

Electrical Injury

How badly electricity hurts you depends on three things: how strong the current is (voltage), where it enters and exits your body, and how long it flows through you.

THE ONE-LINE TRUTH

Electrical injury occurs when current passes through the body, causing burns, heart rhythm problems, muscle damage, and organ injury that is often worse inside than it looks on the skin.

The chain — how it unfolds

1. Current enters body and creates entry/exit burns — why: Electricity breaks through skin resistance at the contact point (entry—often hand or head) and exits where the body touches ground (exit—often foot), burning skin at both spots as current converts to heat.
2. Current flows through internal tissues along path of least resistance — why: Inside the body, electricity travels preferentially through nerves, blood vessels, and muscles (low resistance) rather than bone or fat (high resistance), heating and destroying cells along this path like a wire overheating.
3. Deep muscle and organ damage occurs, worse than skin shows — why: The same current that made a small skin burn has traveled through centimeters or meters of internal tissue, cooking muscle, blood vessels, and organs from the inside—thermal injury is proportional to tissue resistance and current duration, so deep damage is often massive even when surface burns look minor.
4. Heart rhythm disrupted or heart stops — why: External electrical current depolarizes the entire heart at once (like hitting 'reset' on the heart's pacemaker), causing ventricular fibrillation (chaotic quivering) or asystole (complete stop)—if current crosses the chest (hand-to-hand or hand-to-foot), the risk is highest because the path goes directly through the heart.
5. Tetanic muscle contraction causes fractures or throws victim — why: Electrical current makes all muscles contract maximally and simultaneously—flexor muscles are stronger than extensors, so the victim's hand clamps onto the source ('can't let go' phenomenon), or the whole body is thrown backward by extensor spasm, breaking bones (vertebrae, humerus, femur) or causing head trauma from the fall.

6. Rhabdomyolysis releases myoglobin into bloodstream — why: Cooked muscle cells rupture and dump their contents—including myoglobin (the oxygen-carrying protein inside muscle)—into the blood; myoglobin turns urine tea-colored or cola-colored and is visible evidence of massive muscle breakdown.
7. Myoglobin clogs kidney filters, causing acute kidney injury — why: Myoglobin is a large molecule that precipitates (clumps) in the kidney's filtering tubules, physically blocking urine flow like coffee grounds clogging a drain—this leads to acute tubular tissue death (necrosis) and kidney failure if not flushed out quickly with IV fluids.
8. Compartment syndrome develops as burned muscle swells — why: Damaged muscle swells with fluid (edema), but arms and legs are wrapped in tight, non-stretchable fascia (like shrink-wrap)—pressure inside the compartment rises, squeezing shut arteries and veins, which cuts off blood flow and oxygen to any remaining healthy muscle and nerve, killing more tissue and creating a vicious cycle unless the fascia is cut open surgically (fasciotomy).

Spot it — what you see, and why

- Skin burns at entry and exit points: Electricity flowing through the body turns into heat where it enters and leaves the skin, cooking the tissue like a hot wire touches plastic. High-voltage current can burn deep layers (muscle, bone) even if the skin looks okay on the surface.
- Muscle pain, swelling, or weakness in arms or legs
- Heart rhythm problems (arrhythmias) or cardiac arrest: The heart beats because of tiny electrical signals. A strong outside electrical current can scramble those signals, making the heart beat too fast, too slow, or stop completely. Even after the shock, the heart's rhythm can stay unstable for hours.
- Numbness, tingling, or loss of movement: Nerves use electrical signals to send messages. Electric shock can fry the nerve's insulation (myelin, the coating that helps signals travel) or kill nerve cells outright, so signals can't get through. This causes numbness or paralysis in the path the electricity took.
- Confusion, memory loss, or seizures: If electricity passes through the brain, it disrupts the normal electrical activity that lets you think and remember. High-voltage shocks can also cause brain swelling or bleeding, leading to confusion or seizures (uncontrolled bursts of brain activity).
- Dark or cola-colored urine: When muscle cells are destroyed, they release a protein called myoglobin into the blood. The kidneys filter it out, turning the urine dark brown or red. Too much myoglobin can clog the kidney filters and cause kidney failure.

Red flags — act now

- Heart rhythm is irregular, too fast, too slow, or the person has chest pain
- Urine is dark brown, red, or cola-colored (sign of muscle breakdown clogging the kidneys)
- Severe swelling, numbness, or pain in an arm or leg that gets worse (compartment syndrome building pressure)
- Confusion, seizures, or the person is unconscious or hard to wake up
- High-voltage exposure (power lines, industrial equipment) even if burns look small on the outside

Treat it — in this order

1. Continuous cardiac monitoring for 24–48 hours → Electricity can trigger deadly heart rhythms immediately or hours later. Watching the heart lets you catch and treat arrhythmias before they cause cardiac arrest.
2. Aggressive IV fluids (lactated Ringer's or normal saline) to keep urine output > 200 mL/hour (in adults) → Damaged muscle spills myoglobin into the blood. Extra fluid flushes myoglobin through the kidneys before it clogs the filters and causes kidney failure.
3. Check for compartment syndrome; perform fasciotomy if pressure > 30 mmHg or clinical signs are severe → Electricity cooks muscle and it swells inside tight compartments. Cutting open the skin and fascia (the tough layer around muscle) lets swelling expand outward instead of crushing blood vessels and nerves.
4. Treat arrhythmias per ACLS protocols (defibrillation for ventricular fibrillation, pacing for heart block, medications like amiodarone or lidocaine) → Restores normal electrical signals in the heart so it can pump blood to the brain and body. Saves life if the heart has stopped or is in a deadly rhythm.
5. Tetanus prevention (prophylaxis) (vaccine and/or immunoglobulin based on history) → Burn wounds are dirty and at high risk for tetanus (a deadly bacterial infection that locks muscles in spasm). Tetanus shot prevents this infection.

Your top priorities at the bedside

1. Place patient on continuous cardiac monitor and obtain a 12-lead ECG immediately, watching for arrhythmias like ventricular fibrillation, ventricular a fast heart rate (tachycardia), or heart block. — why: Electrical current disrupts the heart's normal electrical system and can cause lethal rhythms even hours after injury—continuous monitoring for 24 to 48 hours catches life-threatening arrhythmias before they cause cardiac arrest.

2. Start two large-bore IV lines and run lactated Ringer's or normal saline wide open, aiming for urine output greater than 200 mL per hour in adults (1 to 2 mL per kilogram per hour in children). — why: Aggressive IV fluids flush myoglobin (muscle breakdown protein) out of the kidneys before it clogs the tiny kidney filters and causes acute kidney injury—high urine output washes the toxins away and protects kidney function.
3. Check urine color every void and send urine myoglobin level and serum creatine kinase (muscle enzyme) if urine is dark, tea-colored, or cola-colored. — why: Dark urine signals rhabdomyolysis where damaged muscles release myoglobin that is toxic to kidneys—tracking these levels tells us how severe the muscle damage is and whether our fluid treatment is working to protect the kidneys.