acclimatize to a hotter climate. During acclimatization, the body becomes more efficient in work productivity as well as heat dissipation through various mechanisms, including several changes to sweat rate, volume, and composition.
- **Wear appropriate clothing:** choose lightweight, light-colored, loose-fitting clothing.
- **Protect yourself outside** by using sunscreen as sunburn limits the body's ability to cope with the heat and use sunglasses and an umbrella.
- **Keep cool indoors** with curtains, shutters, or awnings on the sunny sides and leave windows open at night.
- **Do not leave children alone in parked cars** Indoor temperature in cars can rapidly rise. This is a common cause of heat-related deaths in children.
- **Check for Updates:** Check your local news for extreme heat alerts and safety tips and to learn about any cooling shelters in your area.
- **Awareness** among the public about the dos and don'ts regarding heat-related health events would be created through print and audio-visual media at the beginning of the summer season.

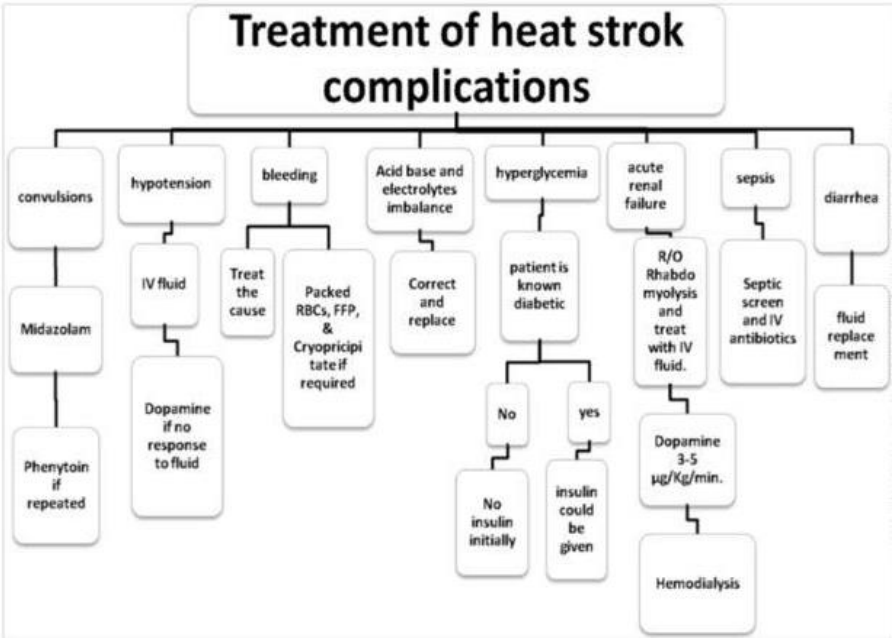
Secondary Prevention[24/25]:

- **Know how to early monitor those at high risk** by visiting them regularly and closely watch them for early signs of heat exhaustion or heat stroke.
- **Know how to manage such a person** with heat-related illness by checking the algorithm for treatment and management.

- **Trained human resource**: the doctors and nurses of the emergency departments and the ambulance paramedics of the concerned cities/rural districts would be trained in the identification of early warning signs and clinical management of heat-related illnesses.

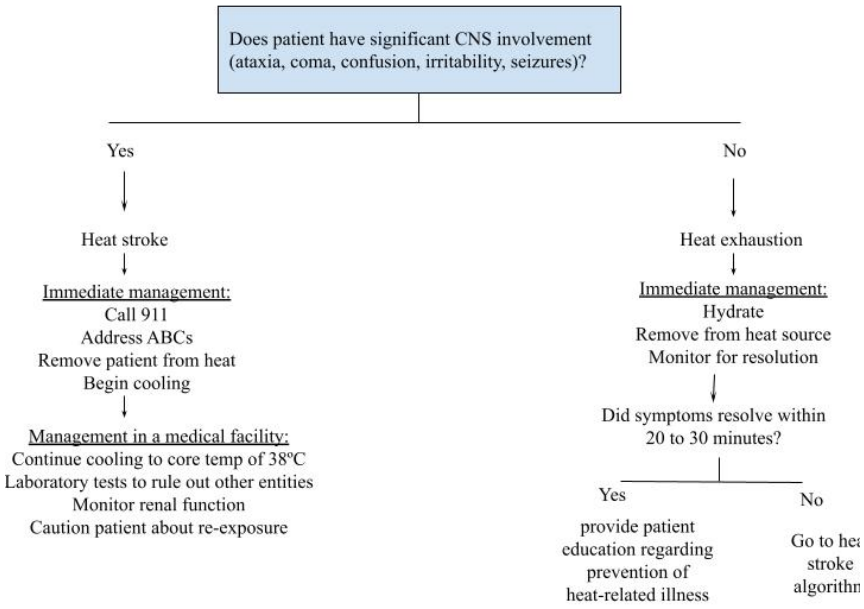
Tertiary Prevention[26]:

- If the heat-related illnesses lasted for long they should be managed in a medical facility, following the treatment algorithm below**.**



- **Bleeding**: replacement of lost blood with packed RBCs and clotting factors with fresh frozen plasma and platelets, cryoprecipitate and fibrinogen may be necessary.
- **Acute renal failure:** renal function studies and serum electrolytes concentrations should be followed closely over the first few days of illness, renal replacement therapy (CRRT/Hemodialysis) for overload, may be needed as indicated, correction of acidosis and electrolyte imbalance.
- **Hepatic injury:** avoid the hepatotoxic drug.
- **Sepsis**: In cases where the etiology of the patient's hyperthermia is unclear initially and infection remains a possibility, empiric administration of an initial dose of antibiotics, following collection of appropriate cultures, is prudent, while cooling measures are implemented.

Treatment of heat-related illnesses[27]**:**



What is the MOH device for Hajjis with heatstroke?

- MOH has developed evidence-based guidelines for heat-related illnesses that have been disseminated among all health providers to unify the practice[28].
- MOH has held training courses and workshops for staff in health facilities to enable them to handle heat exhaustion and sunstroke cases, and means of transporting them[29].
- MOH had developed an awareness program to educate both local and foreign pilgrims on how to deal with heat-related illnesses[28/29].
- MOH has constructed a Heat Illnesses Command and Control Center (HICCC) to be responsible for the following[30]:
    - Ensuring that prevention and preparedness approach is adopted by all health agencies serving during Hajj.
    - Revising plans on heat-related illness overall control through current evidence-based medicine.
    - Conducting researches designed to study new measures for the prevention and management of heat-related illnesses annually.
    - Issuing alerts in advance of an extreme heat event.
- The executive committee of MOH has ensured the readiness of hospitals and primary health centers to operate with the best infrastructure status including[30]:
    - Improving heat stroke units
    - Availability of cooling resources
    - Provision of spraying fans, as they have proven effective in reducing the temperature, and heat exhaustion, and sunstroke cases

- Adequately equipped emergency departments

Objective 7: Recall the Ministry of Labor regulations regarding heat stroke31.

It is no secret that the middle east faces a serious increase in temperature during several months of summer. Hence, a ministerial decree (ministerial decree number 3337) was released in 2014 to limit the work hours under the sun as follows: "A worker may not work in exposed sites under direct sunlight from 12:00 pm until 3:00 pm every day starting from the 15th of June till the end of the 15th of September every year".

This provision is part and parcel of the Ministerial Decree no. (1/1559) dated 22/6/1431H. The Deputy of Labor Minister shall take the required measures to broadcast and implement this decree.

An exception to this provision are workers in gas and petroleum companies and workers in emergency maintenance departments. In such cases, employers shall take the necessary precautions to protect their workers from the harms of direct sunlight. Another exception to this provision are a number of governorates in parts of the Kingdom where temperatures are low enough to a degree that does not require the above-mentioned working-hours suspension. In such case, the Ministry shall coordinate with the Principalities to determine the extent to which this provision can be implemented, each within their respective provinces.

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