

Kidney type of DI

Nephrogenic diabetes insipidus — the kidney ignores ADH (the body's 'save water' hormone), so it keeps making dilute pee even when the body is dry.

THE ONE-LINE TRUTH

The kidney cannot hear ADH's command to save water, so it makes huge amounts of watery pee no matter what the body needs.

The chain — how it unfolds

1. The kidney cannot respond to ADH → water channels (aquaporin-2) stay closed or broken → kidney keeps losing water into the pee. — why: Whether from lithium poisoning, high calcium, low potassium, or a birth defect in the V2 receptor or aquaporin-2 gene, the final common path is the same: ADH tries to tell the collecting ducts 'save water,' but the cells cannot hear it or cannot open the water doors, so water pours out and pee stays dilute (urine osmolality <200 mOsm/kg, often closer to 50–100).
2. Massive excessive urination (polyuria) (3–20 liters/day of pale, watery pee) → blood loses water faster than it is replaced → blood sodium starts to rise. — why: Every liter of dilute pee takes free water out of the blood but leaves salt behind. As water leaves, the remaining blood becomes saltier (hypernatremia). In a normal person, this would trigger more ADH and the kidney would slam the brakes, but here the brakes are broken, so pee keeps flowing.
3. Rising blood sodium → hypothalamus (brain's balance center) senses the salt climb → fires the thirst center → severe excessive thirst (polydipsia) (overwhelming, constant thirst and drinking). — why: The brain's osmoreceptors (salt sensors) in the hypothalamus detect even a 1–2% rise in blood sodium and turn on a powerful thirst drive. The person feels compelled to drink water all day and night, often waking every hour to gulp water. This is the body's only way to defend against getting too salty, because the kidney cannot help.
4. If the person can drink freely → they replace the lost water → blood sodium stays near normal (135–145 mEq/L) → they look 'stable' but are always on the edge. — why: Constant drinking matches constant peeing, so blood volume and sodium stay balanced — but this is a fragile tightrope. The person is never truly stable; they are compensating every minute. Vital signs (BP, HR) look okay because blood volume is maintained, which can fool the care team into thinking the problem is mild.

5. If water is restricted (sleep, vomiting, NPO for surgery, altered mental status) → intake drops below output → blood sodium climbs fast → high sodium (hypernatremia) ($\text{Na}^+ > 145$, often > 160 mEq/L). — why: Without constant drinking, the huge pee output is unopposed. Blood sodium shoots up, pulling water out of brain cells (osmosis). Brain cells shrink, triggering confusion, lethargy, irritability, muscle twitching, seizures, and — if sodium climbs above 160–170 mEq/L — coma and death. Infants and children crash fastest because their small size gives them almost no margin.
6. High sodium (Hypernatremia) → brain cells shrink → seizures, altered mental status, coma → risk of permanent brain damage or death if not corrected slowly. — why: Shrunken brain cells can tear small blood vessels, causing bleeding (intracerebral or subarachnoid bleeding (hemorrhage)). The danger continues during treatment: if you lower sodium too fast (> 10 – 12 mEq/L in 24 hours), water rushes back into brain cells faster than they can handle, causing cerebral swelling (edema) (brain swelling) and herniation. The safe correction is 0.5 mEq/L/hour or 10–12 mEq/L/day, using free water (by mouth or IV D5W) carefully.
7. Chronic excessive urination (polyuria) → bladder stretches (hydronephrosis, megacystis) and sleep is broken → developmental delays in children, exhaustion in adults. — why: The bladder fills every 30–60 minutes, waking the person constantly. Children may wet the bed for years, and infants may fail to gain weight (failure to thrive) because they are too busy drinking to eat. The social and physical toll is huge: school problems, work problems, chronic fatigue, and social isolation.
8. All findings — excessive urination (polyuria), excessive thirst (polydipsia), dilute urine, high sodium (hypernatremia) if deprived — trace back to one upstream break: the kidney cannot respond to ADH. — why: Every symptom, every lab abnormality, every complication flows from a single mechanical failure in the collecting duct. ADH is present (often elevated, because the body keeps trying), but the kidney cells are deaf to it. Fix the underlying cause (stop lithium, correct calcium or potassium, give a thiazide diuretic plus low-salt diet to reduce pee volume, or give desmopressin in central DI — but desmopressin does NOT work in nephrogenic DI because the problem is not ADH deficiency, it is ADH resistance). Understanding this one break makes every clinical decision logical: you must ensure free access to water, monitor sodium closely, and never restrict fluids unless you are prepared to give IV free water to prevent lethal high sodium (hypernatremia).

Spot it — what you see, and why

- You pee a huge amount every day — often 3 to 20 liters (like filling a big water jug, or even more than that): The collecting ducts in your kidneys (the tubes that normally grab water back from your pee) ignore the signal from ADH (antidiuretic hormone, the brain's 'save water' messenger). Because the ducts don't respond, they let tons of water escape straight into your bladder instead of pulling it back into your blood.

- You feel thirsty all the time and drink water constantly: Your blood gets more concentrated (saltier) because you're losing so much water in your pee. The hypothalamus (the brain's thirst center, deep inside your head) notices the salty blood and screams 'drink!' so you'll replace what you lost.
- You wake up many times at night to pee (nocturia): The kidney ducts can't concentrate your pee at night either — they ignore ADH around the clock — so your bladder fills up fast and wakes you to empty it, over and over.
- Your pee is very pale or almost clear: Because the collecting ducts don't reabsorb water, your urine stays super-dilute (watery). It's like pouring a tiny drop of lemonade powder into a gallon of water — it looks almost like plain water.
- Peeing and drinking keep happening even after you take desmopressin (DDAVP, a medicine that acts like ADH): In nephrogenic (kidney type) DI, the problem is in the kidney ducts themselves — they don't listen to ADH or to DDAVP (which is just man-made ADH). Giving more signal doesn't help if the receiver is broken.
- Babies may be fussy, have fevers, vomit, or not gain weight well: Babies with nephrogenic DI can't tell you they're thirsty, so they get dehydrated (not enough water in the body). Dehydration makes the body too hot, upsets the stomach, and stops normal growth because the baby can't keep enough water and nutrients inside.

Red flags — act now

- Blood sodium above 150 mEq/L (very salty blood — can cause confusion, seizures, or coma)
- A baby who is limp, won't wake up, has sunken eyes or a sunken soft spot, or stops making tears (severe dehydration)
- Sudden confusion, muscle twitching, or seizures in anyone with known diabetes insipidus (sign the brain is being hurt by salt imbalance)
- Not making any pee for hours despite drinking (might mean the kidneys shut down from severe dehydration or another emergency)

Treat it — in this order

1. Stop lithium immediately (if lithium is the cause); correct high calcium (hypercalcemia) (goal calcium < 10.5 mg/dL) with IV fluids, bisphosphonates, or calcitonin; correct low potassium (hypokalemia) (goal potassium > 3.5 mEq/L) with oral or IV potassium → Removing the toxin or metabolic poison lets the collecting duct cells start responding to ADH again. Lithium directly blocks the V2 receptor and downstream signaling. High calcium and low potassium disrupt the intracellular machinery that inserts aquaporin-2 water channels into the cell membrane. Fixing these upstream breaks can reverse acquired nephrogenic diabetes insipidus within days to weeks.

2. Low-sodium diet (restrict dietary sodium to < 2–3 grams per day) → Less sodium in the diet means less sodium reaches the blood, so the kidney does not have to make as much urine to dilute it. This reduces urine output (polyuria) by 30–50% and helps normalize blood sodium. It works by lowering the osmotic load the kidney has to clear.
3. Thiazide diuretic (hydrochlorothiazide 25–50 mg daily) or amiloride (5–10 mg daily, especially if lithium-induced) → Thiazides cause mild volume depletion, which triggers the proximal tubule (an earlier part of the kidney) to reabsorb more sodium and water before urine even reaches the broken collecting duct. This reduces urine volume by 30–50% even though ADH is still not working. Amiloride blocks sodium channels in the collecting duct and protects against lithium entry into cells, so it is preferred if lithium is the cause.
4. NSAIDs (indomethacin 25–50 mg two to three times daily) → NSAIDs reduce prostaglandin synthesis. Prostaglandins normally oppose ADH action in the collecting duct, so blocking them enhances whatever little ADH effect remains. Indomethacin can reduce urine output by 25–40% in nephrogenic diabetes insipidus. It also reduces glomerular filtration rate slightly, lowering the total amount of fluid the kidney has to process.
5. Ensure unlimited free access to water at all times; educate patient, family, and caregivers to allow drinking to thirst without restriction → Letting the person drink as much as they want prevents dangerous high sodium (hypernatremia) and dehydration. Thirst is the body's natural alarm system—if it is working, the patient will drink enough to replace urine losses and keep blood sodium near normal. This is the essential safety net while other treatments take effect.

Your top priorities at the bedside

1. Ensure the patient has unrestricted access to water or fluids at the bedside and throughout the care area at all times — why: The kidneys cannot concentrate urine (make it less watery) because ADH receptors do not work, so massive water loss continues. Patients must drink constantly to match urine output or they develop severe high sodium (hypernatremia) and dehydration within hours.
2. Monitor serum sodium level every 4 to 6 hours during acute management and watch for confusion or lethargy signaling high sodium (hypernatremia) — why: Nephrogenic DI causes the kidneys to dump free water while holding sodium, raising blood sodium dangerously high. High sodium (Hypernatremia) above 145 mEq/L (normal is 135–145) shrinks brain cells, causing confusion, seizures, coma, and death if untreated.
3. Measure and record urine output every hour and compare to fluid intake to identify negative fluid balance early — why: Urine output often exceeds 3 to 15 liters daily in nephrogenic DI. Detecting when output surpasses intake prevents hypovolemia (low blood volume) that drops blood pressure and shuts down kidneys.