

Heat Illness and Hypothermia

Heat stroke and hypothermia both break the body's thermostat—one cooks the organs, the other freezes the heart.

THE ONE-LINE TRUTH

When body temperature climbs above 40°C (104°F), the brain and organs start to cook and fail; when it drops below 35°C (95°F), the heart slows dangerously and blood chemistry falls apart.

The chain — how it unfolds

1. Heat illness: core temperature climbs above the safe zone (>40°C / 104°F) — why: Environmental heat plus exertion or impaired sweating overwhelm the body's cooling, so the hypothalamus can't bring temperature back down and the core keeps heating like an oven.
2. Direct heat injury to cells and proteins — why: Above 40°C, the heat unfolds (denatures) enzymes and structural proteins in neurons, liver cells, kidney tubules, and muscle fibers—like cooking an egg, the proteins clump and stop working—so brain cells swell and die, liver enzymes spill into blood, kidneys clog with debris, and muscles break open (rhabdomyolysis) releasing myoglobin and potassium into the bloodstream.
3. Multi-organ failure cascade in heat stroke — why: The brain's temperature control center itself gets cooked, causing confusion, seizures, and coma. Muscle breakdown dumps myoglobin into the kidneys, which clogs the filters and causes acute kidney injury. Liver cells die and release transaminases (ALT, AST shoot up into the thousands). Clotting factors denature, so the blood won't clot (coagulopathy and disseminated intravascular coagulation/DIC), leading to spontaneous bleeding. The heart struggles with low volume (from sweating) and high demands (fast rate, thick blood), so it can fail or throw clots.
4. Hypothermia: core temperature drops below 35°C (95°F) — why: Cold exposure (especially cold water, wet clothing, or wind) strips heat faster than shivering and metabolism can replace it; alcohol, drugs, or hypothyroidism blunt the shiver response, so temperature spirals down.

5. Cold slows chemistry and electrical conduction — why: Every enzyme works slower in the cold—metabolism drops roughly 6% per 1°C fall—so the brain gets sluggish (confusion, slurred speech, then coma), the heart beats slowly and irregularly (bradycardia, atrial fib, then ventricular fib), and kidneys make dilute urine despite dehydration because cold impairs the hormones that concentrate urine.
6. Severe hypothermia (<28°C): the heart becomes electrically unstable — why: Profound cold makes heart muscle stiff and disrupts sodium/potassium pumps, so any bump, rough movement, or sudden attempt to rewarm the shell before the core can trigger ventricular fibrillation—a chaotic quiver that pumps no blood and causes sudden cardiac arrest. Blood also gets thick and won't clot properly (cold inhibits clotting enzymes), so trauma or procedures cause uncontrolled bleeding.
7. Both cascades share a common thread: the body's compensations become part of the problem — why: In heat illness, sweating and skin vasodilation—meant to cool you—drain fluid and tank blood pressure, which then starves organs. In hypothermia, shivering and vasoconstriction—meant to warm you—burn through glucose and oxygen, exhausting reserves, and the slowed heart can't deliver what's left. So the very reflexes meant to restore 37°C accelerate the slide toward organ failure or arrest.
8. The treatment breaks the chain by directly fixing temperature — why: In heat stroke, rapidly cooling the core below 39°C within the first hour (ice packs to groin/axilla/neck, cold IV fluids, evaporative cooling, or ice-water immersion) stops the protein damage before permanent organ failure sets in. In hypothermia, gently rewarming the core (warm IV fluids, warm humidified oxygen, or extracorporeal warming for severe cases) restores enzyme function and rhythm without triggering V-fib. Everything else—IV fluids, oxygen, treating seizures or arrhythmias—is supportive; only correcting temperature stops the dominos.

Spot it — what you see, and why

- Heavy sweating that later stops (in heat stroke): At first, the body's cooling system — your sweat glands — works overtime trying to bring your temperature down. But when the core temperature climbs too high (above 104°F or 40°C), the brain's temperature control center (the hypothalamus, which acts like your body's thermostat) gets damaged and can no longer trigger sweating. When sweating stops in extreme heat, the skin becomes hot and dry, which is a dangerous sign that the body has lost its ability to cool itself.

- Confusion, slurred speech, or acting strange: Both extreme heat and extreme cold harm the brain's nerve cells (neurons). In heat illness, high core temperature literally cooks proteins inside brain cells and makes them swell. In hypothermia, cold slows down the chemical reactions that let brain cells send signals. Either way, the brain — especially the cerebral cortex (the outer layer responsible for thinking and speaking) — struggles to do its job, so thinking becomes fuzzy, words come out garbled, and behavior gets odd.
- Shivering (in mild hypothermia) or no shivering (in severe hypothermia): Shivering is your muscles' automatic way of making heat: they contract rapidly to burn energy and warm the blood. When core temperature drops to around 95°F (35°C), the hypothalamus orders muscles to shiver. But if the core keeps falling below about 90°F (32°C), the muscles run out of fuel (glucose and ATP, the body's energy currency) and the brain signals fade, so shivering stops. When shivering stops in a cold person, it means the body is too cold to defend itself anymore.
- Fast heart rate (tachycardia) or slow heart rate (bradycardia): In heat illness, the heart pumps faster to move hot blood from the core to the skin, where it can release heat through sweating. The sympathetic nervous system (the 'fight or flight' wiring) releases adrenaline, which speeds the heart. In hypothermia, cold slows every chemical reaction, including the electrical signals in the heart's pacemaker cells (in the sinoatrial node), so the heart rate drops — sometimes dangerously low, under 40 beats per minute.
- Nausea, vomiting, or loss of appetite: Both heat and cold stress the gut. In heat illness, blood is diverted away from the stomach and intestines to the skin (to cool the body), starving gut cells of oxygen (ischemia). This triggers nausea and can make the gut lining leak, releasing toxins. In hypothermia, cold slows gut motility (the wave-like muscle squeezes that push food along), causing nausea and a queasy feeling. The brain's vomiting center (in the medulla, at the base of the brain) gets activated by these signals.
- Muscle cramps or weakness: Heat cramps happen when heavy sweating washes out sodium and other electrolytes (minerals like potassium and magnesium) that muscles need to contract and relax smoothly. Without enough sodium, the nerve-muscle connection misfires and muscles lock up painfully. In hypothermia, cold makes muscles stiff and slow because the enzymes that drive muscle contraction work poorly at low temperatures, leading to clumsiness and weakness.

Red flags — act now

- Core temperature above 104°F (40°C) or below 95°F (35°C)
- Confusion, slurred speech, or loss of consciousness
- Hot, dry skin with no sweating in a hot environment (heat stroke)
- Seizures or uncontrollable shivering
- Very slow heart rate (under 50 beats/min) or irregular heartbeat in a cold person

Treat it — in this order

1. Immediate rapid cooling for heat stroke: ice-water immersion, cold IV saline, or evaporative cooling (mist + fans), targeting core temperature 38.5°C (101°F) within 30 minutes → Pulls heat out of the body faster than any other method. Cooling stops proteins from denaturing (unraveling), protects the brain and heart, and reverses the spiral toward multi-organ failure. Every minute above 40°C increases the risk of permanent brain damage.
2. Slow, controlled rewarming for hypothermia: passive warming (blankets, warm room) for mild (32–35°C), active external warming (warm blankets, forced-air warmers) for moderate (28–32°C), or active core rewarming (warm IV fluids, warm humidified oxygen, or extracorporeal warming) for severe (below 28°C), targeting 0.5–1°C per hour → Raises core temperature slowly so the heart does not go into a deadly rhythm (ventricular fibrillation) from sudden warming. Gentle warming wakes up the brain, unfreezes the heart's pacemaker, and restarts the body's normal chemistry. Fast rewarming or rough handling can trigger cardiac arrest.
3. IV normal saline bolus (1–2 liters in adults, 20 mL/kg in children) to restore blood volume → Heat stroke causes massive fluid loss through sweating, which drops blood pressure and makes the heart struggle to pump. Replacing fluid brings blood pressure back up, improves oxygen delivery to organs, and helps the kidneys flush out muscle breakdown products (myoglobin). In hypothermia, warm IV fluids also add gentle core heat.
4. Remove from heat source or cold environment immediately; stop exercise → Stops more heat from entering the body (sun, exercise, hot environment) or stops more heat from leaving the body (wind, water, wet clothes). Removing the trigger is the first step — no treatment works if the body keeps gaining or losing heat.
5. Treat seizures with benzodiazepines (lorazepam 2–4 mg IV or diazepam 5–10 mg IV); intubate and ventilate if airway is unsafe or brain swelling worsens → Heat stroke causes brain cells to swell and misfire, leading to seizures. Benzodiazepines calm the brain by boosting GABA (the brain's main calming chemical). Intubation protects the airway so the patient does not choke and ensures oxygen reaches the brain while it cools and heals.

Your top priorities at the bedside

1. Measure core body temperature using a rectal thermometer every 5 to 10 minutes and start immediate cooling if temperature is above 40 degrees Celsius (104 degrees Fahrenheit) — why: Core temperature above 40 degrees causes proteins in the brain and organs to break down; every minute of high temperature kills more brain cells, so rapid measurement and cooling prevents permanent brain damage and death

2. Remove all clothing and immerse the patient in ice water up to the neck, or apply ice packs to neck, armpits, and groin while pouring cold water over the body until core temperature reaches 38.5 degrees Celsius (101.3 degrees Fahrenheit) — why: Ice-water immersion cools the body fastest by pulling heat from the blood vessels near the skin surface; cooling must stop at 38.5 degrees to prevent overcooling into hypothermia (too-cold body temperature)
3. Start a large-bore IV line and give normal saline bolus at 20 milliliters per kilogram of body weight rapidly, while watching for lung crackles or shortness of breath — why: Heat causes blood vessels to dilate (widen) and fluid to leak out of vessels, dropping blood pressure and reducing blood flow to kidneys and brain; IV saline restores circulating blood volume and prevents kidney failure and shock