

Trauma and Hemorrhage

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THE STORY IN ONE SENTENCE

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“Stop the bleeding first, give blood products early for big bleeds (class III and IV shock), and watch for the lethal triad: too cold, too acidic, and clotting that doesn't work.”

Normal anatomy — the body's job

Blood flows in a closed loop of vessels — arteries carry oxygen-rich blood out from the heart, capillaries deliver it to every cell, and veins bring the used blood back. Blood pressure is the squeeze that pushes blood through the pipes. Clotting factors and platelets (tiny sticky fragments in the blood) plug any small tears instantly to keep the system sealed.

BODY'S JOB

The vascular system's job is to deliver oxygen and glucose (sugar fuel) to every organ and carry away waste like carbon dioxide. Blood pressure must stay high enough to push blood uphill to the brain and through tiny vessels in the kidneys and gut. Clotting keeps the system sealed so pressure stays up.

1. The heart pumps blood into the aorta (the body's main artery) at high pressure — picture a fire hose.
2. Arteries branch smaller and smaller, carrying blood to every organ.
3. Capillaries (tiny one-cell-thick vessels) let oxygen and glucose seep out to feed tissues and let carbon dioxide and waste seep back in.
4. Veins collect the used blood and return it to the heart and lungs to reload oxygen.

5. Clotting factors (proteins made by the liver) and platelets (cell fragments made in bone marrow) rush to any tear and form a plug in seconds, sealing the leak before pressure drops.

What breaks

Trauma tears open blood vessels — sometimes small capillaries, sometimes huge arteries — and blood pours out. Bleeding can be visible (external) or hidden inside the chest, belly, pelvis, or thigh (internal). Big bleeds drain the tank faster than the heart can compensate, so blood pressure crashes and organs starve. If bleeding continues, the body gets too cold (hypothermia), too acidic (acidosis from cells burning fuel without oxygen), and clotting stops working (coagulopathy from using up all the clotting factors and platelets). That trio — cold, acidic, no clotting — is the lethal triad, and once it sets in, even stopping the bleeding may not save the patient.

CLINICAL TERM

Traumatic bleeding (hemorrhage) with hypovolemic shock and risk of the lethal triad (hypothermia, too much acid in the blood (acidosis), impaired blood clotting (coagulopathy)).

How the body compensates

The body tries to protect the brain and heart by squeezing blood vessels, racing the heart, and pulling blood away from the skin, gut, and kidneys. Early shock (class I and II) can look deceptively normal because compensation hides the danger. Once compensation breaks (class III and IV), pressure crashes fast and organs fail. The job is to see the cliff coming before the patient falls off it.

1. {'step': 'Sympathetic surge', 'mechanical': 'The brainstem (the body's automatic control center) senses falling pressure and floods the body with epinephrine and norepinephrine (adrenaline chemicals). These squeeze blood vessels tight to raise pressure and make the heart race to pump faster.'}
2. {'step': 'A fast heart rate (Tachycardia) (fast heart rate)', 'mechanical': 'Heart rate climbs above 100, then 120, trying to push more blood per minute even though each squeeze is nearly empty. This is the earliest vital sign change.'}
3. {'step': 'Peripheral vasoconstriction (vessel squeeze)', 'mechanical': 'Blood is pulled away from the skin (cold, pale, clammy), gut, and kidneys to keep the brain and heart fed. Urine output drops because kidneys are starved.'}

4. {'step': 'Compensated shock (class II: 15–30% blood loss)', 'mechanical': 'Blood pressure stays nearly normal because the body is working hard. Heart rate is up, patient may be anxious, skin is cool. This is the dangerous window — the patient looks stable but is one step from crashing.'}
5. {'step': 'Decompensation (class III: 30–40% blood loss)', 'mechanical': 'Compensation breaks. Blood pressure drops, heart rate races above 120, confusion starts (brain is starving), urine stops. The body cannot hide the problem anymore.'}
6. {'step': 'Lethal triad begins', 'mechanical': 'Core temperature drops below 35°C, pH falls below 7.2, clotting factors are gone. Bleeding becomes impossible to stop even with surgery because the blood will not clot.'}
7. {'step': 'Class IV shock (>40% blood loss)', 'mechanical': 'Blood pressure is critically low, heart rate may paradoxically slow (the heart is too empty to fill), consciousness is lost, death is imminent without immediate blood transfusion and bleeding (hemorrhage) control.'}

Domino effect

1. Trauma tears open a blood vessel (artery, vein, or organ like the spleen or liver). — The closed loop of pipes springs a leak. Blood pours out — externally onto the ground or internally into the chest, belly, pelvis, or thigh where you cannot see it.
2. Circulating blood volume drops (hypovolemia). — The tank empties. Less blood returns to the heart each beat, so each pump pushes out less blood (low stroke volume). Blood pressure starts to fall.
3. The brainstem detects falling pressure and triggers a sympathetic storm (adrenaline flood). — The body's survival reflex kicks in. Epinephrine and norepinephrine squeeze blood vessels and race the heart to try to keep pressure up and protect the brain and heart.
4. Heart rate climbs (tachycardia) and skin gets cold, pale, and sweaty (peripheral vasoconstriction). — The heart races to pump more blood per minute even though each beat is nearly empty. Blood is pulled away from the skin, gut, and kidneys to keep the brain and heart alive. The patient looks anxious and feels cold and clammy.
5. If bleeding continues, compensation fails and blood pressure crashes (decompensated shock). — The heart is pumping an empty tank — no amount of squeezing or racing can push blood that is not there. Pressure drops, brain and kidneys starve, confusion and low urine output appear.
6. The body gets cold (hypothermia), acidic (lactic too much acid in the blood (acidosis)), and clotting stops (coagulopathy) — the lethal triad. — Exposed wounds and cold IV fluids drop core temperature. Cells burning fuel without oxygen make lactic acid. Clotting factors and platelets are used up and diluted by IV fluids. Cold and acid poison the clotting enzymes, so bleeding becomes unstoppable.

7. Without rapid bleeding (hemorrhage) control and blood transfusion, multi-organ failure and cardiac arrest follow. — The brain, heart, kidneys, and gut all starve. Too much acid in the blood (Acidosis) stops the heart from beating effectively. The patient dies from exsanguination (bleeding out) or irreversible shock.
8. Reversal requires three things at once: stop the bleeding (surgery, pressure, tourniquet), replace lost blood with balanced blood products (1:1:1 ratio of red cells, plasma, platelets), and prevent or reverse hypothermia (warm fluids, warm the room, cover the patient). — Fixing only one part fails — you must close the leak, refill the tank with real blood (not just saline), and keep the clotting machinery warm and working. Do all three fast, and the dominoes reverse: pressure comes up, heart slows down, organs wake up, clotting restarts, and the patient survives.

Symptoms · what the patient feels, and why

- Fast heart rate (tachycardia) — the heart beats faster than 100 times per minute: When blood volume drops, the body's alarm system (the brainstem and sympathetic nerves) tells the heart to pump faster to try to keep enough oxygen reaching the brain and vital organs—like a pump speeding up when the tank is low.
- Low blood pressure (hypotension) — top number below 90: With less blood in the system, pressure in the arteries falls because there isn't enough fluid pushing against the vessel walls—like water pressure dropping in a leaky hose.
- Cool, pale, clammy skin: The body shuts blood flow away from the skin to save oxygen for the brain and heart (vasoconstriction driven by norepinephrine and other stress hormones), and fear triggers sweat glands, making skin cold and damp.
- Confusion, restlessness, or anxiety: The brain needs a constant supply of oxygen-rich blood; when blood pressure drops, less oxygen reaches the cerebral cortex (the thinking part) and neurons fire erratically, causing foggy thinking and agitation.
- Weak or absent pulses in the arms or legs: Severe blood loss means less volume is available to travel through peripheral arteries, so pulses at the wrist or ankle feel faint or disappear—like turning down the faucet until water barely trickles out.
- Little or no urine output (oliguria): The kidneys filter blood to make urine; when blood flow drops, less fluid reaches the glomeruli (the kidney's tiny filters), so urine production slows or stops—the body is prioritizing survival over waste removal.
- Visible bleeding from a wound, or blood pooling under the skin (bruising): Injury breaks blood vessels, letting red blood cells spill out onto the surface or into tissues, forming a visible pool or dark bruise as the body tries to clot and seal the leak.
- Swollen, tender abdomen or flanks: Blood leaking inside the belly (from a ruptured spleen, liver, or major vessel) fills the peritoneal space, stretching the tissue and irritating pain nerves—like a water balloon inflating inside you.

- Shortness of breath or fast breathing (tachypnea): The body senses low oxygen delivery and triggers the brainstem respiratory center to speed up breathing, trying to pull in more oxygen with each breath to make up for lost blood—like huffing harder when you're running uphill.
- Thirst: Sensors in the blood vessels (baroreceptors) and kidneys detect falling volume and signal the hypothalamus (the brain's thirst control center) to make you crave water, trying to refill the tank.

Focused exam

- Heart rate faster than 100 beats per minute (tachycardia): When blood leaks out of torn vessels, the body has less volume to pump around. The heart beats faster to push what blood is left to the brain and other organs that need oxygen to survive. This is the body's emergency mode trying to keep you alive.
- Systolic blood pressure below 90 mmHg (hypotension): Blood pressure is the push inside the blood vessels. When you lose blood, there is less fluid in the pipes, so the pressure drops. Low pressure means the brain, heart, and kidneys are not getting the oxygen and fuel they need. This is shock.
- Confusion, slow responses, or other change in mental status: The brain needs constant oxygen from blood. When blood pressure falls or blood volume drops, the brain does not get enough oxygen and starts to shut down. Confusion is the brain's distress signal that it is starving for oxygen. This tells you shock is already hurting the brain.
- Skin that is cold, clammy, and pale or gray: The body pulls blood away from the skin and sends it to the brain and heart instead when blood volume is low. Cold, sweaty skin means blood vessels in the skin have squeezed shut to redirect what little blood is left. Pale color means there are fewer red blood cells reaching the skin because blood is being lost or spread too thin.
- Visible bleeding from wounds, or swelling and firmness in the chest, belly, pelvis, or thigh: You must find where the blood is going. External bleeding you can see and stop with pressure or a tourniquet. Internal bleeding hides inside body cavities. A swollen, firm belly or thigh means blood is pooling there from torn vessels inside. The chest and pelvis can each hide liters of blood without obvious swelling.
- Breathing faster than 20 breaths per minute and shallow: When blood volume drops, the body has fewer red blood cells to carry oxygen. The lungs speed up to pull in more oxygen and try to make up the difference. Fast shallow breathing is the body working harder to get oxygen into what blood is left.

- Weak or absent pulse in an injured arm or leg beyond the wound: A major artery in the limb may be cut or crushed. No pulse past the injury means blood is not flowing to that arm or leg. Without blood flow, the limb will die in hours. A tourniquet must go on immediately to stop the bleeding and save the patient's life, even if it risks the limb.

Diagnostics · every test answers a question

- Hemoglobin and hematocrit (Hgb/Hct) → How much blood has the patient lost, and are red blood cells still carrying oxygen?
- Lactate level → Are the tissues getting enough oxygen, or are they suffocating and switching to survival mode?
- INR, PT, PTT, fibrinogen, and platelet count (coagulation panel) → Can the blood still clot and seal its own leaks, or is the clotting system broken?
- Base deficit or bicarbonate level (from blood gas or basic metabolic panel) → How acidic is the blood, and how long have the tissues been starving for oxygen?
- FAST ultrasound (Focused Assessment with Sonography for Trauma) → Is there free blood floating in the belly or around the heart where it should not be?
- Chest X-ray → Is there blood or air in the chest that is crushing the lungs or heart?
- Pelvic X-ray → Is the pelvis broken, and could broken pelvic bones be tearing vessels and bleeding massively inside?
- CT scan of chest, abdomen, and pelvis with IV contrast (only if patient is stable enough) → Exactly where is the bleeding coming from, and which organ or vessel is torn?

Treatment logic

- Perform ABCDE survey (Airway, Breathing, Circulation, Disability, Exposure) in the first 60 seconds → Finds the life-threatening problem in order of what kills fastest. You check if the airway is open, if the lungs are moving air, if the heart is pumping blood, if the brain is awake, and if there is hidden bleeding under clothes. This roadmap tells you what to fix first.
- Apply tourniquet high and tight on an arm or leg if bleeding does not stop with direct pressure → Squeezes the artery shut above the wound so blood stops pouring out. This saves the blood volume the body has left and buys time to get the patient to surgery. Modern tourniquets can stay on safely for 2-3 hours.

- Give blood products in balanced 1:1:1 ratio (packed red blood cells : plasma : platelets) instead of crystalloid alone → Refills the blood volume with real blood that carries oxygen and contains the clotting factors and platelets the body needs to seal leaks. Balanced resuscitation keeps the blood thick enough to clot and prevents diluting away the clotting system. This reverses shock and stops trauma-induced impaired blood clotting (coagulopathy).
- Permissive low blood pressure (hypotension): keep systolic blood pressure at 80–90 mmHg until bleeding is controlled (except in traumatic brain injury) → Lowers the pressure inside the blood vessels so less blood leaks out of the hole. High pressure before the leak is fixed blows off clots and makes bleeding worse. Permissive low blood pressure (hypotension) buys time and reduces total blood loss until surgery.
- Give tranexamic acid (TXA) 1 gram IV over 10 minutes, then 1 gram over 8 hours, within 3 hours of injury → Blocks the enzyme (plasmin) that breaks down blood clots. TXA tells the body to protect clots that are forming and keep them sealed longer. This reduces bleeding and improves survival in trauma patients, especially in the first hour.
- Emergency surgery or interventional radiology to find and control the bleeding source → Directly closes, clamps, or seals the torn blood vessel or organ so no more blood leaks out. This is definitive bleeding control. Once the hole is fixed, the body can catch up with refilling its blood volume and recovering from shock.
- Avoid large volumes of crystalloid (normal saline or lactated Ringer's) alone → Prevents diluting the blood so thin that it cannot clot (dilutional impaired blood clotting (coagulopathy)). Prevents worsening hypothermia and too much acid in the blood (acidosis), which both break the clotting system further. Small crystalloid volume is okay to keep IV lines open, but blood products do the real work.

Medications

Packed red blood cells (PRBCs) · Blood product replacement

Replaces the red cells that carry oxygen throughout your body. When you lose a lot of blood, you lose both the liquid part and the oxygen-carrying red cells inside it. Giving packed red blood cells refills your supply of oxygen carriers so every organ can keep working.

1. Red blood cells are transfused through an IV into a vein
2. The new red cells flow through the heart and out to the rest of the body
3. Each red cell carries oxygen from the lungs to tissues that are starving for it
4. Organs like the brain, heart, and kidneys get the oxygen they need to keep working

SAFETY WATCH

Must match blood type or the patient's immune system will attack the new cells · Watch for fever, chills, or back pain during transfusion (signs the body is rejecting the blood) · Too much volume too fast can overload the heart and flood the lungs · Stored blood is cold; giving large amounts quickly can drop body temperature and worsen clotting

Fresh frozen plasma (FFP) · Blood product replacement

Replaces clotting factors (proteins your liver makes that help blood clot). Major bleeding washes out these proteins. Fresh frozen plasma is the liquid part of blood, frozen right after donation to keep all the clotting proteins alive. When thawed and given, it refills your supply so your blood can clot again.

1. Plasma is thawed and transfused through an IV into a vein
2. The clotting factor proteins (like Factor V, Factor VIII, fibrinogen, and others) spread throughout the bloodstream
3. When a blood vessel is torn, these factors work together in a cascade (like dominoes falling) to form a solid clot
4. The clot plugs the hole and stops more blood from leaking out

SAFETY WATCH

Must be ABO-compatible or the patient's immune system may react · Large volumes can overload the circulation and flood the lungs (TACO: transfusion-associated circulatory overload) · Rare risk of lung injury from donor antibodies (TRALI: transfusion-related acute lung injury) · Takes time to thaw; delays can happen in emergencies

Platelets · Blood product replacement

Replaces platelets (the tiny disk-shaped cells that form the first plug when a blood vessel tears). Major bleeding uses up and washes away platelets. Giving platelet transfusions refills the supply so your body can form plugs at injury sites and stop bleeding.

1. Platelets are transfused through an IV into a vein
2. The new platelets flow through the bloodstream
3. When they sense a torn blood vessel, they stick to the damaged wall and to each other
4. They form a temporary plug that slows bleeding while clotting factors build a stronger clot on top

SAFETY WATCH

Platelets are stored at room temperature and expire in 5 days, so supply can be limited · Risk of bacterial contamination because they are not refrigerated · ABO matching is preferred but not always required in emergencies · Watch for allergic reactions (rash, hives, itching)

Cryoprecipitate · Blood product replacement

Replaces fibrinogen (the clotting protein that forms the mesh of a blood clot). Massive bleeding washes out fibrinogen faster than other clotting factors. Cryoprecipitate is made by thawing plasma and collecting the part that settles out in the cold. That part is rich in fibrinogen, Factor VIII, and von Willebrand factor. Giving cryo quickly rebuilds the fibrinogen level so clots can form.

1. Cryoprecipitate is thawed and transfused through an IV
2. Fibrinogen spreads through the bloodstream
3. At the site of a torn vessel, clotting factors convert fibrinogen into fibrin (long sticky strands)
4. The fibrin strands weave together into a mesh that traps platelets and red cells, forming a solid clot

SAFETY WATCH

Must be ABO-compatible · Volume overload is less of a risk because the dose is small and concentrated · Rare allergic reactions can occur · Often not stocked in large quantities; may be harder to get quickly

Tranexamic acid (TXA) · Antifibrinolytic (clot-protecting drug)

Stops the body from breaking down clots too early. When you are injured, your body forms clots to stop bleeding, but it also releases enzymes (proteins that act like scissors) to dissolve clots later. In major trauma, this dissolving process starts too early and breaks down clots before bleeding is controlled. Tranexamic acid blocks the enzyme plasmin (the scissors that cut up fibrin clots), so the clots you make can stay in place and do their job.

1. Tranexamic acid is given through an IV: 1 gram over 10 minutes, then 1 gram over 8 hours
2. It travels through the bloodstream to areas of injury
3. It binds to plasminogen (the inactive form of plasmin) and prevents it from turning into plasmin
4. Without plasmin, fibrin clots stay intact and bleeding slows

SAFETY WATCH

MUST give within 3 hours of injury. After that, it may increase the risk of death rather than reduce it. · Do NOT give if the patient has a seizure disorder; TXA can lower the seizure threshold · Rare risk of blood clots forming in the wrong place (like the legs or lungs) if given to the wrong patient · Safe and proven to save lives in trauma when given early

Calcium (calcium chloride or calcium gluconate) · Electrolyte replacement

Replaces calcium (a mineral your body needs for muscles to squeeze and for clotting factors to work). Massive transfusion of stored blood products floods the body with citrate (a preservative that binds calcium and locks it away). Without enough free calcium, the heart muscle cannot squeeze strongly, blood vessels cannot tighten, and clotting slows down. Giving calcium unlocks the citrate and restores the free calcium level.

1. Calcium is given through an IV (calcium chloride is preferred in trauma because it delivers more usable calcium faster)
2. Free calcium ions flood into the bloodstream
3. Heart muscle cells use calcium to contract harder and pump more blood
4. Clotting factors use calcium as a helper to speed up the clotting cascade
5. Blood vessel walls tighten, which raises blood pressure

SAFETY WATCH

Do NOT push calcium through the same IV line as blood products at the same time; it can cause the blood to clot in the tubing · Giving too much calcium too fast can cause the heart to stop (cardiac arrest) · Watch the heart monitor closely during infusion · Calcium leaking outside the vein can burn the skin and tissue

Pelvic binder · Mechanical bleeding (hemorrhage) control device

A wide fabric strap wrapped snugly around the pelvis (the bony ring at your hips). When the pelvis bones break, the ring opens up, the volume inside grows, and blood vessels torn by the fracture bleed heavily into that new space. The binder squeezes the pelvis back together, closes the extra space, and puts pressure on bleeding vessels so they clot.

1. The binder is placed around the pelvis as low as the hip bumps, not up at the waist
2. It is tightened until snug (not loose, not crushing)
3. The pressure pushes broken pelvis bones closer together
4. The internal volume shrinks, and pressure on torn vessels rises, helping them clot
5. Bleeding slows while the patient is moved to the operating room or interventional radiology suite

SAFETY WATCH

Do NOT place too high (at the waist); it will not compress the pelvis bones · Do NOT over-tighten; can cause skin breakdown and pressure sores · Leave in place until definitive treatment is ready; removing it early can restart bleeding · Check pulses in the legs to make sure circulation is not cut off

Tourniquet · Mechanical bleeding (hemorrhage) control device

A tight band applied around an arm or leg above the site of severe bleeding. It squeezes blood vessels shut so no blood can flow past it. This completely stops bleeding from injuries below the tourniquet, buying time to get the patient to surgery.

1. The tourniquet is wrapped around the limb as high and as close to the body as possible (but not over a joint)
2. It is tightened until all bleeding stops (you should not be able to feel a pulse below it)
3. The time it was applied is written on the tourniquet or the patient's skin
4. Blood flow to the limb stops, and bleeding from the wound stops
5. The patient is moved immediately to the operating room or trauma bay

SAFETY WATCH

Limb can survive up to 2 hours under a tourniquet, but nerve and muscle damage risk rises after that · Do NOT loosen or remove the tourniquet in the field; bleeding will restart and can be fatal · Mark the time clearly so doctors know how long it has been on · Only trained personnel should remove it in a controlled setting

Permissive low blood pressure (hypotension) strategy (keeping systolic BP 80-90 mmHg) · Resuscitation strategy (not a drug)

Deliberately keeps blood pressure lower than normal until bleeding is stopped surgically. When you push blood pressure up with fluids or pressors before the hole is fixed, the higher pressure blows clots off the torn vessel and makes bleeding worse (like turning up the water pressure in a leaky pipe). Keeping pressure at 80-90 systolic lets clots stay in place while still delivering enough blood to the brain and heart.

1. Give only enough blood and fluids to keep systolic blood pressure around 80-90 mmHg (or mean arterial pressure around 50-60 mmHg)
2. Do NOT push fluids aggressively to normal pressures (120/80)
3. The lower pressure reduces the force trying to dislodge clots
4. Clots stay in place, and bleeding slows

5. Once the surgeon or interventional radiologist stops the bleeding (fixes the hole), then fluids and blood are given to bring pressure back to normal

SAFETY WATCH

Do NOT use in traumatic brain injury; low pressure worsens brain starved blood flow (ischemia) (lack of blood flow) · Do NOT continue permissive low blood pressure (hypotension) after bleeding is controlled; the patient needs normal pressure to heal · Monitor mental status and urine output to make sure vital organs are getting enough blood · This is a temporary bridge to definitive bleeding (hemorrhage) control, not a long-term plan

Resuscitative endovascular balloon blockage (occlusion) of the aorta (REBOA) · Mechanical bleeding (hemorrhage) control device

A balloon catheter threaded through a blood vessel in the groin up into the aorta (the body's main artery). The balloon is inflated to block blood flow below it. This stops bleeding in the belly or pelvis temporarily and pushes more blood to the heart and brain, buying time to get to the operating room.

1. A catheter is inserted through the femoral artery (in the groin) and advanced up into the aorta
2. The balloon at the tip is inflated to block the aorta
3. Blood flow below the balloon stops, so bleeding in the abdomen or pelvis slows or stops
4. Blood is redirected to the heart, brain, and lungs
5. The patient is rushed to surgery; the balloon is deflated once the bleeding is controlled

SAFETY WATCH

Tissues below the balloon (intestines, kidneys, legs) lose blood flow and can die if the balloon stays inflated too long (ischemia) · Maximum safe time is roughly 30–60 minutes; longer risks organ failure and limb loss · Must be done by a trained team with the right equipment · When the balloon is deflated, bleeding can restart and blood pressure can crash; plan carefully

Warming measures (forced-air warmer, warmed fluids, warmed operating room) · Supportive care intervention (not a drug)

Keeps the patient's body temperature normal (around 98.6°F or 37°C). When you lose a lot of blood, your body loses heat, and cold IV fluids and blood products cool you further. A cold body cannot clot well (enzymes that make clots work slowly in the cold), the heart beats irregularly,

and you are more likely to bleed to death. Warming the patient speeds up clotting and keeps the heart stable.

1. IV fluids and blood products are run through a warmer before entering the patient
2. A forced-air warming blanket is placed over the patient to blow warm air onto the skin
3. The operating room or trauma bay temperature is turned up (often uncomfortably warm for the staff)
4. The patient's core temperature rises back toward normal
5. Clotting enzymes speed up, platelets work better, and the heart rhythm stabilizes

SAFETY WATCH

Do NOT overheat (causing burns or overheating is rare but possible) · Check temperature regularly with a core thermometer (rectal, esophageal, or bladder probe) · Warming alone will not save a patient if bleeding is not controlled

Sodium bicarbonate (baking soda) · Alkalinizing agent (acid-neutralizing drug)

Neutralizes lactic acid that builds up when tissues do not get enough oxygen. During shock, cells switch to a backup energy process that makes lactic acid as a waste product. Too much acid makes the blood acidic (acidosis), which stops clotting enzymes from working and weakens the heart. Giving sodium bicarbonate raises the blood pH (makes it less acidic) so clotting and heart function can recover.

1. Sodium bicarbonate is given through an IV
2. It buffers (soaks up) hydrogen ions (the particles that make blood acidic)
3. Blood pH rises closer to normal (7.35–7.45)
4. Clotting factor enzymes work better, and the heart muscle contracts more effectively

SAFETY WATCH

Giving too much bicarbonate can overcorrect and make the blood too alkaline (alkalosis), which causes its own problems · Can worsen low calcium levels · Only give if blood gas shows severe too much acid in the blood (acidosis) (pH < 7.1–7.2) AND shock is being treated; otherwise it may not help and can cause harm · Not a substitute for stopping bleeding and restoring blood flow

Low-molecular-weight heparin (LMWH) or unfractionated heparin (once bleeding is controlled) · Anticoagulant (blood thinner)

Prevents new clots from forming in the wrong places (like the veins in the legs or the lungs). Trauma patients lie still, their blood flow slows, and their clotting system is activated, raising the risk of a clot in a deep leg vein (deep vein thrombosis) (a clot in a leg vein) or pulmonary embolism (a clot lodging in a lung artery) (a clot that travels to the lungs). Heparin blocks part of the clotting cascade so clots do not form in veins. It does NOT break up clots; it only stops new ones.

1. Heparin (either low-molecular-weight or unfractionated) is injected under the skin or given through an IV
2. It binds to antithrombin (a natural clotting brake in the blood)
3. Antithrombin becomes much more powerful and blocks clotting factors, especially Factor Xa and Factor IIa (thrombin)
4. The clotting cascade slows down, so clots are less likely to form in veins

SAFETY WATCH

Do NOT give until bleeding is completely controlled and the patient is stable; otherwise it will worsen bleeding (hemorrhage) · Watch for new bleeding (in the brain, belly, or at surgical sites) · Can cause heparin-induced a low platelet count (thrombocytopenia) (HIT), a dangerous condition where the immune system attacks platelets and causes clots · Dose must be adjusted in kidney failure · Check platelet count regularly

Red flags

- Blood pressure top number below 90 despite giving fluids (suggests massive ongoing bleeding or shock)
- Confused, drowsy, or unresponsive (means the brain is starving for oxygen)
- No urine for hours (sign the kidneys are shutting down from poor blood flow)
- Abdomen rigid and painful, or flanks bruised (may mean internal bleeding in belly or behind the gut)
- Breathing very fast or gasping, lips or fingers turning blue (severe oxygen shortage)

Nursing priorities

1. Open the airway with chin-lift or jaw-thrust while holding the neck still and give 100 percent oxygen by non-rebreather mask or bag-valve-mask — The brain dies in 4 to 6 minutes without oxygen and cervical spine (neck bone) injury happens in 2 to 3 percent of trauma so moving the neck wrong can cut the spinal cord

2. Apply direct pressure or tourniquet to any visible bleeding from arms or legs and tighten tourniquet until bleeding completely stops — External bleeding (hemorrhage) (outside bleeding) you can see kills fast and tourniquets stop arterial bleeding (bleeding from high-pressure blood vessels) that pressure alone cannot control and can stay on safely for 2 hours
3. Start two large-bore IV lines with 18-gauge or 16-gauge needles and draw blood for type-and-cross, hemoglobin, lactate, and coagulation tests before giving any fluids — Big IV catheters (plastic tubes in veins) let blood products flow fast and baseline labs tell starting hemoglobin and if the patient has impaired blood clotting (coagulopathy) and lactate above 4 signals shock from poor oxygen delivery to tissues
4. Give 1 unit packed red blood cells with 1 unit plasma with 1 unit platelets in 1:1:1 ratio and limit crystalloid fluids like normal saline to less than 1 liter total — Balanced transfusion prevents dilutional impaired blood clotting (coagulopathy) where too much salt water dilutes clotting factors and platelets (blood cells that form clots) and cold fluids cause hypothermia (low body temperature) that stops clotting enzymes from working
5. Keep systolic blood pressure at 80 to 90 mmHg until bleeding is controlled unless patient has head injury or spinal cord injury then keep systolic above 110 mmHg — Permissive low blood pressure (hypotension) keeps clots from blowing off bleeding vessels because high pressure breaks fragile clots but the brain and spinal cord need higher pressure to prevent starved blood flow (ischemia) (tissue damage from no blood flow)
6. Give tranexamic acid 1 gram IV over 10 minutes then 1 gram over 8 hours if injury happened less than 3 hours ago — TXA (tranexamic acid) stops plasmin (an enzyme that dissolves clots) and cuts death from bleeding by 30 percent if given early but increases clots and death if given after 3 hours
7. Expose the entire body by cutting off all clothes and log-roll to inspect the back then cover with warm blankets and turn up room heat — Thirty percent of injuries hide on the back or scalp and hypothermia below 35 Celsius stops clotting factors and increases death so preventing heat loss is critical in trauma
8. Monitor vital signs every 5 minutes and watch for narrowing pulse pressure (top number minus bottom number less than 30) and rising heart rate above 120 — Pulse pressure narrows when stroke volume (amount of blood the heart pumps each beat) drops from hypovolemia (low blood volume) and a fast heart rate (tachycardia) (fast heart rate) is the first sign of shock before blood pressure falls

Sources

- American College of Surgeons ATLS 10th Edition
- Eastern Association for the Surgery of Trauma (EAST) Guidelines
- American College of Emergency Physicians (ACEP)

- World Society of Emergency Surgery (WSES)

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