

Salicylate Toxicity

When you take too much aspirin, it uncouples mitochondria (your cell power plants), so they burn energy as heat instead of storing it. Your brain screams 'breathe faster!' to blow off acid, which makes your blood too alkaline at first, then too acidic as more poison builds up. Doctors give you IV sodium bicarbonate to make your pee alkaline so your kidneys can dump the aspirin faster, and they use hemodialysis to clean your blood if the level is dangerously high.

THE ONE-LINE TRUTH

Too much aspirin poisons the tiny power plants inside your cells, makes your breathing race, and floods your blood with acid.

The chain — how it unfolds

1. Aspirin saturates the liver's enzyme pathways and starts piling up in the blood. — why: At toxic doses, the liver can't break down aspirin fast enough. The drug switches to zero-order kinetics, meaning even a small extra dose causes a big jump in blood level.
2. Salicylate crosses into cells and uncouples mitochondria, so they burn energy as heat instead of storing it as ATP. — why: Salicylate makes the inner mitochondrial membrane leaky to protons. The electron transport chain keeps running, but no ATP is made. All the energy comes out as heat, so the patient gets hot (hyperthermia) and cells run out of fuel.
3. The medulla (brainstem breathing center) is directly stimulated by salicylate, triggering fast, deep breathing (hyperventilation). — why: Salicylate acts like a chemical alarm in the medulla. It makes you breathe hard even before CO₂ or oxygen levels change. This blows off CO₂ and causes respiratory alkalosis (blowing off too much carbon dioxide) (blood becomes too alkaline).
4. At the same time, salicylate dumps acid (H⁺) into the blood and uncoupling causes lactic acid to build up, so you develop high anion-gap metabolic acidosis (acid building up in the blood). — why: Salicylate is an organic acid. When mitochondria can't make ATP the normal way, cells switch to anaerobic metabolism (burning glucose without oxygen), which makes lactic acid. Now you have two sources of acid flooding the blood.

5. You end up with a mixed acid-base disorder: respiratory alkalosis (blowing off too much carbon dioxide) (from hyperventilation) and metabolic acidosis (acid building up in the blood) (from salicylate and lactic acid) at the same time. — why: This is the hallmark of salicylate toxicity. Your blood gas shows low CO₂ (because you're breathing it off) and low bicarbonate (because acid is eating it up). The pH can be high, normal, or low depending on which problem is winning at that moment.
6. Your ears ring (tinnitus) and you may have trouble hearing. — why: Salicylate poisons the hair cells in the cochlea (the hearing organ in your inner ear) and damages the eighth cranial nerve (the hearing and balance nerve). This causes a high-pitched ringing and temporary hearing loss.
7. You feel sick to your stomach, throw up, and may have belly pain. — why: Salicylate directly irritates the lining of the stomach and triggers the vomiting center in the brainstem (area postrema). Vomiting makes you lose fluids and electrolytes, which worsens dehydration and kidney function.
8. Your blood sugar drops (hypoglycemia), especially in young children. — why: Uncoupling increases the cells' hunger for glucose, but it also blocks the liver from making new glucose (gluconeogenesis). Once stored glycogen runs out, blood sugar crashes and the brain starves.

Spot it — what you see, and why

- Breathing very fast and deep: Aspirin directly tickles the breathing center in the brainstem (the control tower at the base of the brain), forcing you to take big, fast breaths. This blows off carbon dioxide and makes the blood turn basic (alkaline), like adding too much baking soda.
- Ringing in the ears (tinnitus): Aspirin builds up in the fluid of the inner ear and irritates the tiny hair cells that sense sound, making them fire off false signals that you hear as ringing or buzzing.
- Nausea and throwing up: Aspirin irritates the stomach lining directly and also triggers the vomiting center in the brainstem (the part of the brain that controls the urge to throw up).
- Confusion or acting strange: High levels of aspirin cross into the brain and interfere with how nerve cells make energy, slowing their signals and scrambling thinking.
- Very high body temperature (hyperthermia): Aspirin uncouples oxidative phosphorylation in mitochondria (the tiny power plants inside cells). Energy that should become fuel instead leaks out as pure heat, like a car engine revving without moving forward.

- Blood that is both too basic and too acidic (mixed acid-base disorder): Early on, fast breathing blows off carbon dioxide and makes the blood basic (respiratory too little acid in the blood (alkalosis)). At the same time, aspirin itself is an acid and also blocks cells from burning fuel cleanly, so lactic acid and ketones pile up, making the blood acidic (metabolic too much acid in the blood (acidosis)). Both happen at once.

Red flags — act now

- Confusion, slurred speech, or not responding normally
- Body temperature above 104°F (40°C)
- Seizure or uncontrolled shaking
- Very fast or very slow breathing, or gasping for air
- Heart racing or blood pressure dropping (shock)

Treat it — in this order

1. Activated charcoal 1 g/kg (max 50 g) by mouth or nasogastric tube if patient presents within 1–2 hours of ingestion and airway is protected → Charcoal binds aspirin still sitting in the stomach and gut, blocking absorption into the bloodstream.
2. IV normal saline bolus (20 mL/kg, repeat as needed) then continuous infusion at 1.5–2× maintenance, PLUS IV dextrose 5% or 10% to keep glucose > 100 mg/dL → Fluid expands blood volume so kidneys can flush salicylate into urine. Dextrose feeds starving cells and prevents brain glucose depletion.
3. Sodium bicarbonate 1–2 mEq/kg IV bolus, then continuous infusion (150 mEq NaHCO₃ in 1 L D5W at 1.5–2× maintenance rate) to achieve serum pH 7.45–7.50 and urine pH 7.5–8.0 → Alkalinizes blood and urine, which traps salicylate in its ionized form — it cannot cross back into cells and gets stuck in urine for excretion. Also directly buffers metabolic acidosis (acid building up in the blood).
4. Potassium chloride 20–40 mEq/L added to IV fluids, titrated to keep serum K⁺ 4.0–4.5 mEq/L (higher than usual target) → Replaces potassium lost in urine during alkalinization. Adequate potassium is essential for bicarbonate to work — without it, cells stay acidic even when you give bicarbonate.
5. Hemodialysis: start urgently if (1) salicylate > 100 mg/dL acute or > 60 mg/dL chronic, (2) altered mental status, (3) pulmonary edema (fluid flooding the lungs), (4) refractory too much acid in the blood (acidosis) (pH < 7.20 despite treatment), (5) acute kidney injury, or (6) seizures → Physically removes salicylate and toxic metabolites from blood. Corrects severe too much acid in the blood (acidosis) and electrolyte chaos faster than any other treatment.

Your top priorities at the bedside

1. Place patient on continuous cardiorespiratory monitor and pulse oximetry; obtain venous or arterial blood gas immediately — why: Salicylate causes mixed respiratory alkalosis (blowing off too much carbon dioxide) (fast breathing lowers CO₂) and metabolic acidosis (acid building up in the blood) (aspirin itself is acid plus cells make lactic acid) at same time; blood gas shows pH and helps calculate anion gap (measures unmeasured acids); falling pH below 7.35 despite fast breathing means severe toxicity
2. Start two large-bore IV lines; give normal saline bolus 10 to 20 mL/kg over 1 hour, then continuous infusion at 200 to 300 mL/hour — why: Aspirin causes fluid loss through vomiting, sweating, and fast breathing; dehydration makes kidneys hold onto aspirin instead of removing it in urine; IV fluid reverses shock and supports high urine output needed to wash aspirin out through kidneys
3. Check fingerstick blood sugar immediately and repeat every 1 to 2 hours; give dextrose 1 amp (25 grams D50) IV push if glucose under 60 mg/dL, then add dextrose to all IV fluids — why: Aspirin blocks cells from using glucose for energy even when blood sugar looks normal; brain glucose drops critically low causing confusion and seizures; dextrose in IV fluid prevents neuroglycopenia (brain starvation) which can happen even with normal blood glucose number