

Intracranial Hemorrhage

Intracranial bleeding (hemorrhage) means bleeding inside the skull; the type of bleed tells you the cause, the danger, and the fix.

THE ONE-LINE TRUTH

Bleeding inside the skull can happen in four spaces—inside brain tissue (intracerebral), around the surface of the brain (subarachnoid), between the brain and the dura (subdural), or between the dura and the skull (epidural)—and where the blood lands tells you what broke and what to do.

The chain — how it unfolds

1. A blood vessel inside or around the brain bursts, and blood spills into the skull. — why: The trigger is trauma tearing a vein or artery, chronic high blood pressure popping a deep small artery, an aneurysm rupturing, tangled vessels (AVM) breaking, a tumor eating through a vessel wall, or blood-thinner medicine preventing a normal clot from sealing a tiny leak.
2. Blood pools in a space where it does not belong—either inside brain tissue (intracerebral), in the fluid cushion around the brain (subarachnoid), under the dura between the brain and skull (subdural), or between the dura and the skull bone itself (epidural). — why: That puddle of blood is like a growing balloon inside a locked box; the skull cannot stretch, so the blood takes up space meant for brain and fluid.
3. The blood clot presses on brain tissue, squeezes blood vessels, and blocks oxygen from reaching neurons. — why: Brain cells need a constant stream of oxygen and glucose; when vessels are crushed or flow is blocked, neurons start to die within minutes (ischemia), and the tissue swells like a bruise (edema).
4. Intracranial pressure rises, triggering headache (the worst of your life if subarachnoid), confusion, vomiting, weakness or numbness on one side, slurred speech, vision loss, seizures, or loss of consciousness. — why: These symptoms are the brain's alarm system—different parts of the brain control movement, speech, vision, and alertness, so where the bleed lands determines which functions break first.

5. If the bleed is in the subarachnoid space (around the surface arteries), blood irritates vessels and they clamp down in spasm (vasospasm), cutting off even more blood flow days later. — why: Breakdown products from the leaked blood—especially oxyhemoglobin—trigger smooth muscle in artery walls to contract, causing delayed blood-starved (ischemic) stroke 3–14 days after the first bleed; this is why subarachnoid bleeding (hemorrhage) needs ICU monitoring with daily transcranial Doppler ultrasound and nimodipine (a calcium channel blocker) to prevent vasospasm.
6. As pressure keeps climbing, the brain herniates—soft tissue is pushed through openings in the skull or the tentorium (the dura shelf separating brain compartments)—compressing the brainstem. — why: The brainstem controls breathing, heart rate, and consciousness; when it is crushed (uncal herniation squashes the third cranial nerve and midbrain, central herniation pushes the diencephalon down, tonsillar herniation shoves the cerebellum into the foramen magnum), pupils dilate and stop reacting to light, breathing becomes irregular or stops, and the patient dies.
7. If you do not diagnose the bleed with an urgent non-contrast head CT, reverse anticoagulation (vitamin K, prothrombin complex concentrate, or idarucizumab depending on the drug), lower systolic blood pressure gently to 140 mmHg (or 110–140 for intracerebral bleeding (hemorrhage) per ATACH-2/INTERACT-2), evacuate large clots surgically when needed, clip or coil a ruptured aneurysm, give nimodipine for subarachnoid bleeds, drain cerebrospinal fluid, give mannitol or hypertonic saline to pull down swelling, and monitor in the ICU, the patient herniates and dies. — why: Every intervention buys time and space—stopping the bleed, pulling fluid out of the brain, draining blood or cerebrospinal fluid, and fixing the broken vessel—so the brain can survive long enough to heal; delay means irreversible neuron death and brainstem compression.
8. Even if the patient survives, leaked blood and dead tissue leave behind scar, seizures, permanent weakness, speech or swallowing problems, memory loss, or need for a shunt if cerebrospinal fluid drainage is blocked. — why: Neurons do not grow back; the brain reorganizes around the damage, but function lost to dead tissue or stroke from vasospasm often stays gone, and irritation from old blood and gliosis (brain scar tissue) lowers the seizure threshold for life.

Spot it — what you see, and why

- Sudden, severe headache (often called 'the worst headache of my life'): Blood spills into the space around the brain or into brain tissue itself, which stretches the sensitive covering of the brain (the meninges) and irritates pain-sensing nerves. The pressure inside the skull rises quickly, triggering intense pain.

- Nausea and vomiting: Rising pressure inside the skull presses on the brainstem (the part of the brain that controls automatic body functions like breathing and stomach signals), triggering the vomit reflex.
- Confusion or trouble staying awake: Blood pools and presses on brain tissue, blocking normal electrical signals. The brain's network for awareness and thought (especially the cerebral cortex and reticular activating system, which keeps you alert) can't work properly under that pressure.
- Weakness or numbness on one side of the body: The bleed damages or presses on the motor cortex or nearby pathways (the strips of brain that send movement commands down the spinal cord to muscles). When one side of the brain is hurt, the opposite side of the body loses strength or feeling.
- Slurred speech or trouble understanding words: Blood disrupts the language centers in the brain—usually Broca's area (which creates speech) or Wernicke's area (which understands words), most often in the left side of the brain. Without clean signals, words get jumbled or lost.
- Seizure: Blood spilled onto brain tissue is irritating, like pouring salt on a wound. The neurons (brain cells) around the bleed fire wildly and out of sync, creating an electrical storm that spreads as a seizure.

Red flags — act now

- Sudden, thunderclap headache—the worst headache of your life, peaking in seconds
- Fainting or collapsing, especially right after the headache starts
- Rapidly worsening confusion, sleepiness, or inability to wake someone up
- New weakness, numbness, or paralysis on one side of the face or body
- Seizure in someone with no prior seizure history

Treat it — in this order

1. Reverse anticoagulation immediately: vitamin K 10 mg IV + prothrombin complex concentrate (PCC) 25–50 units/kg, or fresh frozen plasma (FFP) if PCC unavailable, for warfarin; idarucizumab 5 g IV for dabigatran; andexanet alfa for apixaban/rivaroxaban → Restores clotting factors and stops the blood from staying too thin, which slows or halts bleeding (hemorrhage) expansion. PCC works faster than FFP (minutes vs. hours) and is the guideline first choice (AHA/ASA, 2022).

2. Lower systolic blood pressure to 130–150 mmHg within 1 hour using IV nicardipine (5–15 mg/hr) or labetalol (10–20 mg IV bolus, then infusion) → Reduces the force pushing more blood out of the ruptured vessel, limiting a pooled collection of blood (hematoma) growth. The INTERACT2 and ATACH-2 trials support this target for intracerebral bleeding (hemorrhage) (AHA/ASA).
3. Neurosurgery consult within 1 hour: consider craniotomy for a pooled collection of blood (hematoma) evacuation (> 30 mL lobar, cerebellar > 3 cm with brainstem compression), external ventricular drain (EVD) for hydrocephalus, aneurysm clipping or coiling, or AVM resection → Relieves mass effect (the pressure from the blood clot squashing brain tissue), lowers intracranial pressure, secures the bleeding source to prevent re-rupture, and restores cerebrospinal fluid flow if blocked.
4. Manage intracranial pressure: elevate head of bed 30°, keep head midline, osmotic therapy with mannitol 0.25–1 g/kg IV or 3% hypertonic saline 150–250 mL bolus if signs of herniation, avoid low oxygen (hypoxia) (keep $\text{SpO}_2 \geq 94\%$) and hypercarbia (keep CO_2 35–40 mmHg) → Pulls fluid out of swollen brain tissue (osmotic agents), improves venous drainage (positioning), and keeps brain oxygen supply steady. This lowers intracranial pressure and preserves cerebral blood flow (perfusion) pressure ($\text{CPP} = \text{MAP} - \text{ICP}$, goal ≥ 60 mmHg).
5. Preventive (Prophylactic) antiseizure medication — levetiracetam 500–1000 mg IV twice daily — for lobar bleeding (hemorrhage), cortical involvement, or early seizure → Prevents seizures that would spike intracranial pressure, worsen brain injury, and complicate monitoring. Routine prevention (prophylaxis) is controversial; AHA/ASA recommends it only in high-risk cases, not for all hemorrhages.

Your top priorities at the bedside

1. Check neurologic status every 15 minutes using the Glasgow Coma Scale (a 3-to-15 point scoring system measuring eye opening, verbal response, and motor response), and immediately alert the provider if the score drops by 2 or more points. — why: A falling Glasgow Coma Scale score means the brain is herniating (shifting downward because pressure is too high), compressing the brainstem (the part controlling breathing and heart rate), which can cause death within minutes if not treated with emergency surgery or a burr hole (a small skull opening to drain blood).
2. Keep the head of the bed elevated to 30 degrees and the patient's head in neutral midline position, not turned to either side. — why: Elevating the head helps venous blood (blood in veins) drain out of the skull by gravity, lowering intracranial pressure; twisting the neck kinks the jugular veins (the large neck veins draining the brain) and traps blood inside the skull, raising pressure.

3. Measure blood pressure every 5 to 15 minutes and titrate IV nicardipine or labetalol to keep systolic pressure between 130 and 150 mmHg, never lowering it faster than 20 mmHg per hour. — why: High blood pressure pushes more blood into the bleeding (hemorrhage), making it bigger, but dropping pressure too fast or too low cuts off blood flow (perfusion) (blood flow) to healthy brain tissue around the bleed, causing blood-starved (ischemic) stroke (tissue death from lack of oxygen) on top of the bleeding.