

Hypernatremia

High sodium (Hypernatremia) means not enough water for the amount of sodium in your blood. Brain cells shrink because water is pulled out of them.

THE ONE-LINE TRUTH

Sodium level is high because the body has too little water compared to salt.

The chain — how it unfolds

1. Water is lost from the body, or sodium is added, faster than replacement occurs. — why: Whether from diabetes insipidus dumping urine, diarrhea, burns weeping fluid, or too much salt given IV, the result is the same: the concentration of sodium in the blood climbs above 145 mEq/L because there is now too little water for the amount of sodium present.
2. Water moves out of cells into the bloodstream. — why: Water always flows toward higher concentration of particles (osmosis). High sodium in the blood pulls water out of every cell in the body, down the osmotic gradient, trying to dilute the blood back to normal.
3. Brain cells shrink. — why: Neurons and glial cells lose water and shrivel. The brain physically pulls away from the inside of the skull, stretching and sometimes tearing bridging veins (the small veins that connect the brain surface to the dura). This can cause subdural a pooled collection of blood (hematoma), intracerebral bleeding (hemorrhage), or subarachnoid bleeding, especially in infants and older adults.
4. The brain makes organic osmolytes (idiogenic osmoles) to protect itself. — why: To fight back against shrinking, brain cells synthesize or import small particles—taurine, glutamine, myoinositol, glutamate, and others—within hours to days. These raise the osmolality inside the cell so that water stops leaving and even flows back in slightly, cushioning the cell and preventing mechanical damage. This adaptation is protective but creates a trap for treatment.
5. If sodium is corrected too fast, water floods into brain cells. — why: When you give free water or hypotonic fluids, blood sodium falls quickly. But the brain still has high levels of organic osmolytes inside its cells from the adaptation. Now the inside of the cell is more concentrated than the blood, so water rushes into the brain cells down the new gradient, faster than the cell can clear out the osmolytes.

6. The brain swells inside the rigid skull. — why: The skull is a closed box with no room to expand. As brain cells take in water and swell, intracranial pressure rises. This compresses blood vessels (reducing oxygen delivery), squeezes the brainstem, and can cause herniation (the brain pushes down through the opening at the skull base), which is often fatal.
7. Seizures, altered mental status, coma, or death occur. — why: Rising intracranial pressure and brain swelling disrupt normal electrical signaling in neurons, triggering seizures. Brainstem compression shuts down breathing and heart rate control. This is why overcorrection of chronic high sodium (hypernatremia) is as dangerous as the high sodium itself.
8. Every step in this chain is the body trying to protect itself, not random damage. — why: Pulling water out of cells protects blood volume and tries to dilute sodium. Making osmolytes protects the brain from collapsing. Even the final swelling is water following physical laws, not a disease process. The job of the clinician is to understand the chain, correct the upstream break (restore water or remove excess sodium) at a safe speed, and not trigger the downstream disaster (cerebral swelling (edema) from overcorrection).

Spot it — what you see, and why

- Thirst: When sodium (salt) in the blood climbs too high, special sensors in the brain (the hypothalamus, the body's water-balance control center) notice the blood has become too salty and trigger a powerful thirst drive to make you drink and dilute the blood back down.
- Confusion or trouble thinking clearly: High sodium pulls water out of brain cells (osmosis—water moves from where there's less salt to where there's more salt), shrinking the cells slightly and slowing the electrical signals between them, which makes thinking foggy.
- Muscle weakness or twitching: Muscles need the right balance of sodium and water to contract smoothly; when sodium is too high and cells are dehydrated, the electrical signals that tell muscles to fire become erratic, causing weakness or twitches.
- Irritability or restlessness: Brain cells that regulate mood and behavior are especially sensitive to dehydration; as they shrink, their normal signaling is disrupted, making a person feel cranky, on edge, or unable to settle.
- Seizures: If sodium rises very fast or very high, brain cells shrink so much that the normal brakes on electrical activity fail, letting waves of uncontrolled signals fire across the brain—a seizure.
- Extreme drowsiness or coma: Severe dehydration of brain cells shuts down the arousal centers (the reticular activating system deep in the brainstem, which keeps you awake and aware), causing deep sleepiness or complete loss of consciousness.

Red flags — act now

- Seizure or sudden collapse—means the brain is in immediate danger from severe cell shrinkage.
- Cannot wake the person or they are deeply confused—sign of life-threatening brain dysfunction.
- Sodium above 160 mEq/L or rising faster than 0.5 mEq/L per hour—rapid or extreme rises can tear small blood vessels in the brain.
- No urine for many hours despite drinking, or urine output suddenly stops—may mean the kidneys are failing.

Treat it — in this order

1. Give free water by mouth, or give D5W (5% dextrose in water) IV if patient cannot drink → Water enters the bloodstream and dilutes the sodium back down. Water then moves back into shrunken brain and body cells. This reverses the cell shrinkage causing confusion and weakness.
2. Correct sodium slowly — drop sodium by no more than 10 mEq/L per 24 hours (goal 0.5 mEq/L per hour maximum) → Gives the brain time to dump the protective osmolytes it made when it was shrinking. Slow correction prevents water from rushing into brain cells too fast, which would cause brain swelling (cerebral swelling (edema)) and seizures.
3. For central diabetes insipidus, give desmopressin (DDAVP) — synthetic ADH → DDAVP replaces the missing ADH (antidiuretic hormone normally made by the hypothalamus). It tells the kidneys to hold water instead of dumping it. Water stays in the body, diluting sodium naturally.
4. For nephrogenic diabetes insipidus, give thiazide diuretic (hydrochlorothiazide or amiloride) plus low-sodium, low-protein diet → Thiazide diuretics make the kidneys reabsorb more water in the early part of the kidney tubule, even though the kidneys cannot hear ADH. Low sodium and low protein mean fewer particles (solutes) in the urine, so less water is dragged out with them.
5. Find and fix the root cause — stop medications causing water loss (lithium, diuretics), treat fever, cover burns, restore access to water, or treat the brain injury affecting thirst → Stops the ongoing water loss or restores the thirst signal. This prevents high sodium (hypernatremia) from coming back after you dilute the sodium.

Your top priorities at the bedside

1. Check sodium level and calculate how fast it rose; notify provider immediately if sodium is above 160 mEq/L or patient has altered mental status — why: Sodium above 160 mEq/L or rapid rise causes brain cells to shrink and bleed; seizures and coma can happen; you must know the baseline to calculate safe correction speed of 10 mEq/L per 24 hours maximum
2. Start seizure precautions: padded bed rails up, suction at bedside, oxygen ready, IV access secured — why: Shrinking brain cells from high sodium lower the seizure threshold (make seizures more likely); aspiration (breathing in vomit) during a seizure can cause death
3. Give free water by mouth if patient can swallow safely, or start D5W (5% dextrose in water) IV if ordered; recheck sodium every 2 to 4 hours during correction — why: Free water dilutes the high sodium concentration; D5W provides pure water because body cells use up the sugar quickly and only water enters cells; dropping sodium faster than 0.5 mEq/L per hour causes cerebral swelling (edema) (brain swelling) and death