

Burns

Stop the burning source immediately, measure how much skin is burned (using the rule of nines), replace lost fluids with IV saline (guided by urine output), protect the airway if smoke or face burns are present, cover wounds to prevent infection, watch for compartment syndrome in deep or circumferential burns, and manage pain aggressively.

THE ONE-LINE TRUTH

Heat, electricity, chemicals, or radiation damages or kills skin cells, breaking the body's protective barrier and triggering fluid loss, swelling, and infection risk.

The chain — how it unfolds

1. Heat, electricity, chemicals, or radiation hits the skin and kills cells on contact. — why: Energy (thermal, electrical, chemical) denatures proteins and ruptures cell membranes instantly, like cooking an egg; once cells are dead, the protective barrier is gone.
2. Dead and dying cells release inflammatory chemicals (cytokines, histamine, prostaglandins) into surrounding tissue. — why: When cells die, they spill their contents and send distress signals; the body responds by flooding the area with inflammatory molecules to clean up debris and start healing.
3. Blood vessels in and around the burn become leaky (increased capillary permeability). — why: Inflammatory chemicals loosen the tight junctions between endothelial cells lining blood vessels; plasma (the liquid part of blood) pours out into tissue, causing massive swelling (edema) and dropping blood volume.
4. Fluid shifts out of the bloodstream into burned tissue and other body compartments (third-spacing), leading to hypovolemic shock. — why: With less fluid in the vessels, the heart struggles to pump enough blood to organs; blood pressure falls, kidneys make less urine, and the brain gets confused from low oxygen delivery.
5. If the burn is deep or wraps around a limb (circumferential), swelling inside tight compartments squeezes blood vessels and nerves, causing compartment syndrome. — why: Burned skin becomes stiff like leather (eschar) and cannot stretch; swelling underneath has nowhere to go, so pressure builds and chokes off blood flow to muscles and nerves, leading to permanent damage or limb loss if not released urgently (escharotomy or fasciotomy).

6. If smoke, steam, or toxic gases are inhaled, the airway lining swells over 12–24 hours, progressively narrowing the breathing tube. — why: Heat and chemicals burn the delicate mucosa of the trachea and bronchi; just like burned skin, the airway tissue swells, and because the airway is a rigid tube with limited space, even small swelling can completely block airflow, causing respiratory arrest.
7. Electrical burns cause muscle cells deep inside the body to rupture (rhabdomyolysis), releasing myoglobin into the bloodstream. — why: Electrical current travels through the path of least resistance (nerves, blood vessels, muscles); it makes muscle cells contract violently and tear apart, spilling myoglobin (a muscle protein) that clogs kidney filters and causes acute kidney injury and dark urine.
8. Electrical current can also disrupt the heart's rhythm, causing arrhythmias or cardiac arrest on contact. — why: The heart runs on its own electrical signals; external electricity scrambles or overpowers those signals, leading to ventricular fibrillation (chaotic quivering) or asystole (flatline).

Spot it — what you see, and why

- Red, warm skin that hurts when you touch it (first-degree burn): Heat damages only the top layer of skin (the epidermis), so the blood vessels just below get wider and leak fluid, making the area red and swollen; the nerve endings are still working, so it hurts.
- Blisters with clear or yellow fluid, very painful, weeping surface (second-degree / partial-thickness burn): Heat destroys both the top layer and part of the deeper layer (dermis), so fluid collects under the skin forming blisters; nerve endings are still alive and exposed, which causes sharp pain.
- White, brown, or black leathery skin that does not hurt (third-degree / full-thickness burn): Heat destroys all layers of skin including the nerves, so the area looks charred or waxy and has no feeling because the pain sensors are dead.
- Burned area covers a large part of the body (measured by percentage of total body surface area, or TBSA): The bigger the burn, the more fluid the body loses through the open wound and the more stress hormones flood the bloodstream, which can drop blood pressure and harm organs like the kidneys.
- Burn goes all the way around an arm, leg, chest, or neck (circumferential burn): Burned skin gets tight and stiff like a hard band; if it wraps all the way around a limb it can squeeze blood vessels shut (like a tourniquet) or squeeze the chest so the person cannot breathe deeply.
- Soot or burned hairs inside the nose or mouth, hoarse voice, or coughing up black mucus: Hot air, smoke, or steam burned the airways (inhalation injury), causing the lining to swell; swelling can narrow the airway like a kinked straw and make breathing hard or impossible.

Red flags — act now

- Burns covering more than 10% of the body in an adult or more than 5% in a child (high risk of shock and organ failure)
- Any burn that goes all the way around an arm, leg, chest, or neck (can cut off blood flow or breathing)
- Burn on the face, airway signs (soot in nose, hoarse voice, trouble breathing), or suspected smoke inhalation (airway can swell shut)
- Electrical or chemical burns (hidden deep-tissue damage or ongoing chemical injury)
- Burns in very young children, older adults, or people with other serious medical problems like diabetes or heart disease (higher risk of complications)

Treat it — in this order

1. Stop the burning process immediately: put out flames by rolling on the ground or smothering with a blanket, remove all burned clothing and jewelry (metal and fabric keep burning the skin), run cool (not ice-cold) tap water over the burn for 10-20 minutes, brush off dry chemical powders before rinsing with water, flood chemical burns with copious water for at least 20 minutes → Halts the transfer of heat or chemical energy into deeper layers of skin and tissue, limiting how far the damage spreads. Cooling also reduces pain by calming nerve endings. Removing clothing stops smoldering fabric from continuing to cook the skin.
2. Secure the airway early with endotracheal intubation if any of these are present: burns to the face or neck, soot in the nose or mouth, singed nasal hairs or eyebrows, hoarse or changing voice, a high-pitched noise on breathing in (stridor) (high-pitched breathing sound), respiratory distress, fire in an enclosed space, or carboxyhemoglobin > 10% → Guarantees an open route for air to reach the lungs before swelling from heat and inflammation narrows or closes the throat completely (usually peaks at 12-24 hours). Protects the airway from vomit if the person's consciousness drops. Allows you to deliver high-concentration oxygen or put the person on a ventilator if needed.

3. Start large-volume IV fluid resuscitation using the Parkland formula: $4 \text{ mL of lactated Ringer's (preferred) or normal saline} \times \text{patient's weight in kilograms} \times \text{percent total body surface area burned}$; give half of the calculated volume in the first 8 hours from the time of the burn (not from arrival), and the other half over the next 16 hours. Titrate the rate up or down every hour to keep urine output at 0.5–1 mL/kg/hour in adults or 1–2 mL/kg/hour in children. If urine is dark (myoglobinuria), target 1–2 mL/kg/hour and consider adding IV sodium bicarbonate to keep urine pH > 6.5 and IV mannitol to flush the pigment out faster.
→ Replaces the massive amounts of fluid leaking out of damaged capillaries into burned tissue and the space around cells. Maintains blood pressure and blood flow to vital organs (brain, heart, kidneys, gut), preventing hypovolemic shock and acute kidney injury. Dilutes and flushes out myoglobin or hemoglobin to protect kidney tubules.
4. Perform escharotomy (surgical cuts through the full thickness of burned skin) within hours if circumferential full-thickness burns on the chest restrict breathing (you see the chest barely moving or oxygen levels dropping despite the airway being open) or circumferential burns on an arm, leg, or digit show signs of poor blood flow (absent pulses by Doppler, cold skin, blue color, severe pain, or tight compartment on exam) → Releases the tourniquet effect of the tight, non-stretchable dead skin (eschar). Allows the chest wall to expand so the lungs can fill with air. Restores blood flow to the tissues downstream (hand, foot, fingers, toes) by letting swollen tissue expand outward instead of crushing the arteries and veins.
5. Apply topical antimicrobial to partial-thickness and full-thickness burns after cleaning: silver sulfadiazine 1% cream (avoid on the face, in pregnant women, newborns, or anyone allergic to sulfa drugs) or alternatives like mafenide acetate, silver-impregnated dressings, or bacitracin. Change dressings once or twice daily. Give tetanus toxoid booster if the last dose was > 5 years ago (or tetanus immune globulin if never vaccinated). Control pain with IV opioids (morphine, fentanyl) titrated to effect; do not rely on oral or IM routes in the first 48 hours because gut absorption and muscle blood flow are unpredictable during resuscitation. → Reduces bacterial colonization and invasion of the burn wound, lowering the risk of life-threatening burn wound sepsis (infection spreading into the blood). Tetanus prevention (prophylaxis) prevents the toxin-producing bacterium *Clostridium tetani* from growing in dead tissue. Adequate pain control reduces the body's stress response (which worsens fluid leak and suppresses immune function) and allows the person to breathe deeply and cooperate with physical therapy.

Your top priorities at the bedside

1. Check airway every 15 to 30 minutes for the first 24 hours: listen for a high-pitched noise on breathing in (stridor) (high-pitched squeaky breathing), hoarseness, drooling, or increased work of breathing; keep intubation equipment and the rapid response team immediately available. — why: Airway swelling from inhaled heat or smoke peaks 12 to 24 hours after injury but starts silently; once the airway narrows enough to cause a high-pitched noise on breathing in (stridor), swelling may progress too fast to place a breathing tube safely, requiring emergency surgical airway.
2. Start two large-bore IV lines (18-gauge or bigger) in unburned skin if the burn covers more than 20% of body surface, and give warmed Lactated Ringer solution using the Parkland formula: 4 milliliters times body weight in kilograms times percent body surface burned, with half given in the first 8 hours from time of injury. — why: Burn injury makes capillaries (tiny blood vessels) leak massive amounts of fluid into tissues, dropping blood volume and blood pressure into hypovolemic shock (not enough fluid in vessels to perfuse organs); formula-guided fluid replacement prevents kidney failure and death but must start immediately because the clock begins at injury time, not arrival time.
3. Measure urine output every hour with a Foley catheter and adjust IV fluid rate to keep urine output between 30 and 50 milliliters per hour in adults or 1 milliliter per kilogram per hour in children. — why: Urine output is the most reliable bedside measure of whether organs are getting enough blood flow; too little urine means inadequate fluid resuscitation and the kidneys are failing, while too much means fluid overload that causes pulmonary edema (fluid flooding the lungs) (fluid in the lungs) and compartment syndrome (pressure buildup in limbs).