

Tumor Lysis Syndrome

Tumor lysis syndrome happens when cancer cells die in huge numbers and spill their insides — potassium, phosphate, and uric acid — into the bloodstream faster than the kidneys can clean it up.

THE ONE-LINE TRUTH

Cancer treatment kills millions of cancer cells so fast that the kidneys cannot clear all the stuff they dump into the blood.

The chain — how it unfolds

1. Chemotherapy or targeted therapy kills millions of cancer cells within hours — why: Drugs like cytarabine, cyclophosphamide, steroids (dexamethasone, prednisone), or rituximab trigger rapid cancer cell death (apoptosis or tissue death (necrosis)) in bulky, fast-growing tumors like Burkitt lymphoma, acute lymphoblastic leukemia, or acute myeloid leukemia. Each dying cell bursts open and spills its insides into the bloodstream.
2. Potassium floods the blood (hyperkalemia) — why: Every cell holds potassium inside at high concentration (about 140 mEq/L inside vs. 4 mEq/L outside). When millions of cells rupture at once, potassium pours into the blood, spiking serum potassium to 6, 7, or even 8 mEq/L within 12–24 hours.
3. The heart's rhythm falls apart — why: The heart's electrical system depends on a precise potassium gradient across heart muscle cells. High potassium depolarizes (flattens) the cell membranes so they cannot repolarize (reset) after each beat. The EKG shows tall, peaked T waves first, then the QRS complex widens, the P wave disappears, and finally the rhythm degenerates into a sine wave, ventricular fibrillation, or asystole (flatline) — cardiac arrest.
4. Phosphate floods the blood (hyperphosphatemia) — why: Dying cells also release phosphate (another mineral stored inside cells). Blood phosphate shoots up to 6, 8, or 10 mg/dL or higher, far above the normal range of 2.5–4.5 mg/dL.
5. Phosphate binds calcium and drops blood calcium (hypocalcemia) — why: Phosphate and calcium are chemical opposites: when phosphate rises, it grabs onto calcium and forms solid calcium-phosphate crystals that deposit in tissues. Free calcium in the blood plummets, often below 7 mg/dL (normal is 8.5–10.5 mg/dL).

6. Muscles twitch and the brain seizes — why: Calcium is the off-switch for muscle contraction and the brake on nerve firing. Without enough free calcium, muscles cannot relax after they contract (causing tetany — rigid, painful muscle spasms, especially in the hands and feet) and neurons fire uncontrollably (causing tonic-clonic seizures).
7. Uric acid floods the blood and crystallizes in the kidneys (hyperuricemia and crystal nephropathy) — why: When DNA from dying cancer cells breaks down, the liver converts the purine bases (adenine and guanine) into uric acid. Uric acid levels spike to 10, 15, or 20 mg/dL (normal is under 7 mg/dL). Uric acid is not very soluble, especially in acidic urine, so it forms sharp, needle-shaped crystals in the kidney tubules, physically clogging them like sand blocking a drainpipe.
8. The kidneys fail (acute kidney injury) — why: Uric acid crystals and calcium-phosphate crystals obstruct the tubules and damage the nephrons (the kidney's working filters). Urine output drops (oliguria) or stops (anuria), creatinine and BUN rise, and the kidneys can no longer clear potassium, phosphate, or any other waste. This makes the high potassium (hyperkalemia) and hyperphosphatemia even worse, creating a vicious cycle.

Spot it — what you see, and why

- Fast or skipping heartbeat (arrhythmia): High potassium (from cancer cells breaking open) makes the heart's electrical signals misfire, so the heart beats out of rhythm or stops suddenly.
- Muscle stiffness, cramps, or twitching (tetany): Low calcium (pulled into crystals with the high phosphate released from dying tumor cells) makes nerves fire too easily, causing muscles to lock or jerk.
- Seizures: Low calcium or high phosphate throws off the brain's electrical balance, so neurons fire all at once, triggering a seizure.
- Peeing very little or not at all (acute kidney injury): Calcium and phosphate crystals clog the tiny filters (tubules) in the kidneys, and uric acid (from tumor DNA breaking down) plugs them further, so urine can't flow out.
- Nausea, vomiting, or diarrhea: High uric acid and high phosphate irritate the gut lining, and the kidneys can't clear waste, so toxins build up in the blood and upset the stomach.
- Feeling very tired and weak: High potassium, low calcium, and kidney failure together slow the heart and muscles and make cells struggle to do their jobs, draining energy.

Red flags — act now

- Heart rhythm suddenly becomes very slow, very fast, or stops (from dangerously high potassium)
- Urine output drops to almost nothing within hours of starting cancer treatment

- Seizure or severe muscle spasms (tetany) that won't stop

Treat it — in this order

1. Aggressive IV hydration with normal saline at 200–250 mL/m² per hour (about 3 L/m² per day) to keep urine output at least 80–100 mL/m² per hour → Flooding the bloodstream with IV fluid dilutes the burst-cell contents (potassium, phosphate, uric acid) and flushes them through the kidneys faster. Fast-flowing urine washes uric acid out before it can settle and turn into sharp crystals that clog the kidney tubes. This protects the kidneys from shutting down.
2. Rasburicase (a recombinant enzyme) for high-risk patients, or allopurinol for low-to-intermediate risk, to lower uric acid → Rasburicase breaks down uric acid that already exists in the blood into allantoin, a harmless substance that dissolves easily and leaves through urine. This stops uric acid from crystallizing in the kidneys. Allopurinol blocks the enzyme (xanthine oxidase) that makes new uric acid, so less is produced going forward. Rasburicase works in hours; allopurinol takes days.
3. Treat high potassium (hyperkalemia) with IV calcium gluconate (if EKG shows dangerous changes), insulin + dextrose (glucose), inhaled beta-agonists (albuterol), and oral or rectal potassium binders (sodium polystyrene sulfonate, patiromer) → Calcium gluconate protects the heart muscle from high potassium's dangerous electrical effects for 30–60 minutes but does not lower potassium itself. Insulin + dextrose and beta-agonists push potassium out of the blood and into cells temporarily (within minutes to hours). Potassium binders remove potassium from the body through stool over hours to days. Together, these treatments prevent deadly heart rhythms.
4. Oral phosphate binders (sevelamer or lanthanum carbonate, NOT calcium-based if phosphate is very high) and avoid giving IV calcium until phosphate drops below 6 mg/dL → Phosphate binders stick to phosphate in the gut so the body does not absorb it from food. This lowers the amount of new phosphate entering the blood. Giving IV calcium too early when phosphate is sky-high causes calcium and phosphate to combine and form hard crystals that deposit in tissues (calcification), which damages organs. Lowering phosphate first makes it safe to replace calcium.
5. Continuous heart (cardiac) monitoring on telemetry and urgent hemodialysis if potassium > 6.5 mEq/L despite treatment, phosphate > 10 mg/dL, severe symptoms (seizure, dangerous heart rhythm), or acute kidney injury with rising creatinine and low urine output → Continuous monitoring catches deadly heart rhythm changes the moment they start, so you can act in seconds. Hemodialysis (a machine that filters the blood) directly removes potassium, phosphate, and uric acid from the bloodstream in hours and takes over kidney function when the kidneys shut down. It is the only treatment that can drop all three electrolytes fast when medications are not enough.

Your top priorities at the bedside

1. Place patient on continuous cardiac monitoring and check potassium level immediately if any arrhythmia appears — why: High potassium (Hyperkalemia) (high potassium) from dying tumor cells causes peaked T waves then wide QRS complexes on EKG and can lead to ventricular fibrillation and cardiac arrest within minutes
2. Measure intake and output every hour and notify the provider if urine output drops below 100 mL per hour or 2 mL per kilogram per hour in children — why: The kidneys must flush out huge amounts of uric acid, potassium, and phosphate; decreased urine output means uric acid crystals are blocking kidney tubules and acute kidney failure is starting
3. Run IV normal saline at the ordered rate of 3 liters per square meter per day (usually 200 to 250 mL per hour in adults) without stopping for bathroom breaks — why: High-volume hydration dilutes uric acid and other toxins in the blood and kidney tubules so crystals cannot form; also increases urine flow to wash out the metabolic waste before it damages kidneys