

Transfusion Reactions

Transfusion reaction — stop the bag first, ask questions second.

THE ONE-LINE TRUTH

The bag is guilty until proven innocent.

The chain — how it unfolds

1. Acute destroying red blood cells (hemolytic) reaction: Receiver antibodies bind donor red cells and burst them open (hemolysis), spilling hemoglobin into the plasma. — why: The receiver's immune system (from prior transfusion, pregnancy, or transplant) has antibodies (usually anti-A, anti-B, or minor antigens like Kell or Duffy) that recognize donor cell-surface markers as foreign, bind them, activate complement proteins, and punch holes in the cell membrane — the red cell explodes, dumping hemoglobin and cell fragments into the bloodstream.
2. Free hemoglobin clogs the kidney filters and triggers acute kidney injury. — why: Free hemoglobin is toxic to the proximal tubule cells in the kidney (the part that reabsorbs water and salt). It also binds nitric oxide (a vessel relaxer), causing kidney blood vessels to clamp down. Together, hemoglobin physically blocks the tubules like mud in a drainpipe and starves the cells of oxygen, so the kidneys stop making urine, and waste, potassium, and acid pile up in the blood.
3. Shock develops as blood vessels dilate and blood pressure drops. — why: Red blood cell destruction (Hemolysis) and immune activation release cytokines (TNF-alpha, IL-1, IL-6) that tell blood vessels to relax and leak fluid into tissues. At the same time, the kidneys cannot balance fluid and electrolytes, and the heart struggles to pump enough blood to fill the widened vessels — blood pressure falls, organs are underfed, and the patient feels dizzy, weak, or confused.
4. DIC (disseminated intravascular coagulation) starts: clotting factors are used up everywhere, causing bleeding and clotting at the same time. — why: Free hemoglobin, cell fragments, and cytokines activate the clotting cascade all over the body at once, forming thousands of tiny clots in small vessels (using up platelets, fibrinogen, and clotting factors). The body then activates its clot-busting system (fibrinolysis), breaking clots into D-dimer fragments. The result: bleeding from the IV site, gums, or gut because clotting factors are gone, plus clots blocking blood flow to fingers, toes, kidneys, or lungs.

5. TRALI: Donor antibodies attack the receiver's lung capillaries, flooding the air sacs with fluid within six hours. — why: Donor plasma (not fully removed) has antibodies against the receiver's white-cell markers (HLA or neutrophil antigens). These antibodies bind white cells stuck to the lung capillary walls, activate them, and make them release enzymes and oxygen radicals that damage the thin vessel wall — fluid pours from blood into the air sacs (alveoli), blocking oxygen from crossing into the blood and causing sudden shortness of breath, low oxygen, and white patches on chest X-ray.
6. Septic reaction: Bacteria in the bag multiply and dump toxins that trigger systemic inflammation and shock. — why: Bacteria (skin flora from the needle stick or cold-tolerant Gram-negatives like *Yersinia* or *Pseudomonas*) grow in the stored blood and release endotoxin (from Gram-negative cell walls) or exotoxin. These toxins bind receptors on white cells and blood-vessel walls, triggering a cytokine storm (TNF-alpha, IL-1, IL-6) that dilates vessels, leaks fluid, drops blood pressure, and raises body temperature — the patient spikes a high fever, shakes with rigors, and can crash into septic shock within minutes.
7. Allergic reaction and anaphylaxis: Receiver antibodies recognize donor proteins, release histamine, and cause hives or, rarely, airway swelling and shock. — why: The receiver's IgE antibodies (from prior exposure to donor plasma proteins) bind those proteins, cross-link on mast cells and basophils, and trigger degranulation — the cells dump histamine, leukotrienes, and prostaglandins that dilate blood vessels (causing hives, flushing, and itching) and, in anaphylaxis, relax airway smooth muscle and leak fluid into the throat (causing wheezing, throat tightness, tongue swelling, and shock). IgA-deficient patients with anti-IgA antibodies are at highest risk.
8. TACO (volume overload): The heart cannot pump the extra volume, so pressure backs up into the lungs and fluid leaks into the air sacs. — why: The transfusion adds volume faster than a weak or stiff heart (from heart failure, kidney failure, or old age) can pump it forward. Pressure rises in the left atrium, then the pulmonary veins, then the lung capillaries — fluid is pushed across the thin capillary wall into the alveoli (air sacs), blocking oxygen exchange and causing shortness of breath, low oxygen, jugular-vein distension in the neck, leg swelling, and crackles heard with a stethoscope. Unlike TRALI, TACO improves with diuretics (water pills) and slowing the transfusion.

Spot it — what you see, and why

- Fever (temperature rises above 100.4°F / 38°C) during or right after the transfusion: When donor blood cells don't match yours, your immune system spots them as invaders and releases alarm chemicals called cytokines (messengers that crank up body heat to fight what looks like an infection), so your temperature spikes.

- Pain in your back, sides, or chest: Mismatched red cells burst apart inside your blood vessels (hemolysis), spilling their insides everywhere. This clogs tiny filters in your kidneys and irritates blood-vessel walls, triggering pain signals along your back and flanks where the kidneys sit.
- Trouble breathing or breathing faster than usual: Either fluid is leaking into the air sacs of your lungs (from donor white cells releasing chemicals that make lung capillaries leaky — called TRALI), or you got too much volume too fast and your heart can't keep up (volume overload), so oxygen can't cross into your blood easily and you gasp for air.
- Hives or itchy red welts on your skin: Your immune system's mast cells (guard cells in the skin) release histamine (a chemical that makes blood vessels widen and leak) when they recognize foreign proteins in the donor plasma, causing itchy raised bumps.
- Blood pressure drops suddenly (systolic falls below 90 or drops more than 30 points from baseline): Massive red blood cell destruction (hemolysis) or a severe allergic reaction floods your bloodstream with inflammatory chemicals (cytokines, histamine, bradykinin) that tell blood vessels to relax and widen; blood pools in the belly and legs, so not enough pressure pushes blood back to the heart and brain.
- Dark brown or cola-colored urine: When red cells explode (hemolysis), hemoglobin (the oxygen-carrying protein inside) spills into your plasma, travels to your kidneys, and gets filtered into the urine, turning it brown or red — a direct sign that cells are being destroyed.

Red flags — act now

- Blood pressure drops below 90 systolic or falls more than 30 points suddenly — sign of shock
- Trouble breathing, gasping, or oxygen saturation below 90% — may be fluid in the lungs (TRALI) or volume overload
- Dark brown or red urine during or right after transfusion — means red cells are bursting (hemolysis)
- Chest or back pain with fever — can mean acute destroying red blood cells (hemolytic) reaction, which can damage kidneys fast
- Bleeding that won't stop from gums, IV sites, or anywhere — may be DIC from massive cell destruction

Treat it — in this order

1. Stop the transfusion immediately and keep IV line open with normal saline → Stops more donor cells or bacteria from entering the body. Keeps the vein open so you can give fluids and emergency medicines fast.

2. Give large amounts of IV normal saline to keep urine flowing fast (goal urine output ≥ 100 mL/hr in adults) → Dilutes free hemoglobin in the blood and flushes it through the kidneys before it clogs the kidney tubules and shuts down the kidney.
3. Give vasopressors (like norepinephrine) if blood pressure stays low despite fluids → Squeezes blood vessels to push blood to the heart, brain, and kidneys when the body cannot hold pressure on its own after red blood cell destruction (hemolysis) or septic shock.
4. For anaphylaxis: give epinephrine 0.3–0.5 mg intramuscular (into the thigh muscle) right away → Blocks the allergic cascade by tightening blood vessels (raising blood pressure) and opening airways (stopping throat swelling). Works within 1–2 minutes.
5. For suspected septic reaction: draw blood cultures from patient and the donor bag, then start broad-spectrum IV antibiotics immediately (e.g. ceftriaxone + vancomycin or piperacillin-tazobactam) → Kills bacteria before they multiply and release toxins that cause organ failure and septic shock.

Your top priorities at the bedside

1. Stop the transfusion immediately at the first sign of reaction and keep the IV line open with new normal saline tubing — why: Every additional drop of the suspect blood can worsen red blood cell destruction (hemolysis) (red cell destruction), introduce more allergen causing anaphylaxis, or pump more bacteria into the bloodstream; new tubing prevents any remaining donor blood from entering the patient
2. Keep the blood bag, all tubing, and attached labels and send them to the blood bank with a fresh patient blood sample — why: The lab must compare patient antibodies against donor cells to confirm red blood cell destruction (hemolysis), culture the bag for bacteria, and verify the right unit went to the right patient; this evidence determines if we report to the FDA
3. Monitor vital signs every 5 to 15 minutes including blood pressure, heart rate, oxygen saturation, temperature, and respiratory rate — why: Falling blood pressure signals shock needing vasopressors; rising fever may mean infection; dropping oxygen saturation shows lung injury or anaphylaxis; rapid changes require immediate escalation to the provider