

Case Report

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Heat Stroke

Definition

- Core temperature $\geq 40^{\circ}\text{C}$ accompanied by central nervous system dysfunction in patients with environmental heat exposure.

Classification


- Classic(nonexertional) heat stroke:
 - Environmental exposure to heat (e.g. heat waves)
 - Underlying chronic medical conditions:
 - Cardiovascular disease, neurologic or psychiatric disorders, obesity, anhidrosis, extremes of age, use of drugs(e.g. anticholinergic agents or diuretics)

■ Exertional heat stroke:


- Exercise
- High ambient temperature and/or humidity
- Dehydration
- Medication: antihistamines with anticholinergic side effects

Pathophysiology

Core temperature rises
↓
Preoptic nucleus of ant. hypothalamus
↓
Autonomic efferent nerve
↓
Produce sweating and cutaneous vasodilation




- Evaporation: ineffective when relative humidity > 75%
- Radiation, conduction, and convection: not efficiently when environmental temperature exceeds skin temperature



When Body Temperature elevation


- Increase oxygen consumption and metabolic rate
- Hyperpnea and tachycardia
- Above 42°C:
 - Oxidative phosphorylation becomes uncoupled
 - Enzymes cease to function



- Hepatocytes
- Vascular endothelium
- Neural tissue


↓

Multiorgan system failure



Physical Finding in Heat Stroke

- Cutaneous vasodilation
- Tachypnea
- Rales
- Excessive bleeding
- Neurologic dysfunction
- Skin: moist or dry



Laboratory Studies

- Coagulopathy
- Acute renal failure
- Acute hepatic necrosis
- Respiratory alkalosis
- Leukocytosis



Risk Factors for Increased Mortality

- Anuria
- Coma
- Cardiovascular failure
- Take long-term antihypertensive medication
- Lack access to air conditioning
- Socially isolated
- Unable to care for themselves

Diagnosis

- History taking
- Physical examination
- Vital signs: rectal temperature
- CXR, ECG
- Laboratory studies: CBC, electrolytes, BUN, Cr, liver enzymes, PT/aPTT, CPK, Ca, P
- Toxicologic screening
- Head CT
- Lumbar puncture

Differential diagnosis of hyperthermia

Environmental exposure	Hypothalamic stroke
Sepsis	Status epilepticus
Encephalitis	Cerebral hemorrhage
Brain abscess	Neuroleptic malignant syndrome
Meningitis	Alcohol, sedative-hypnotic withdrawal
Tetanus	Salicylate, lithium toxicity
Typhoid fever	Sympathomimetic toxicity
Thyroid storm	Anticholinergic toxicity
Pheochromocytoma	Dystonic reactions
Catatonia	Serotonin syndrome
Malignant hyperthermia	

Redrawn from Lanken, PN, Manaker, S, Hanson, CW III (Eds), *The Intensive Care Unit Manual*, WB Saunders, Florida (in press).

Clinical features of heat stroke and heat exhaustion*

	Heat stroke	Heat exhaustion
Core body temperature	$>40^{\circ}\text{C}$ (104°F)	$\leq 40^{\circ}\text{C}$ (104°F)
Mental status	Abnormal mental status (eg, obtunded, coma, delirium, hallucinations, seizures, ataxia, slurred speech)	Normal mental status, dizziness, or mild confusion that rapidly normalizes within 30 minutes of treatment. May see syncope with rapid recovery of alertness.
Airway and breathing	May be compromised due to altered mental status, tachypneic	Clear airway, may be tachypneic
Circulation	Tachycardia with hypotension, moderate to severe dehydration	Tachycardia with normal blood pressure, mild to moderate dehydration
Skin findings	Dry skin (classic heat stroke) or sweating (exertional heat stroke)	Sweating
Other clinical features	<ul style="list-style-type: none"> - Vomiting - Diarrhea - Clinical and laboratory findings of DIC, rhabdomyolysis, acute renal failure, cardiogenic shock, and liver failure 	<ul style="list-style-type: none"> - Nausea, vomiting - Headache - Fatigue, weakness - In some patients, hyponatremia or hypernatremia

* For a discussion of treatment, see appropriate topics.
 • Some patients with heat stroke may have a core body temperature $<40^{\circ}\text{C}$ (104°F) if cooling measures were initiated in the prehospital setting.
 Data from:
 1. Jardine, DS. Heat illness and heat stroke. *Pediatr Rev* 2007; 28:249.
 2. Glazer, JL. Management of heatstroke and heat exhaustion. *Am Fam Physician* 2005; 71:2133.


Management

- ABC
- Rapid cooling
- Treatment of complications
- CVP
- Stop cooling measures when BT 39.5°C

Cooling Measures


- Augmentation of evaporative
- BZD IV form if shivering
- Cold water immersion
- Ice packs to the axilla, neck, and groin
- Cold peritoneal lavage (invasive technique)
- Cold oxygen, cold gastric lavage, cooling blankets, cold IV fluids

- Antipyretic agents: not necessary
 Mechanism dose not involve a change in the hypothalamic set-point
- Avoid alcohol sponge baths: may be absorbed through dilated cutaneous vessels



Pharmacologic therapy

- Not required in heat stroke



Management of heat stroke

	Intervention	Goal
Out of hospital	<p>Heat stress (due to heat waves, summer heat, or strenuous exertion) with changes in mental status (irritability, delirium, seizures, or coma)</p> <p>Measure the patient's core temperature: use a rectal probe, if possible</p> <p>If the core temperature is $\geq 40^{\circ}\text{C}$, move the patient to a cooler place, remove his or her clothing, and initiate external cooling. Cool down to the rectal, axillary, and groin temperatures falling (or opening of the antipyretic window) and opening of the skin with water at 20°C to 25°C.</p> <p>Position an unconscious patient on his or her side and clear the airway.</p> <p>Administer oxygen at 4 liters/min</p> <p>Give isotonic crystalloid (normal saline)</p> <p>Rapidly transfer the patient to an emergency department</p>	<p>Diagnose heat stroke*</p> <p>Lower the core temperature to $< 38.5^{\circ}\text{C}$</p> <p>Prevent cooling to conductive and evaporative</p> <p>Minimize the risk of aspiration</p> <p>Increase arterial oxygen saturation to $> 95\%$ per cent</p> <p>Provide volume expansion</p>
In hospital	<p>Cooling period</p> <p>Confirm diagnosis with the rectal calibrated to measure high temperature ($\geq 40^{\circ}\text{C}$ to 41°C)</p> <p>Monitor the rectal and skin temperatures: continue cooling</p> <p>Hyperthermia</p> <p>Give benzodiazepines</p> <p>Seizures</p> <p>Consider active intubation (for impaired gag and cough reflexes or deterioration of respiratory function)</p> <p>Respiratory failure</p> <p>Administer fluids for volume expansion, consider vasopressors, and consider monitoring central venous pressure</p> <p>Hypotension</p> <p>Expand volume with normal saline and administer intravenous for sepsis, myocarditis, and sodium bicarbonate</p> <p>Shallow breathing</p> <p>Monitor serum potassium and calcium levels and treat hypokalemia</p> <p>Multifactorial dysfunction</p> <p>Supportive therapy</p>	<p>Keep rectal temperature $< 38.5^{\circ}\text{C}$ and skin temperature $< 39^{\circ}\text{C}$</p> <p>Control seizures</p> <p>Protect airway and support oxygenation</p> <p>Prevent oxygenation failure or oxygenation failure</p> <p>Increase mean arterial pressure to $> 65\text{ mm Hg}$ and restore organ perfusion and tissue oxygenation</p> <p>Prevent respiratory acidosis (oral NaHCO_3 promote renal blood flow, diuresis, and elimination of uric acid)</p> <p>Prevent the worsening cardiac arrhythmia</p> <p>Recovery of organ function</p>

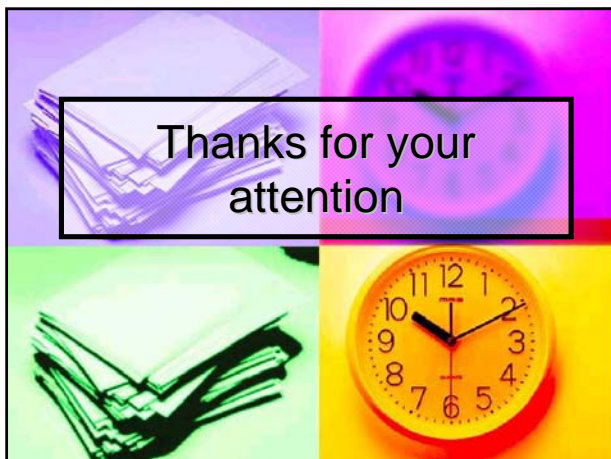
* Heat stroke should be suspected in any patient with changes in mental status during heat stress, even if his or her core temperature is $< 40^{\circ}\text{C}$.

† There is no evidence that any cooling technique is superior to another. Conventional techniques that are easy to apply, well tolerated, and not likely to cause reflexive vasoconstriction are preferred.

‡ There is no evidence to support a specific temperature and point at which cooling should be halted. However, a rectal temperature of 38.5°C has been used in large series and has proved to be safe.

§ In hypotension usually responds to volume expansion and cooling. Vasodilatory shock and primary myocardial dysfunction may underlie sustained hypotension that is refractory to volume expansion. Therapy should be individualized and guided by the patient's clinical response.

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Thanks for your attention