

Heat Stroke

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THE STORY IN ONE SENTENCE

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“Heat stroke means the body's cooling system has completely failed. Every minute of delay burns organs from the inside. Cool first, ask questions later.”

Normal anatomy — the body's job

The hypothalamus (a pea-sized control center deep in the middle of the brain) acts as the body's thermostat. It constantly reads the temperature of blood flowing past it and sends out orders to keep core temperature at 98.6°F. When you get hot, it tells sweat glands in your skin to release water (which cools you as it evaporates) and tells blood vessels near the skin surface to widen (so more warm blood flows near the air and heat escapes). At the same time, you feel thirsty and look for shade — automatic behaviors that help dump heat. This system works beautifully as long as the air is not too hot, you have water to make sweat, and the hypothalamus itself is healthy.

BODY'S JOB

Normally, the hypothalamus senses even a tiny rise in blood temperature and immediately turns on cooling — sweat pours out, skin blood vessels open wide, and you move toward cooler air. This keeps your core steady even during exercise or on a hot day. The system is built to handle a lot, but it has limits: if the outside air is hotter than your skin, heat cannot escape; if you are dehydrated, you run out of sweat; if certain drugs block sweating or blood vessel widening, the signals do not work; and if you make heat faster than you can dump it (like during all-out exercise in the heat), the system falls behind. Once core temperature climbs above about 104°F, the hypothalamus itself starts to fail — heat damages its own cells, and the thermostat goes offline. That is when normal compensation stops and heat stroke begins.

1. The hypothalamus constantly reads blood temperature as blood flows through it, like a thermostat checking the air in a room.
2. When it senses heat rising, it sends nerve signals down the spinal cord to sweat glands all over the skin: 'Pour out water now.'
3. At the same time, it signals tiny muscles around blood vessels near the skin surface to relax, so the vessels widen and more warm blood flows close to the air — heat radiates out, just like a car radiator.
4. The hypothalamus also triggers thirst (you feel like drinking) and makes you want to find shade or take off layers — built-in behaviors that help dump heat.
5. As sweat evaporates, it pulls heat away from the skin. As widened vessels bring warm blood to the surface, that heat escapes into cooler air. The cycle keeps core temperature steady.
6. If the air is cooler than your skin and you have water to sweat, this feedback loop works perfectly — you stay at 98.6°F even during hard exercise or a hot day.

What breaks

Heat stroke happens when the body's cooling system is overwhelmed or blocked, and core temperature climbs above 104°F while the brain stops working right. There are two main paths. In classic (non-exertional) heat stroke, extreme outside heat — a heat wave, a closed car, a hot room with no air conditioning — overpowers the body's ability to dump heat, especially in people who already have weak defenses (elderly, very young, people taking drugs that block sweating like antihistamines or diuretics, or people who are dehydrated). In exertional heat stroke, the person is exercising so hard that their muscles make heat faster than the body can get rid of it, even if the air is not extremely hot; this happens to soldiers, athletes in two-a-day practices, or workers doing heavy labor in heat and humidity. Either way, once core temperature crosses 104°F, the hypothalamus itself gets damaged by the heat — the

thermostat breaks — and normal cooling shuts down. Cells all over the body start to cook: proteins unfold, membranes leak, and organs fail.

CLINICAL TERM

Heat stroke is defined as core temperature above 40°C (104°F) plus central nervous system dysfunction (confusion, delirium, seizures, or coma). It occurs via two mechanisms: (1) Classic heat stroke results from environmental exposure (high ambient temperature and humidity) in individuals with impaired thermoregulation — typically the elderly, infants, persons taking anticholinergic or diuretic medications, or those with dehydration or cardiovascular disease. (2) Exertional heat stroke results from strenuous physical activity (military training, athletics, manual labor) in which metabolic heat production exceeds heat dissipation, even in moderate ambient conditions. In both, once core temperature exceeds the threshold, direct cellular injury ensues — the hypothalamus itself suffers hyperthermic damage, thermoregulatory feedback fails, and a cascade of multi-organ injury begins: cytokine release, endothelial damage, impaired blood clotting (coagulopathy) (consumptive and disseminated intravascular coagulation), rhabdomyolysis, acute liver injury, acute kidney injury, cerebral swelling (edema), and cardiovascular collapse.

How the body compensates

In the early minutes of heat stroke, the body tries desperately to cool down and keep blood pressure up — the heart races, breathing speeds up to blow off heat, and blood vessels in the skin open wide. For a short time, the person may still be awake and talking, so the team might not realize how bad things are. But underneath, cells are dying and organs are starting to fail. Once core temperature stays above 104°F for more than a few minutes, compensation fails — the heart cannot keep up, blood pressure drops, and multiple organs shut down at once. The key is to recognize heat stroke early (very hot skin, confusion, core temp above 104°F) and cool immediately, because there is no compensation that can save the person if you wait.

1. {'title': 'Heart races to try to cool the body', 'mechanism': 'The hypothalamus signals the heart to beat faster so more blood flows to the skin, where heat can escape. You see a pulse of 120 to 160 — very fast. But this only works if the air is cooler than the skin and if the person has enough blood volume. In heat stroke, the air is too hot or the person is dehydrated, so the racing heart just burns more energy without actually cooling the body.'}
2. {'title': 'Breathing speeds up to blow off heat and CO₂', 'mechanism': 'Fast breathing (tachypnea) helps dump a little heat from the lungs and blows off carbon dioxide (CO₂) made by working muscles. You see 30 to 40 breaths per minute. But if the person is confused or unconscious, breathing becomes irregular or stops, and oxygen levels drop — then compensation fails completely.'}

3. {'title': 'Skin blood vessels open wide (vasodilation)', 'mechanism': 'Blood vessels near the skin surface widen to bring warm blood close to the air so heat can radiate out. Early on, the skin may look red and feel very hot. But if the person is dehydrated or blood pressure is dropping, the body clamps down on skin blood flow to keep blood going to the brain and heart — then the skin becomes pale or blotchy, and cooling stops.'}
4. {'title': 'Sweating may continue briefly — or may stop', 'mechanism': "In exertional heat stroke, the person is often drenched in sweat because they were exercising hard. In classic heat stroke, especially in elderly or dehydrated people, sweating may have already stopped before the person collapses — the myth that 'heat stroke always means dry skin' is wrong. Either way, once the hypothalamus is damaged, sweating shuts down and the person cannot cool themselves at all."}
5. {'title': 'The dangerous plateau: vital signs hide the collapse', 'mechanism': "For the first 10 to 30 minutes, the person may still have a blood pressure (even if low), a pulse, and some level of consciousness. The team might think, 'They are stable, we have time.' But inside, cells are cooking — the liver is failing, muscles are breaking down, clots are forming. This plateau is a trap. The window to prevent permanent brain damage or death is only minutes, not hours. You must cool first, stabilize second."}
6. {'title': 'The crash: multi-organ failure and cardiovascular collapse', 'mechanism': "Once core temperature has been above 104°F for more than about 30 minutes without cooling, compensation fails everywhere at once. The heart muscle itself is damaged by heat, so it cannot pump well. Potassium leaking from dying muscle cells poisons the heart's electrical system, causing dangerous rhythms (ventricular a fast heart rate (tachycardia) or fibrillation). Blood pressure drops (shock). The brain swells and herniates. The kidneys shut down. The lungs fill with fluid (ARDS). The person dies unless cooling started minutes ago."}

Domino effect

1. Core temperature climbs above 104°F (40°C) and the hypothalamus fails — The hypothalamus (the brain's thermostat, a small cluster of cells deep in the center of the brain) is damaged by the extreme heat. Its own cells start to die — proteins inside them unfold, membranes leak, and the chemical signals it uses to control sweating and blood vessel widening stop working. The thermostat goes offline, so the body can no longer cool itself. At the same time, heat causes the blood-brain barrier (the tight seal around blood vessels in the brain) to become leaky, and fluid seeps into brain tissue. The brain swells. Swelling pushes on brain cells and squeezes blood vessels, cutting off oxygen. The person becomes confused, then has seizures, then loses consciousness.

2. Liver cells die (acute hepatic injury), and liver enzymes skyrocket — The liver (the organ under your right ribs that cleans the blood and makes clotting factors) has huge blood flow — about 25% of all the blood your heart pumps. But in heat stroke, two things kill liver cells. First, direct heat damage: when blood temperature is above 104°F, the heat itself makes liver cell membranes fall apart and mitochondria (the cell's power plants) stop making energy. Second, low blood flow (ischemia): as blood pressure drops and the body diverts blood to the brain and heart, the liver does not get enough oxygen. Liver cells burst open and dump their enzymes — AST and ALT — into the blood. You see AST and ALT levels in the thousands (normal is under 40). If cooling is delayed, the liver completely fails — it stops making clotting factors (so the person bleeds) and stops cleaning toxins (so ammonia builds up and poisons the brain further).
3. Muscle cells burst (rhabdomyolysis), releasing myoglobin and potassium into the blood — In exertional heat stroke, hard exercise plus heat makes muscle cells work so hard they run out of energy (ATP). Without ATP, the pumps that keep calcium out of the cell stop working, calcium floods in, and the muscle cell's proteins clump together and the cell membrane tears open. In classic heat stroke, direct heat damage does the same thing. Either way, dying muscle cells dump their contents into the bloodstream: myoglobin (the oxygen-carrying protein inside muscle, which is dark red and turns urine tea-colored or cola-colored), creatine kinase (CK, an enzyme — you see levels in the tens of thousands), and potassium (a lot of it, because muscle cells are packed with potassium). Myoglobin travels to the kidneys and clogs the tiny filters (the glomeruli and tubules), causing acute kidney injury. Potassium floods the blood (hyperkalemia) and poisons the heart — it makes the heart's electrical signals go haywire, causing peaked T-waves on the EKG and dangerous rhythms like ventricular a fast heart rate (tachycardia) or cardiac arrest.
4. Blood clotting system goes haywire (disseminated intravascular coagulation, DIC) — Heat damages the endothelium (the smooth inner lining of all blood vessels). Normally, this lining is slippery and keeps blood flowing smoothly. But when it is injured by heat, it becomes sticky and sends out chemical alarms that activate the clotting cascade (the body's emergency repair system). Tiny clots (microthrombi) form in blood vessels everywhere — brain, lungs, kidneys, liver. These clots use up all the platelets (the sticky cell fragments that plug holes) and all the clotting factors (proteins like fibrinogen that glue clots together). Once they are used up, the person cannot clot anymore, so bleeding starts — from IV sites, gums, in the brain (hemorrhagic stroke), in the lungs, in the gut. You see platelets dropping (thrombocytopenia), PT and PTT climbing (clotting times get longer), fibrinogen falling, and D-dimer skyrocketing (a marker that clots are forming and breaking down all at once). This is DIC — clotting and bleeding at the same time — and it is a sign of extreme, life-threatening illness.

5. Lungs fill with fluid (acute respiratory distress syndrome, ARDS) — Heat and the flood of inflammatory chemicals (cytokines like IL-1, IL-6, TNF- α released by injured cells) damage the capillaries (the tiniest blood vessels) in the lungs. Normally, the walls of these capillaries are tight, so fluid stays in the blood and air stays in the alveoli (the tiny air sacs where oxygen crosses into the blood). But in heat stroke, the capillary walls become leaky. Fluid, proteins, and even red blood cells seep out of the blood and flood the alveoli. The alveoli collapse and fill with fluid, so oxygen cannot cross into the blood. The person's oxygen level (SpO₂) drops. They breathe faster and faster, but it does not help. You see white patches (infiltrates) all over both lungs on chest X-ray. This is ARDS — the lungs are drowning from the inside — and the person needs a ventilator (breathing machine) to survive.
6. Kidneys fail (acute kidney injury, AKI) — Three things kill the kidneys in heat stroke. First, myoglobin released from dying muscles travels through the blood to the kidneys, clogs the tiny tubules (the plumbing inside each kidney that filters waste), and is directly toxic to kidney cells — the tubules die and stop making urine. Second, low blood pressure (shock) means the kidneys do not get enough blood flow to filter waste, so they shut down to protect themselves. Third, tiny clots (from DIC) block blood vessels inside the kidneys. The person stops making urine (oliguria or no urine output (anuria) — less than 400 mL per day or none at all). Creatinine (a waste product normally filtered by the kidneys) climbs in the blood. Potassium, acid, and fluid build up. Without dialysis (a machine that filters the blood), these toxins poison the heart and brain and the person dies.
7. Heart fails (myocardial injury and arrhythmias) — The heart muscle itself is damaged by heat — just like any other muscle, when heart cells (cardiomyocytes) get too hot, their proteins unfold, their membranes leak, and they stop contracting well. You see troponin (a protein that leaks out of dying heart cells) rise in the blood. The heart cannot pump hard enough, so blood pressure drops (cardiogenic shock). At the same time, electrolyte chaos — high potassium (from muscle breakdown), low calcium, low magnesium — disrupts the heart's electrical system. The EKG shows wide QRS complexes, peaked T-waves, and then ventricular a fast heart rate (tachycardia) or ventricular fibrillation (the heart quivers uselessly instead of pumping). The person goes into cardiac arrest and dies unless the team cools them, shocks the heart (defibrillation), and fixes the electrolytes immediately.

- 8.** Death occurs within minutes to hours without aggressive cooling — Once the domino effect is in motion — brain swelling, liver failure, rhabdomyolysis, DIC, ARDS, kidney failure, and cardiac arrest — the body cannot recover unless core temperature is brought down fast. Every minute above 104°F (40°C) causes more cells to die. The standard teaching is: cool first, ask questions later. The goal is to drop core temperature below 102°F (38.9°C) within 30 minutes. Methods include ice-water immersion (the fastest), evaporative cooling (misting the skin with water and blowing air over it), ice packs on the neck/armpits/groin (where big blood vessels are close to the skin), and cold IV fluids. If cooling is delayed even 30 to 60 minutes, the chance of permanent brain damage or death climbs steeply. Survival depends on how fast you cool, not on what drugs you give — there is no medicine that reverses heat stroke; only cooling works.

Symptoms · what the patient feels, and why

- Core body temperature over 104°F (40°C): The body's cooling system (sweating and blood flow to the skin) can't keep up with the heat load, so temperature climbs dangerously high and starts cooking the brain and other organs.
- Confusion, strange behavior, or trouble thinking clearly: The overheated brain—especially the cerebral cortex (the thinking and decision-making layer)—can't work properly when it gets too hot, like a phone that starts glitching in the sun.
- Seizures (sudden jerking or stiffening of the body): Extreme heat disrupts the electrical signals in the brain—especially in the hippocampus and cortex—triggering uncontrolled firing, like a short circuit.
- Loss of consciousness or coma: When the brain's temperature control center (the hypothalamus) and the rest of the brain overheat, they shut down to try to protect themselves, and the person can no longer stay awake.
- Hot, dry skin (classic form) or hot, sweaty skin (exertional form): In classic heat stroke (often in older adults during heat waves), sweating stops because the sweat glands are overwhelmed. In exertional heat stroke (young people exercising hard), sweating may still happen but can't cool the body fast enough.
- Fast, pounding heartbeat: The heart races to pump blood to the skin to try to dump heat and to keep blood pressure up as vessels widen; it's working overtime like a fan on high speed.
- Fast, shallow breathing: The body tries to blow off heat through the lungs and also compensates for the stress by breathing faster, like panting.
- Severe headache: Blood vessels in the brain swell and pressure builds as the brain overheats, causing intense pain.
- Nausea and vomiting: The gut slows down and becomes irritated when blood is shunted away to the skin for cooling, and the heated digestive tract sends distress signals.

- Muscle cramps or weakness: Dehydration and loss of salt through sweat upset the balance of electrolytes (sodium, potassium, calcium) that muscles need to contract smoothly, causing them to cramp or fail.

Focused exam

- Core body temperature over 40°C (104°F) measured by rectal probe: Heat stroke is defined by a core temperature this high plus brain changes. The body's thermostat (the hypothalamus, a small control center deep in the brain) has lost control, and brain cells are literally being cooked right now. Skin thermometers and forehead strips are not reliable enough.
- Altered mental status: confusion, slurred speech, seizures, or unresponsiveness: The prefrontal cortex (the front part of the brain that handles thinking and decision-making) and other brain regions start to fail when they overheat. This is not the mild confusion you get with a fever—this is brain tissue swelling and dying. Cooling must start within minutes.
- Skin hot to touch, either wet with sweat or completely dry: In classic heat stroke (often in elderly people during heat waves), the skin is dry because the hypothalamus stopped signaling sweat glands. In exertional heat stroke (athletes, workers), the skin may still be wet because sweating was working at first but could not dump enough heat. Either way, the body's cooling system is overwhelmed or broken.
- Rapid heart rate (tachycardia), low blood pressure (hypotension), and weak pulses: Heat damages the walls of blood vessels, so fluid leaks out of the bloodstream into tissues. The heart races to try to pump what little blood volume is left, but blood pressure drops because the vessels are leaky. This means organs are not getting enough oxygen and nutrients.
- Dark red or brown urine, or muscle rigidity and tenderness: Extreme heat cooks muscle cells, which break open and spill a protein called myoglobin into the blood. The kidneys try to filter it out, turning urine dark like cola or tea. Myoglobin clogs the tiny filters in the kidneys (the nephrons) and can cause kidney failure if not treated quickly.
- Bleeding from gums, IV sites, or bruises appearing without injury: Heat stroke triggers disseminated intravascular coagulation (DIC), where tiny blood clots form all over the body and use up all the clotting proteins (like fibrinogen) and platelets. Once those are gone, the blood cannot clot anymore, so the person bleeds easily. This is a life-threatening cascade.

Diagnostics · every test answers a question

- Core body temperature (rectal or esophageal thermometer) → Is the core temperature above 40°C (104°F)?

- Serum creatine kinase (CK) and urine myoglobin → Are muscle cells breaking down (rhabdomyolysis)?
- Basic metabolic panel (BMP): sodium, potassium, creatinine, blood urea nitrogen (BUN) → Are the kidneys failing, and are electrolytes dangerously out of balance?
- Complete blood count (CBC) with platelet count → Is the blood clotting system failing?
- Coagulation panel: prothrombin time (PT), international normalized ratio (INR), activated partial thromboplastin time (aPTT), fibrinogen, D-dimer → Is disseminated intravascular coagulation (DIC) happening?
- Liver function tests: AST, ALT, bilirubin → Is the liver being damaged by heat?
- Arterial blood gas (ABG) or venous blood gas (VBG) → Is the blood too acidic, and are the lungs and kidneys compensating?
- Electrocardiogram (ECG) → Is the heart rhythm stable, or is high potassium causing dangerous changes?

Treatment logic

- Immediate rapid cooling: ice water immersion (if no cardiac arrest) or evaporative cooling (mist water on skin + fans) → Drops core temperature as fast as possible to stop brain cells, liver cells, and other tissues from cooking. The goal is to reach 38.5–39°C (101.3–102.2°F) within 30 minutes. Every minute of delay increases the risk of permanent brain damage and multi-organ failure.
- Stop active cooling at 38.5–39°C and monitor temperature every 15–30 minutes → Prevents overcooling (hypothermia) which can cause dangerous slow heart rate (bradycardia), low blood pressure, and abnormal heart rhythms. The body's own cooling system takes over from here if it is recovering.
- Large-bore IV lines (14- or 16-gauge) with cold normal saline bolus (1–2 liters rapidly, then titrate) → Replaces lost fluid from sweating and leaky blood vessels. Restores blood volume so the heart can pump effectively and deliver oxygen to organs. Cold fluid also helps cool the core. Prevents shock and supports the kidneys as they try to filter muscle breakdown waste.
- Benzodiazepines (lorazepam 2–4 mg IV or midazolam 2–5 mg IV) for seizures or severe shivering → Stops seizures by calming overactive neurons (brain cells) that are misfiring due to heat damage. Stops shivering, which generates extra heat and works against cooling. GABA (the brain's main calming messenger) is boosted by benzodiazepines, which quiets the brain's alarm signals.

- Aggressive IV hydration + urine alkalinization (sodium bicarbonate to keep urine pH > 6.5) if rhabdomyolysis is confirmed → Flushes myoglobin (muscle protein) out of the kidneys before it clogs the nephrons (tiny kidney filters). Alkaline urine (pH > 6.5) keeps myoglobin dissolved so it does not crystallize and block the kidney tubules. Prevents acute kidney injury and the need for dialysis.
- Monitor and treat high potassium (hyperkalemia) (potassium > 5.5 mEq/L): calcium gluconate, insulin + glucose, and possibly dialysis → Calcium gluconate stabilizes the heart muscle so high potassium does not cause cardiac arrest. Insulin (with glucose to prevent low blood sugar) drives potassium back into cells temporarily. Dialysis removes potassium if it stays dangerously high. Prevents deadly heart rhythms.
- Blood product transfusion (fresh frozen plasma, platelets, cryoprecipitate) if DIC causes active bleeding → Replaces clotting factors (like fibrinogen) and platelets that were used up in the widespread clotting cascade. Stops life-threatening bleeding from the gut, brain, or IV sites.

Medications

Ice-water immersion or evaporative cooling (cold mist + fans) · Physical cooling method (not a drug)

Heat stroke is too much heat inside the body that the brain's temperature control center (the hypothalamus) can no longer fix. The fastest way to save the person is to cool the body from the outside. Ice-water immersion (putting the person in a tub of ice water up to the neck) is the gold standard and can drop core temperature by 0.15–0.2°C every minute. If a tub is not available, spray the skin with cool water and blow air with fans so the water evaporates and pulls heat away (evaporative cooling). Pack ice packs around the neck, armpits, and groin where big blood vessels run close to the skin. The goal is to bring core temperature down to 38.5–39°C within 30 minutes. Stop active cooling at 38.5°C to avoid overcooling (hypothermia). This is the single most important treatment and must start immediately, even before the ambulance arrives.

1. Cold water or evaporating mist touches the skin and pulls heat energy away from the blood flowing just below the surface.
2. The cooled blood travels back through veins to the heart and then out to the rest of the body.
3. Core temperature (measured in the rectum or esophagus) starts to fall, usually within minutes.
4. Once core temperature reaches 38.5°C, the immediate danger to the brain and organs drops sharply, so active cooling is stopped to prevent the body from getting too cold.

SAFETY WATCH

Monitor core temperature continuously with a rectal or esophageal probe; skin or ear thermometers are not accurate enough in heat stroke. · Stop cooling at 38.5°C to avoid hypothermia (too-low body temperature), which can cause dangerous heart rhythms. · If the person is shivering, the shivering makes more heat and fights your cooling; give a benzodiazepine (see below) to stop the shivering. · Do NOT give acetaminophen (Tylenol) or ibuprofen (Advil); heat stroke is not a fever from infection, it is direct heat injury to the hypothalamus, so fever medicines will not help and waste time.

0.9% Normal Saline (IV fluids) · Isotonic crystalloid (IV fluid replacement)

Heat stroke makes people lose huge amounts of water and salt through sweat, and the heart and blood vessels dilate (open wide) to try to dump heat, which drops blood pressure. IV normal saline replaces the lost fluid volume in the bloodstream so blood pressure stays high enough to push blood to the brain, kidneys, and other organs. It also helps the kidneys flush out myoglobin (a muscle protein released when heat breaks down muscle cells) to prevent kidney failure. Start IV fluids as soon as possible; many patients need 1–2 liters in the first hour, but the exact amount depends on blood pressure, urine output, and heart function.

1. Normal saline (salt water that matches the salt concentration of blood) flows into a vein through an IV catheter.
2. The fluid spreads through the bloodstream and raises the total volume of blood, which lifts blood pressure.
3. Better blood pressure pushes more blood through the kidneys, so the kidneys can filter waste and make urine.
4. Urine carries out myoglobin and other toxins before they clog the tiny kidney filters and cause acute kidney injury.

SAFETY WATCH

Watch for fluid overload: listen to the lungs for crackles (a sign of fluid backing up into the lungs) and check oxygen levels. · Monitor urine output (goal is at least 200–300 mL per hour if rhabdomyolysis is present) and kidney function (creatinine, BUN). · Check electrolytes (sodium, potassium, calcium) frequently because heat stroke and muscle breakdown can throw them dangerously out of balance. · If the person has heart failure or kidney disease, give fluids more slowly and watch closely for swelling and trouble breathing.

Benzodiazepines (e.g., lorazepam, diazepam) · GABA-A receptor agonist (central nervous system depressant)

Heat stroke often causes shivering (the body's automatic attempt to warm itself, even though it is already dangerously hot) and sometimes seizures (the overheated brain misfires). Both shivering and seizures make the muscles contract hard, which generates even more heat and worsens the stroke. Benzodiazepines boost the effect of GABA (the brain's main calming neurotransmitter) at GABA-A receptors in the brain and spinal cord. This calms overactive nerve cells, stops shivering, and stops seizures. Lorazepam 1–2 mg IV or diazepam 5–10 mg IV are common first choices. Do NOT use other anti-shivering drugs (like meperidine) that can raise body temperature or harm the heart in heat stroke.

1. The benzodiazepine molecule locks onto the GABA-A receptor on the surface of a nerve cell.
2. This makes the receptor more sensitive to GABA, so when GABA binds, the receptor opens wider and lets more chloride ions flow into the cell.
3. Chloride ions have a negative charge, so they make the inside of the cell more negative and harder to fire an electrical signal.
4. Nerve cells that control shivering and seizures quiet down, the muscles relax, and heat production from muscle work drops.

SAFETY WATCH

Monitor breathing rate and oxygen saturation closely; benzodiazepines can slow breathing, and heat stroke patients may already have lung injury or fluid in the lungs. · Be ready to support breathing with a bag-mask or ventilator if respiratory depression occurs. · Use the lowest effective dose; the goal is to stop shivering or seizures, not to sedate deeply. · Avoid giving other sedatives (like opioids or antipsychotics) at the same time unless absolutely necessary, because stacking sedatives raises the risk of stopped breathing or dangerously low blood pressure. · Benzodiazepines can lower blood pressure, so make sure IV fluids are running and blood pressure is monitored.

Red flags

- Core body temperature above 104°F (40°C)
- Confusion, bizarre behavior, or not making sense
- Seizures or loss of consciousness
- Stopped sweating in a very hot person (classic heat stroke)
- Rapid deterioration—getting worse by the minute

Nursing priorities

1. Start immediate whole-body cooling with ice water immersion up to neck level or evaporative cooling using water mist spray and high-powered fans while taking rectal or esophageal temperature every 5 to 10 minutes — Every minute above 40°C kills more brain cells and damages organs through protein destruction (denaturing). Core temperature must drop to 39°C within 30 minutes to prevent permanent brain damage and death. Rectal or esophageal temperature is the only accurate core temperature; skin, oral, and ear temperatures are wrong during heat stroke.
2. Stop all cooling measures when core temperature reaches 38.5°C to 39°C and watch for temperature rebound every 15 minutes for the next 2 hours — Overcooling causes dangerous shivering that makes more body heat and can drop temperature too low (hypothermia below 36°C), which causes heart rhythm problems. The body's temperature control center (hypothalamus) stays broken for hours after heat stroke, so temperature can climb back up without warning.
3. Insert two large-bore IV lines (18-gauge or bigger) and give cold normal saline bolus 1 to 2 liters fast while monitoring lung sounds and checking for leg swelling — Heat stroke causes massive fluid loss through sweating and fluid leaking from blood vessels into tissues (third-spacing). Dehydration makes blood pressure drop and reduces blood flow to kidneys, brain, and organs. Cold IV fluids help cool from inside while replacing volume, but too much fluid floods the lungs (pulmonary swelling (edema)), especially in elderly or heart failure patients.
4. Give benzodiazepine medicine (lorazepam 2 to 4 mg IV or midazolam 5 mg IV) immediately if patient has seizures or severe muscle shaking and tremors — Seizures and shivering both create more metabolic heat that fights our cooling efforts. Muscle activity releases potassium, causes rhabdomyolysis with myoglobin release, and increases oxygen demand. Benzodiazepines stop seizures and reduce muscle activity without lowering blood pressure as much as other seizure medicines.
5. Draw blood for complete metabolic panel checking potassium, creatinine, liver enzymes (ALT and AST), and creatine kinase (CK) levels; send urine to check for myoglobin; repeat these labs every 4 to 6 hours — Rhabdomyolysis releases myoglobin that clogs kidney filters and potassium that stops the heart. CK levels above 5,000 units per liter confirm muscle breakdown. Rising creatinine means acute kidney injury. High potassium (hyperkalemia above 5.5 mEq/L) causes deadly heart rhythms. Liver enzyme elevation shows liver damage from low blood flow and heat.

6. Place urinary catheter to measure urine output hourly with goal of 200 to 300 mL per hour; if urine is dark brown give IV sodium bicarbonate to make urine pH above 6.5 — Urine output shows if kidneys are working and if patient is getting enough IV fluid. Dark urine means myoglobin is present. Alkaline urine (higher pH from bicarbonate) keeps myoglobin dissolved so it does not crystalize and block kidney tubules. Target urine output prevents kidney failure (acute tubular tissue death (necrosis)).
7. Monitor heart rhythm continuously on telemetry and check ECG for peaked T waves, wide QRS, or arrhythmias; keep patient on supplemental oxygen with pulse oximetry goal above 94% — High potassium from muscle breakdown changes ECG showing tall pointy T waves first, then widening of QRS complex before the heart stops (cardiac arrest). Heat stroke damages the heart muscle directly (myocardial dysfunction) causing low cardiac output. ARDS (acute respiratory distress syndrome) develops in 20% of heat stroke patients from inflammatory response, needing early oxygen support.
8. Perform neurologic checks every 15 minutes using Glasgow Coma Scale and assess pupil reactions; report any worsening confusion, decreased responsiveness, or unequal pupils immediately — Brain swelling (cerebral swelling (edema)) can develop hours after cooling from inflammatory damage and reperfusion injury. Declining Glasgow Coma Scale or unequal pupils signal rising intracranial pressure needing head CT scan and possible neurosurgery consultation. Permanent brain injury correlates with how long the patient stayed confused and how high the peak temperature reached.

Sources

- CDC Heat Stress Guidelines
- American College of Sports Medicine (ACSM) Position Stand on Exertional Heat Illness
- Wilderness Medical Society Practice Guidelines for Heat Illness
- Annals of Internal Medicine / NEJM reviews on heat-related illness

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