

Acute Kidney Injury

The body's filter clogs. Everything the filter should catch now floats in the blood.

THE ONE-LINE TRUTH

The kidneys suddenly stop cleaning the blood fast enough—waste piles up, salt and water go out of balance, and every organ starts to feel it within hours to days.

The chain — how it unfolds

1. Trigger hits the kidney: severe dehydration (vomiting, diarrhea, not drinking), sepsis (bloodstream infection that drops blood pressure), major bleeding, heart failure (heart cannot pump enough blood forward), IV contrast dye (used in CT scans, toxic to tubules especially in people with diabetes or existing kidney disease), NSAIDs (ibuprofen, naproxen—they block prostaglandins that keep kidney blood vessels open), ACE inhibitors or ARBs during dehydration (they relax the vessel that drains the filter, dropping pressure inside), aminoglycoside antibiotics (gentamicin, tobramycin—directly poison tubule cells), kidney stone stuck in the ureter, or enlarged prostate (BPH) blocking urine flow out of the bladder. — why: Any hit to blood flow (pre-renal), poison or injury to the filter tissue itself (intrinsic), or blockage stopping urine from draining (post-renal) can trigger AKI.
2. Glomerular filtration rate—GFR—drops. This is the speed at which blood gets filtered. Normal is around 90–120 mL per minute. In AKI it can fall to half that or lower within hours. — why: Less blood reaches the filters, or the filters themselves are damaged and cannot clean blood anymore.
3. Serum creatinine and BUN start climbing in the blood. Creatinine is a waste product made by muscles every day; BUN comes from breaking down protein. Both are normally filtered out and dumped into urine. — why: The kidney cannot clear waste fast enough, so it backs up into the bloodstream like a clogged drain.
4. Urine output drops. Low urine output (Oliguria) means less than 400 mL in 24 hours (less than about one and a half cups). No urine output (Anuria) means less than 100 mL a day (almost no urine at all). — why: Either not enough blood is reaching the filter to make urine, or the tubule cells are dead and cannot process fluid anymore.

5. Potassium builds up in the blood (hyperkalemia). Normal potassium is 3.5–5.0 mEq/L; in AKI it can climb to 6, 7, or higher. Acid also builds up (metabolic too much acid in the blood (acidosis)), dropping blood pH below 7.35. — why: The kidney normally dumps potassium and hydrogen ions into urine every day. When the kidney stops working, both pile up in the blood.
6. Fluid overloads the body. Lungs fill with water (pulmonary swelling (edema)), causing shortness of breath, cough, and low oxygen. Legs and ankles swell (pitting swelling—you press the skin and a dent stays). Weight climbs fast—sometimes several pounds in one day. Blood pressure may spike because extra fluid increases the volume in the blood vessels. — why: The kidney cannot get rid of salt and water anymore. Every glass of water you drink, every bit of salt in food, stays in the body and has nowhere to go.
7. Severe waste buildup in the blood (Uremia) develops. Waste products (urea, creatinine, guanidine compounds, and many others) reach toxic levels. Patients feel sick to their stomach, itch all over, taste metal, become confused or drowsy (uremic encephalopathy), and may develop pericarditis (chest pain from inflammation of the sac around the heart). If potassium climbs high enough, the heart rhythm becomes dangerously unstable (peaked T waves on EKG, then wide QRS, then ventricular fibrillation and cardiac arrest). — why: Waste and electrolytes that should leave the body every day are now poisoning the brain, heart, and every other organ.
8. Without treatment—fixing the cause, giving IV fluids (if pre-renal), stopping nephrotoxic drugs, relieving any obstruction (catheter for BPH, stent or surgery for stone), and sometimes urgent dialysis—AKI can become irreversible. Patients may need long-term dialysis or develop chronic kidney disease. In the most severe cases, multi-organ failure and death occur within days. — why: The longer the kidney goes without blood flow or stays poisoned, the more tubule cells die. Once enough nephrons are lost, the kidney cannot recover. Meanwhile, high potassium can stop the heart, fluid overload can drown the lungs, and uremic toxins can shut down the brain.

Spot it — what you see, and why

- Decreased urine output (oliguria < 400 mL/day or no urine output (anuria) < 100 mL/day): The kidney's filter speed (glomerular filtration rate, or GFR) has dropped, so less blood gets cleaned and less urine is made. Think of it like a water filter that's clogged—less water comes out the other side.
- Swelling in legs, ankles, hands, or face (peripheral swelling (edema)): The kidney can't dump extra salt and water into the urine, so fluid builds up in the blood and leaks into the tissues. It's like overfilling a water balloon—fluid seeps out where it shouldn't be.

- Shortness of breath, wet cough, or crackles on lung exam (pulmonary swelling (edema)): Extra fluid backs up from the bloodstream into the tiny air sacs of the lungs (alveoli), making it hard to breathe. It's like trying to breathe through a wet sponge.
- Nausea, vomiting, and loss of appetite: Waste products (urea, creatinine, and other toxins) pile up in the blood because the kidney isn't cleaning them out. These uremic toxins irritate the stomach lining and trigger vomit signals in the brain.
- Itching all over (uremic itching (pruritus)): Uremic waste in the blood irritates nerve endings in the skin, making you itch. The exact reason isn't fully known, but the build-up of toxins is the trigger.
- Confusion, drowsiness, or altered mental status (uremic encephalopathy): Uremic toxins cross from the blood into the brain and poison the nerve cells (neurons), slowing down brain signals. It's like fog rolling into your thoughts.

Red flags — act now

- Potassium > 6.5 mEq/L or EKG changes (peaked T waves, wide QRS, sine wave)—heart can stop at any moment (cardiac arrest)
- Pulmonary edema (fluid flooding the lungs) (wet lungs, crackles, shortness of breath) not getting better with diuretics (water pills like furosemide)—dialysis needed urgently to pull fluid off
- Uremic encephalopathy (confusion, lethargy), pericarditis (chest pain with friction rub), or uremic bleeding (nose bleeds, bruising)—severe waste buildup in the blood (uremia) requiring urgent dialysis
- No urine output (Anuria) (no urine at all) plus a palpable bladder or hydronephrosis (swollen kidneys) on ultrasound—obstruction blocking urine flow; needs urgent catheter or nephrostomy tube
- Toxic ingestion (methanol, ethylene glycol, lithium, aspirin overdose)—dialyzable poison requiring emergent hemodialysis to remove it before it kills the patient

Treat it — in this order

1. Stop all nephrotoxic drugs immediately: NSAIDs (ibuprofen, naproxen, ketorolac), aminoglycoside antibiotics (gentamicin, tobramycin), hold ACE inhibitors or ARBs, hold metformin → Removes the chemical insult that is damaging the kidneys. Stopping metformin prevents lactic acidosis (acid from oxygen-starved tissues) (dangerous buildup of lactic acid when the kidneys cannot clear it). Holding ACE inhibitors and ARBs allows kidney blood vessels to autoregulate (adjust blood flow) better during injury.

2. Give intravenous isotonic crystalloid fluids (normal saline or lactated Ringer's solution) ONLY if the patient is volume-depleted (dry mucous membranes, low blood pressure, high heart rate) → Restores blood flow to the kidneys so they can filter again. Reverses pre-renal AKI by correcting low blood flow (perfusion) (low blood delivery). Creatinine should start dropping within 24 to 48 hours if this was the main problem.
3. Give loop diuretics (furosemide, bumetanide) if the patient is fluid-overloaded with crackles in the lungs or swelling—do NOT use in pre-renal AKI → Removes excess fluid from the body by making the kidney excrete more urine. Relieves symptoms like shortness of breath from pulmonary edema (fluid flooding the lungs).
4. Treat high potassium (hyperkalemia) in the following sequence: (1) intravenous calcium gluconate 1 gram over 2 to 3 minutes, (2) insulin 10 units IV with dextrose 25 grams IV, (3) inhaled albuterol 10 to 20 mg by nebulizer, (4) oral or rectal potassium binders (sodium polystyrene sulfonate, patiomer, sodium zirconium cyclosilicate), (5) urgent dialysis if refractory → Calcium gluconate stabilizes the heart cell membrane in 1 to 3 minutes to prevent arrhythmia (does not lower potassium). Insulin and albuterol shift potassium from blood into cells within 15 to 30 minutes, lowering serum potassium by 0.5 to 1 mEq/L temporarily (lasts 4 to 6 hours). Binders and dialysis physically remove potassium from the body (permanent removal).
5. Relieve urinary obstruction urgently: place a Foley catheter if the bladder is blocked (urinary retention), place a nephrostomy tube (tube through the skin into the kidney) or ureteral stent (tube inside the ureter) if the ureters or kidney outlet are blocked → Restores urine drainage immediately. If obstruction was the only cause of AKI, creatinine often starts dropping within hours once the blockage is relieved. Prevents permanent scarring of the kidney from prolonged high pressure.

Your top priorities at the bedside

1. Strict I/O and daily weight — why: Best trend for volume status.
2. Recognize high potassium (hyperkalemia) signs early (EKG changes, weakness) — why: K > 6.5 is a code waiting to happen.
3. Hold all nephrotoxic drugs; check every medicine on the list — why: Ongoing insult delays recovery.