

ESRD & Dialysis Complications

End-stage kidney disease means the kidneys have stopped working (below 15% function), so the person needs dialysis or a transplant to survive—watch for fluid overload, dangerous potassium spikes, access clots, and infections between treatments.

THE ONE-LINE TRUTH

When kidneys fail completely, the body cannot clean the blood or balance fluids and minerals—only dialysis or a transplant can do that job.

The chain — how it unfolds

1. The nephrons die off (from diabetes, high blood pressure (hypertension), or other kidney disease) until fewer than 15% are working (GFR below 15 mL/min)—the kidneys cannot filter waste, balance minerals, control fluid, or make hormones. — why: The underlying disease (high blood sugar, high blood pressure, autoimmune attack, inherited cysts) damages the glomeruli (filter balls) and tubules (twisty tubes) over years; scar tissue replaces working nephrons, and once you lose 85% or more, the kidney can no longer sustain life on its own.
2. Waste (urea, creatinine) piles up in the blood (uremia), causing nausea, vomiting, loss of appetite, confusion, itching, a metallic taste, and eventually seizures or coma if untreated. — why: Urea and creatinine are breakdown products of protein and muscle; normally the kidneys dump them into urine, but when filtration fails, they accumulate in the blood and poison the brain, gut, and nerves—this is called uremic syndrome.
3. Potassium climbs (hyperkalemia) because the tubules cannot secrete it into urine—serum potassium above 6.0–6.5 mEq/L can cause dangerous heart rhythms (peaked T waves, wide QRS, sine wave, cardiac arrest). — why: Potassium controls the electrical charge across heart muscle cells; too much potassium makes the cells fire unpredictably, and the heart can stop suddenly—this is the most immediate life threat between dialysis sessions.

4. Acid builds up (metabolic too much acid in the blood (acidosis), low serum bicarbonate) because the kidneys cannot excrete hydrogen ions or make new bicarbonate—this causes fast breathing (Kussmaul), weakness, confusion, and breaks down bone and muscle. — why: The blood pH drops below 7.35; the body tries to compensate by breathing faster to blow off CO₂ and by pulling calcium carbonate from bone to buffer the acid, but this only buys time and weakens the skeleton.
5. Fluid overloads the body (volume overload) because the kidneys cannot pull off extra water—this causes swelling (edema in the legs, face), high blood pressure, and fluid in the lungs (pulmonary swelling (edema), shortness of breath, crackles on exam). — why: Every cup of water you drink or infuse stays in the bloodstream (no urine to dump it), so the heart has to pump against higher pressure, fluid leaks into the tissues and air sacs of the lungs, and the person feels like they are drowning.
6. Without erythropoietin (EPO) from the kidneys, the bone marrow does not make enough red blood cells—anemia (low hemoglobin) causes fatigue, pale skin, shortness of breath, dizziness, and worsens heart strain. — why: EPO is the hormone signal that tells the bone marrow to produce red blood cells; without it, hemoglobin drops (often below 10 g/dL), so oxygen delivery to tissues falls and the heart has to pump faster to compensate, which accelerates heart failure.
7. Without calcitriol (active vitamin D), calcium absorption drops, phosphorus rises (because kidneys cannot excrete it), and the parathyroid glands pour out PTH—this pulls calcium from bone (renal osteodystrophy), causing fractures, bone pain, and deposits calcium-phosphate in arteries and heart valves (vascular calcification). — why: Low calcium and high phosphorus signal the parathyroid glands to release parathyroid hormone (PTH); PTH leaches calcium from bone to raise serum calcium, but this weakens the skeleton and the high phosphorus binds calcium to form crystals that stiffen blood vessels—these calcified arteries raise the risk of heart attack and stroke.
8. Dialysis (hemodialysis 3 times a week) removes some waste, potassium, acid, and fluid—but only for a few hours, so between sessions everything creeps back up, and the patient lives in a cycle of buildup and cleanup. — why: Dialysis runs blood through an external filter (the dialyzer) that pulls out urea, creatinine, potassium, and water by diffusion and ultrafiltration—but it cannot fully replace the kidney's 24/7 work, cannot make hormones, and leaves gaps between sessions where toxins and fluid accumulate again.

Spot it — what you see, and why

- Swelling in the legs, ankles, or face: The kidneys can no longer remove extra water from the blood, so fluid builds up in the body's tissues (like a sponge soaking up water it cannot wring out).

- Shortness of breath: Extra fluid backs up into the lungs (pulmonary swelling (edema)), making it harder for air sacs to fill with oxygen; or waste products in the blood (uremia) make the lungs inflamed and stiff.
- Feeling very tired and weak all the time (fatigue): The kidneys no longer make enough erythropoietin (the hormone that tells bone marrow to build red blood cells), so the blood cannot carry enough oxygen to muscles and the brain, causing anemia.
- Itching all over (uremic itching (pruritus)): Waste products like urea and phosphate pile up in the blood and irritate nerve endings in the skin; also, extra phosphate can form tiny crystals in the skin that trigger itching.
- Nausea, vomiting, or loss of appetite: High levels of urea and other toxins (uremia) irritate the stomach lining and trigger the brain's vomiting center (the area postrema in the brainstem), making food unappealing and causing sickness.
- Trouble thinking clearly or concentrating (brain fog): Toxins like urea cross into the brain and interfere with neurotransmitters (the brain's chemical messengers), slowing down signals between nerve cells; low red blood cells also mean less oxygen reaches the brain.

Red flags — act now

- Sudden severe shortness of breath or chest pain — may mean fluid in the lungs or a heart problem and needs emergency care right away.
- Fever with chills, especially with redness, warmth, or drainage at the dialysis catheter or fistula site — may be a blood infection (sepsis) and needs antibiotics and urgent evaluation.
- New confusion, severe headache, seizure, or trouble staying awake — may mean toxins are affecting the brain (uremic encephalopathy) or there is bleeding in the brain and needs immediate attention.
- Irregular heartbeat, palpitations, or feeling like the heart is racing or skipping beats — may be dangerously high potassium and needs an ECG and emergency treatment to protect the heart.

Treat it — in this order

1. Hemodialysis (typically 3 times per week, 4 hours per session) or peritoneal dialysis (daily exchanges at home) → The dialysis machine does what broken kidneys cannot: it pulls out extra water, potassium, urea, creatinine, and acid through a filter (artificial kidney). This reverses the toxic buildup (uremia) and fluid overload that happen between sessions.

2. Create and maintain vascular access (arteriovenous fistula preferred, then arteriovenous graft, then tunneled dialysis catheter as last resort) → A good access (preferably an AVF, where a surgeon connects an artery directly to a vein in the arm) lets blood flow fast enough through the dialysis machine — at least 300–400 mL per minute — so toxins and fluid actually leave the body efficiently in 4 hours.
3. Phosphate binders (calcium carbonate, sevelamer, lanthanum) taken with meals, plus calcitriol (active vitamin D) or calcimimetics (cinacalcet) to control parathyroid hormone → Broken kidneys cannot filter out phosphate or activate vitamin D, so phosphate rises, calcium drops, and the parathyroid gland works overtime (secondary hyperparathyroidism). This leaches calcium from bones (renal osteodystrophy) and deposits it in blood vessels and heart valves (vascular calcification). Phosphate binders trap phosphate in the gut so it leaves in stool instead of blood. Calcitriol replaces the missing active vitamin D. Calcimimetics tell the parathyroid gland to calm down.
4. Erythropoiesis-stimulating agent (ESA: epoetin alfa or darbepoetin alfa injected weekly or every 2 weeks) plus intravenous iron supplementation → Broken kidneys stop making erythropoietin (the hormone that signals bone marrow to produce red blood cells), so red blood cell production drops and anemia develops. ESA replaces the missing erythropoietin. Iron (given IV because gut absorption is poor in ESRD) supplies the raw material to build hemoglobin inside red blood cells.
5. Dietary restriction: potassium < 2–3 grams/day, sodium < 2 grams/day, fluid intake limited to urine output plus 1 liter per day (most ESRD patients make little to no urine) → Restricting what enters the body between dialysis sessions reduces the gap between toxic buildup and the next cleaning. This prevents dangerous potassium spikes (hyperkalemia), pulmonary edema (fluid flooding the lungs) from fluid overload, and high blood pressure from sodium and volume.

Your top priorities at the bedside

1. Assess dialysis access site for thrill, a whooshing sound over a vessel (bruit) (whooshing sound with stethoscope), redness, swelling, warmth, and drainage every 4 hours — why: The access is the patient's lifeline for dialysis; a clot stops treatment and needs emergency intervention, while infection can cause sepsis and death if not caught early
2. Weigh patient on same scale at same time daily and compare to dry weight (goal weight after dialysis removes extra fluid) — why: Each kilogram of weight gain equals one liter of retained fluid; tracking trends prevents pulmonary edema (fluid flooding the lungs) (fluid in lungs) and guides how much fluid to remove during next dialysis

3. Monitor vital signs and assess for fluid overload: listen to lung sounds for crackles, check jugular venous distension (bulging neck veins), and examine ankles for pitting swelling (edema) (indents when pressed) — why: Kidneys cannot remove excess fluid, so it backs up into lungs and tissues; early detection allows urgent dialysis before respiratory failure occurs