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PRACTICE POINTER

Heat illnesses in clinical practice

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What you need to know

- Increased frequency and intensity of heatwaves are leading to greater incidence of heat illness and exacerbations of heat sensitive disease (eg, cardiac, respiratory, renal, and mental health conditions) globally
- People over 65, pregnant women, infants, young children, athletes, outdoor workers, those living in urban environments, patients with comorbidities, and those on certain medications are particularly at risk of heat related illness
- The foundations of managing heat illnesses include recognising heat as a cause, removing patients from hot environments, and rapid cooling

Case studies

A 14 year old boy is brought by his family to the emergency department after collapsing on the field during a high school football practice. The region has been under a heatwave alert for the past three days, with daytime temperatures reaching 40°C and night time low temperatures of 32°C. The boy's coach saw him struggling during running exercises, then collapse, and have seizure like activity. The boy's mother says he has no underlying medical conditions and was feeling well before the practice. On arrival at hospital, his heart rate is 145 beats/min, blood pressure 100/60 mm Hg, and his rectal temperature is 40°C. He is breathing spontaneously and responding to painful stimuli. Heat stroke is identified immediately. The patient is intubated for airway protection, sedated with benzodiazepines, and rapidly cooled with cold water immersion and chilled IV fluids. His temperature comes down to 37.5°C within 30 minutes. On hospital day 1, he is found to have an acute kidney injury and a mild liver injury, which rapidly improve by day 2. On day 3, he is extubated and has an excellent neurological recovery.

A 55 year old woman who works as a store clerk is brought to hospital because she appears confused. She has schizoaffective disorder which has been well managed on clozapine. There is a heatwave in the region, and the patient has no access to air conditioning at work or at home. She has been taking diphenhydramine at night to help with difficulty sleeping. On physical examination, her heart rate is 100 beats/min, blood pressure 150/100 mm Hg, and her core temperature 39°C. Her skin is dry and flushed and she is confused. Diagnosis of her condition is delayed because she is first treated for sepsis, and then for stroke. Three hours into her clinical course, with worsening agitation and a further decline in her mental status, the diagnosis of classic heat stroke is made, and presumed to be precipitated by medication use and lack of access to a cool environment. At this point she is rapidly cooled further, and her mental status gradually improves.

More than one third of global warm season heat related deaths are now attributable to climate change.[1] Most of the world is expected to encounter periods of unprecedented temperatures approximately every other year by the middle of this century, with permanent exceedance of unprecedented heat conditions in the latter part of the century.[2] Heat exposure poses acute health hazards to individuals and communities globally, threatens the functioning of health systems,[3] and disproportionately impacts lower income households and people of ethnic minorities.[4] These impacts and inequalities are expected to increase as the climate warms further.[5] In addition to adapting their practice to changing temperatures, healthcare providers need to make healthcare systems more prepared for these changes, and reduce emissions from the health sector, which globally contributes nearly 5% of all greenhouse gas emissions.[3 6] This article offers an approach to the recognition, treatment, and prevention of common heat related illnesses.

How does heat affect health?

The past seven years have been the hottest on record.[7] Recent heatwaves can be attributed to climate change,[8] including events in Europe (2003),[9] Japan (2018),[10] the Pacific Northwest (2021),[11] and India (2022).[12] Globally, in the past 20 years, heat related mortality among people over 65 has increased by 53.7%.[13] While vulnerabilities to heat related illness have risen globally, countries that have a low to middle Human Development Index (HDI) have seen greater increases in vulnerability than those with a high HDI.[7]

Heat stroke is the most evident manifestation of heat illness, but more concerning is that heat exposure can exacerbate existing long term conditions, including cardiovascular, pulmonary, and renal disease, and mental illnesses. Heatwaves (box 1) and even small increases in average temperature are often followed by surges in all-cause morbidity and mortality.[18] These effects are often excluded from traditional analyses of heat impact, yet likely contribute to the bulk of heat related morbidity and mortality. Furthermore, emerging evidence suggests that, at least in some regions, most deaths owing to heat may occur outside declared heatwaves. For example, the evaluation of the Heatwave Plan for England concluded that more than 90% of heat related deaths in many parts of the country occurred during periods when no heatwave alert had been declared.[19]

Box 1: What is a heatwave?

A heatwave is a period of unusually hot weather, often accompanied by excessive humidity and typically lasting two or more days.[14] The temperatures must be outside the historical averages for a given area. Classifications vary by country and are defined relative to a geographical region.

- UK—A heatwave threshold is met when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. The threshold varies by UK county.[15]
- India—A heatwave is declared when temperatures exceed 40°C for plains and 30°C for hilly regions, with a daily average exceeding 45°C constituting a severe heatwave.[16]
- South East Asia—A heatwave is declared when the daily maximum temperature exceeds the 90th centile threshold at each geographical grid for at least three consecutive days.[16]
- Spain—The minimum and maximum temperatures must both be >95% of the "historical series" for five days.[17]
- Senegal—A heatwave is defined based on three or more consecutive days with daily minimum and maximum temperatures greater than the 90th centile.[17]

How do heatwaves affect health systems?

Extreme heat events and even modest rises in temperature cause surges in demand for health services to treat heat illness and exacerbations of comorbid conditions (fig 1).[20-22] These may cause hospital overcrowding, delayed emergency response times, staff shortages, and compromised patient outcomes.[3] Periods of extreme heat can disrupt electrical grids and cause power blackouts which, in the absence of robust back up supply, put patients at greater risk through reduced access to home oxygen, elevators, water (on pump-dependent higher floors), and air conditioning.[3] A 2021 study of three US cities combined regional climate models with an advanced building energy model to simulate building interior temperatures in response to concurrent heatwave and black out conditions. The study results estimated that power outages during a heatwave would expose more than 60% of those urban populations to an elevated risk for heat exhaustion and heat stroke.[23]

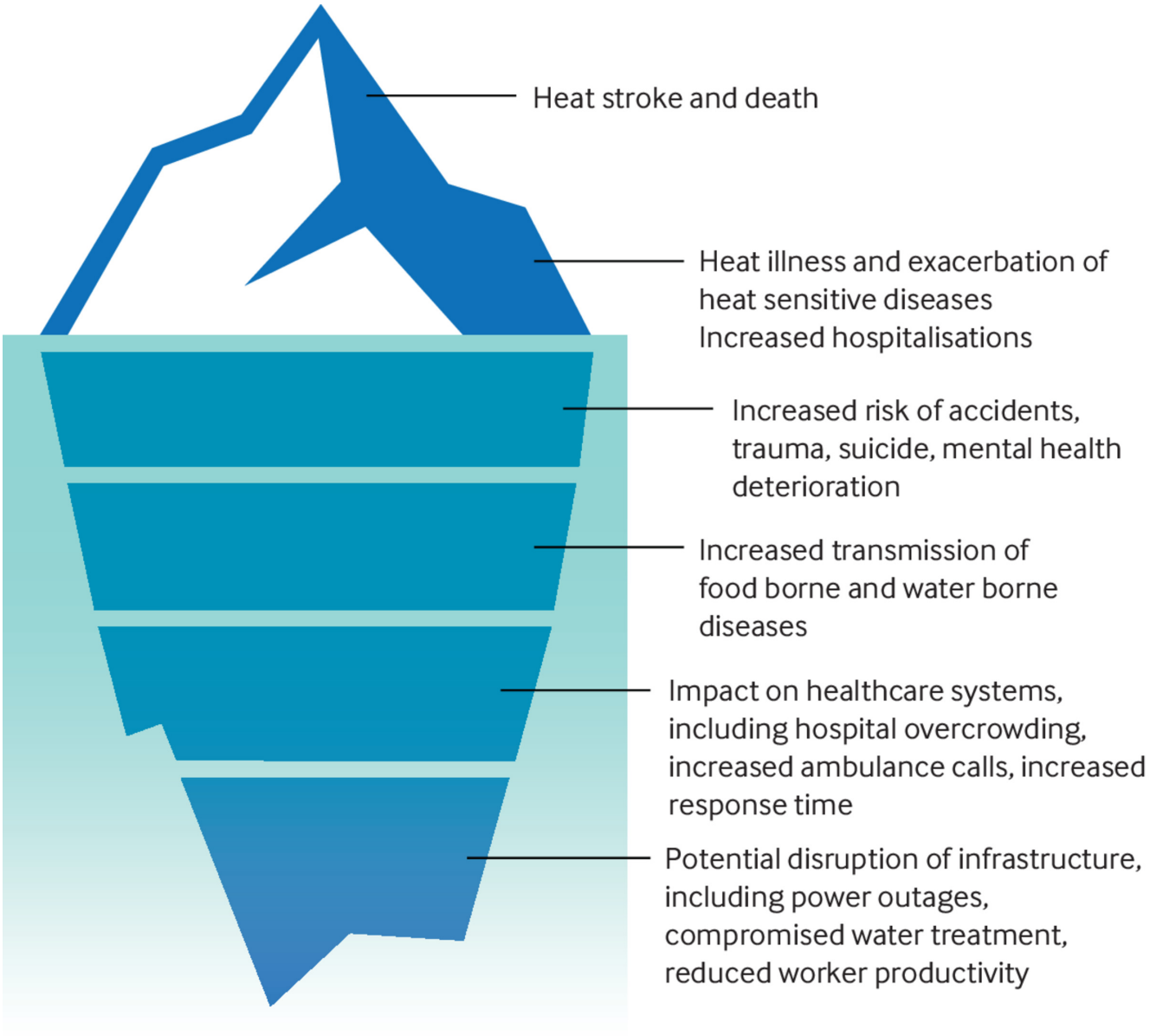

Fig 1 | Heatwaves result in many less visible impacts on health and health system infrastructure

Who is most vulnerable to heat illness?

Vulnerability to heat illness results from a combination of exposure, susceptibility, and sociocultural factors (eg, social isolation, low socioeconomic status, and differential treatment by health workers). Populations at risk for heat illness are presented in box 2.[24 25] Studies show substantial variability in personal exposure based on occupation, time spent indoors and outdoors, and wealth (because of the ability to take precautions or relocate if needed).[26] Furthermore, greater exposure and vulnerability to unfavourable social, economic, and environmental circumstances,[27] which often intersect with gender, race/ethnicity, and disability, are associated with poorer health outcomes during periods of extreme heat.[28]

Box 2: Populations vulnerable to heat

- Infants and young children
- Older people
- Patients with chronic diseases
- Outdoor workers
- Pregnant women
- Athletes
- Patients on high risk medications such as diuretics and antidepressants
- People who are socially displaced, or have substance use disorders

Lack of green spaces and limited investment in energy efficient infrastructure contribute to substantial temperature differences and exposure across urban areas.[29]

How do you recognise heat related illness in a patient?

Diagnosing heat illnesses and preventing complications require the clinician to have a high index of suspicion.

In a healthy individual exposed to high ambient temperatures at rest or while engaged in exercise, the body seeks to maintain a core temperature close to 37°C. This occurs either through behavioural modification (for example removing clothing, seeking shade, and rest) or physiological responses that transfer heat back to the environment, such as peripheral vasodilation, increased cardiac output, and sweating, coupled with thirst to replace fluid losses.[30] When these compensatory mechanisms are saturated, heat illness may develop.

Classic heat illnesses include heat stroke, heat exhaustion, heat cramps, and heat syncope (table 1). Exertional heat illness develops in the setting of physical exertion, in young and otherwise healthy individuals, when internal heat generation (with or without exposure to excessive ambient heat) overwhelms physiological compensation (table 1). This may occur within one hour of exertion and core temperature may rise rapidly over the course of 10 to 15 minutes.[35] A change in mental status, such as confusion or delirium, best differentiates heat stroke from milder forms of heat illness.[36]

Ensure environmental factors are considered in patients presenting with a fever. The initial assessment of a patient with suspected heat illness should include:

- Consideration of timing—inquire about preceding heat exposure and degree of physical exertion. Be aware that core temperature may have decreased by the time of initial assessment
- Medical history—be aware of heat sensitive diseases, which are exacerbated during heatwaves (box 3)
- Current medications—high risk medications are those that could impair thermoregulation, cognitive awareness, or sweating, such as β blockers, antidepressants, diuretics, anticholinergic agents, antihistamines, sedatives, and anti-dopaminergic agents[30 42]
- Social history—home environment, use of alcohol or illicit drugs.

Box 3: Heat sensitive medical conditions

- Cardiovascular disease, including ischaemic heart disease, atrial fibrillation, and abnormal heart rate variability[18 37]
- Acute ischaemic stroke[38]
- Respiratory diseases, such as chronic obstructive pulmonary disease and respiratory tract infections[18]
- Gastrointestinal diseases among children[18]
- Hyperglycaemia in patients with types 1 and 2 diabetes mellitus[39]
- Kidney disorders, including renal failure[18 40]
- Neuropsychiatric and mental health disorders are exacerbated, resulting in psychosis, suicides, homicides, anxiety, depression, and altered mental state[21 40]
- Adverse birth outcomes, such as preterm delivery, low birth weight, and stillbirth[41]

Table 1 | Spectrum of heat related illnesses

	Severe heat illness	Moderate heat illness	Mild heat illness		
Heat illness	Heat stroke[31]	Heat exhaustion[32]	Heat syncope[32]	Heat cramps[32]	Heat rash (prickly heat)[32]
Description	Classic: a multisystem, life-threatening illness with central nervous systemdysfunction, liver injury, renal injury, disruption of homeostatic thermoregulation, and elevation of body temperature. Exertional: as for classic heat stroke, but results from strenuous physical activity	Results from a decrease in body water content or blood volume owing to water and/or salt depletion	Characterised by dizziness and/or loss of consciousness while immobile, usually standing in the heat for a long period. Occurs mainly in those not acclimatised to heat. Results from pooling of blood in dilated blood vessels of the skin and legs, with a resultant decrease in blood flow to the brain	Painful muscle spasms in the abdomen, arms, or legs during or following activity. Occurs when people lose excessive amounts of salt while sweating during hard physical labour when it is hot	An inflammatory disorder of the epidermis that results from blockage of sweat glands; may be followed by superimposed staphylococcal infection. If large areas involved, sweat production may be compromised, decreasing thermoregulation and reducing capacity to work in the heat
Diagnosis	Triad of hyperthermia (>40°C), altered mental status or neurological abnormalities, and recent exposure to hot weather (classic) or physical exertion (exertional). Clinical features: confusion, delirium, dizziness, weakness, agitation, nausea, vomiting, possible seizures, and decreased level of consciousness. Sweating may be absent in classic heat stroke but present in exertional. Possible signs of renal, cardiac, and hepatic end-organ dysfunction related to disseminated intravascular coagulation, acute respiratory distress syndrome	Core body temperature normal or only slightly elevated: 38-39.5°C. Clinical features: fatigue, extreme weakness, nausea, headache, faintness, tachycardia, oliguria, and cool, pale, clammy skin	Diagnosis of exclusion in the setting of a syncopal episode coupled with ambient heat exposure. Rule out other causes of syncope	Signs may include muscle spasms, moist/cool skin, normal or slightly elevated heart rate, body temperatures usually normal	Initial phase: severely pruritic superficial vesicular rash most often seen in areas covered by clothing or bandages. In some cases, over the subsequent week: obstructed ducts rupture, producing deeper, dermal vesicles that can persist for weeks and become chronic
Treatment principles[32 33]	Key principles: rapid identification, removal from the hot environment, cool (including placing in a shaded area), and remove excess clothing				
	Severe heat illness				
	• CPR according to protocol • Institute aggressive cooling techniques until core temperature reaches 38-39°C, ideally within 30 minutes • Out-of-hospital setting: begin cooling on scene and continue during transport. • Caregivers to advise emergency responders or hospital staff of any temperature recordings taken prior to cooling measures • External cooling measures: cold water immersion, ice packs to axilla, groin, and neck, mist patient and direct fan or use cooling blankets • Internal cooling measures: rehydration using chilled intravenous (IV) fluids, IV cooling devices • Do not use antipyretics or dantrolene as they are not effective in addressing the underlying physiological mechanisms associated with hyperthermia in heat illness[34] • Provide supportive care and monitor for complications such as electrolyte imbalance, seizures, rhabdomyolysis, and acute kidney injury. Treat all complications according to local protocols				
	Moderate heat illness				
	• Consider external cooling measures: ice packs to forehead, neck, axilla, groin, mist patient and direct fan • Monitor for mental status changes or cardiac dysrhythmias • Fluid and electrolyte replacement as needed, rest				
	Mild heat illness				
	• Treat prickly heat with corticosteroid and antibacterial creams as needed and monitor for cellulitis. Advise patients to avoid hot environments and wear loose clothing • Offer oral or IV rehydration and correction of underlying electrolyte abnormalities • Consider benzodiazepines for shivering or cramps				

How can heat illness be prevented?

Recent heatwaves may present opportunities for healthcare workers to discuss with their patients how to prevent heat illness, for instance as part of care planning or reviews of long term conditions. If hazards in the home environment are identified, a referral or signposting to social care, social prescribing services, or voluntary sector organisations may be indicated. Be aware of heat advisories and regional thresholds for when health harms from heat may arise, and risk stratify patients prior to heat season to alert them to their risks. Counsel patients on the explicit signs and symptoms of heat illness, reducing unnecessary use of high risk medications when possible, and when to seek medical attention.

Providing healthcare in hot environments

Maintaining cool temperatures in health facilities is important for the comfort and safety of health workers and patients, to prevent medication spoilage, and to keep equipment functional. In hotter temperatures, air conditioning helps avert heat related illness and deaths, but can also contribute to greenhouse gas emissions, air pollution, peak energy demand, and heat islands (urban areas that

experience higher temperatures than surrounding regions).[7] Air conditioning systems are also costly to install and run, and can be unreliable and challenging to maintain in low resource settings that may face frequent power cuts, particularly when power grids themselves are challenged by temperature spikes.[4]

Long term measures, surveillance, and plan evaluation are essential for prevention of heat illness. Successful solutions include public health advisories deployed prior to peak heat seasons to help providers, community leaders, and health systems prepare for heatwaves and learn the signs and symptoms of heat illness,[43] and heatwave early warning systems that involve forecasting heatwave events, predicting possible health outcomes, triggering timely response plans targetting vulnerable populations, and broad communication.[17] In Ahmedabad, India, a comprehensive Heat Action Plan provided the framework for planning and implementing early warning systems, preparedness strategies, mechanisms for inter-agency coordination, and capacity building among health professionals. This plan has proved successful in reducing both morbidity and mortality through an inter-sectoral response.[43] A range of solutions, adapted to the setting, may be needed (box 4).

Box 4: Solutions to mitigate heat impacts[34]

Short term, low cost solutions

- Ensure regular ambient temperature checks in health facilities
- ·Ensure areas remain under pre-determined limits on temperature
- Provide sufficient cold water and ice to staff and patients
- Encourage staff to take breaks to ensure rehydration
- Reduce energy consumption by turning off lights and equipment when possible
- Add fans if possible.

Longer term solutions

- Clinician training in recognition and management of heat related illness
- Develop and practise heatwave surge plans and heat early warning and response plans that incorporate heat vulnerability mapping with community derived knowledge about attitudes and practices among the populations most at risk[3]
- Promote cool environments for vulnerable patients, eg, air conditioning or shaded areas
- Promote public education so patients can recognise signs of heat illness
- Encourage planting of trees and other vegetation in suitable areas
- Develop community plans to check up on patients at high risk of heat illness, especially those living alone[43]
- When designing health infrastructure, consider local temperature and precipitation projections for the anticipated duration of use of the health service building, maximising natural cooling strategies such as cross-ventilation, and ensure a low carbon electrical supply with back up capabilities in case of electrical grid failure associated with extreme heat
- Promote healthcare associated active transport corridors (roadways and bike paths) that allow active transport to and from hospital, and roof top gardens that act as therapeutic spaces for patients and supply food for the facility and can reduce the urban heat island effect and improve health[44]
- Promote heat resilient health settings by using heat reflective paint, tinted window film, and energy efficient devices that emit little waste heat, such as LED bulbs[45]
- Ensure manufacturer servicing of air conditioners in as many geographical locations as possible, and develop the local technical expertise required to keep machines running
- Install solar panels at health facilities, which can provide uninterrupted power for cooling but must be supplemented by batteries, grid, or generator electricity[46]

Given limits to adaptation, the ultimate prevention must include advocating for the rapid reduction of greenhouse gas emissions, to stay within a global surface temperature rise of 1.5°C.[47] Decarbonisation of the health sector is a critical part of this and perhaps the place the heat needs to be turned up is within the health community itself.

Education into practice

- How might heat exposure affect the health of your patients now and in the future?
- Does your department, clinic, hospital, or health system have plans in place for a heatwave? How might those plans be improved?

Tips for patients

- Cool living spaces with fans or air conditioning, while keeping curtains and windows closed during the day
- Locate cooling centres in your area and stay in an air conditioned location as much as possible
- Limit physical activity
- Increase water intake
- Wear lightweight clothing
- Take cool showers or baths
- Monitor for symptoms of heat illness such as excessive sweating, thirst, or confusion
- If air conditioning is not affordable, contact local resources, eg, the Low Income Energy Assistance Program[48]
- If you live in an area prone to extreme heat, consider investing in improved insulation in your home structure, and increasing tree canopy coverage near your dwelling
- Check on friends and neighbours and have someone do the same for you
- Establish an emergency contact system in the event of power outages

How patients were involved in the creation of this article

Two patients known and cared for by authors of this study reviewed each draft of this manuscript and provided critical feedback. As a result of their feedback, we included preventive steps that patients can take and advice on how clinicians can and should counsel patients. We also clarified which patients are vulnerable and how they are vulnerable.

How this article was created

This article was created using a combination of expert advice and patient perspectives through a review process and the established literature. A geographically and clinically diverse author group was brought together with representation from Australia, India, Canada, and the US with clinical and research expertise in emergency medicine, primary care, pulmonology, and epidemiology. Literature was searched using Medline and Google Scholar databases up to April 2022 with search terms such as “heat illness” AND “health” OR “respiratory health” OR “cardiovascular health” OR “perinatal health” OR “cognitive health”.

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Contributorship and guarantor: All authors conceptualised the study, drafted and revised the manuscript, and read and approved the final manuscript.

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