

Shock

Shock means the body cannot deliver enough oxygen-rich blood to cells, so cells start to die.

THE STORY IN ONE SENTENCE

Shock means the body cannot deliver enough oxygen-rich blood to cells, so cells start to die.

“Shock is blood flow failure. Find which of the three things broke—tank, pump, or pipes—and fix it fast.”

Normal anatomy — the body's job

Oxygen delivery to cells depends on three things working together: enough blood volume (the tank), a strong heart pump, and blood vessels that squeeze or relax to control pressure. Heart output (how much blood the heart pumps per minute) times oxygen content (how much oxygen each drop of blood carries) equals oxygen delivery. Blood pressure equals heart output times how tight the vessels squeeze (resistance). Keep this picture in your head—every shock finding is a break in one of these three things.

BODY'S JOB

The heart pumps oxygen-rich blood out to every cell in the body. Cells use that oxygen to make energy (like a battery charging). Blood vessels act like adjustable pipes—they can squeeze tight to raise pressure or relax to lower it. The kidneys watch pressure and tell the body to hold onto water and salt when pressure drops. The brain monitors everything and can speed up the heart, tighten vessels, or shift blood flow to protect itself and the heart first. When all three things (tank, pump, pipes) work right, every cell gets the oxygen it needs and waste gets carried away.

1. The heart squeezes and pushes blood out into the aorta (the body's main highway).
2. Blood flows through smaller and smaller arteries (like highway exits) until it reaches tiny vessels called capillaries in every organ.
3. Oxygen jumps out of the blood into cells, and carbon dioxide (waste) jumps into the blood.

4. Blood flows back through veins (like return roads) to the heart, then to the lungs to pick up fresh oxygen and drop off carbon dioxide.
5. The cycle repeats—heart pumps about 5 liters of blood every minute when resting in an adult, more when you're active.
6. Blood pressure is highest in arteries (systolic over diastolic, like 120/80) and drops as blood moves through capillaries and veins.
7. Mean arterial pressure (MAP) is the average squeeze through the whole cycle; normal is around 70–100, and organs need at least 65 to get enough blood.

What breaks

Shock happens when one of the three parts of the oxygen-delivery system breaks: the tank runs dry (not enough blood volume), the pump fails (heart can't squeeze), or the pipes go haywire (vessels open too wide or get blocked). Once that break happens, cells don't get oxygen, and the body's emergency responses kick in to protect the brain and heart—but those responses can't hold forever.

CLINICAL TERM

Shock is acute circulatory failure leading to inadequate tissue blood flow (perfusion) and cellular low oxygen (hypoxia). It is classified by the upstream mechanism: distributive (pathologic vasodilation from sepsis, anaphylaxis, or neurogenic injury), hypovolemic (absolute intravascular volume loss from bleeding (hemorrhage), GI losses, burns, or third-spacing), cardiogenic (myocardial pump failure from MI, decompensated heart failure, arrhythmia, or valvular rupture), and obstructive (mechanical impediment to flow such as cardiac tamponade (the heart squeezed by fluid around it), tension pneumothorax, or massive pulmonary embolism (a clot lodging in a lung artery)). The common downstream pathway is poor blood flow (hypoperfusion), anaerobic metabolism, lactic acidosis (acid from oxygen-starved tissues), and compensatory neurohumoral activation (SNS, RAAS) that redistributes cardiac output to vital organs at the expense of splanchnic, renal, and cutaneous beds.

How the body compensates

The body has backup tricks to keep blood pressure and oxygen delivery up when shock starts. It speeds up the heart, squeezes vessels tighter, pulls blood away from skin and gut to protect the brain and heart, and tells the kidneys to hold onto salt and water. These tricks can hide how sick someone is for a while—vital signs may look almost normal even as cells are starving.

The danger is missing the slow slide toward the crash point, because once compensation fails, organs shut down fast and the window to save them closes.

1. {'step': 'Baroreceptors (pressure sensors in the neck and chest) detect the blood pressure drop within seconds.', 'why': 'These sensors are like the body's pressure gauges—when they feel pressure falling, they send an alarm signal to the brainstem to activate emergency mode.'}
2. {'step': 'Sympathetic nervous system fires up: heart rate climbs (tachycardia), and vessels in skin, gut, kidneys, and muscles squeeze tight (vasoconstriction).', 'why': 'The brain orders the release of adrenaline (epinephrine) and norepinephrine to make the heart beat faster and harder and to narrow vessels everywhere except the brain and heart, trying to raise pressure and keep critical organs fed.'}
3. {'step': 'Blood is redistributed—flow to skin, gut, and kidneys drops; flow to brain and heart is preserved as long as possible.', 'why': 'The body sacrifices less critical organs to buy time for the ones you can't live without, so you get pale, cold, clammy skin (vasoconstriction in skin), gut shuts down (ileus, risk of gut starved blood flow (ischemia) later), and urine output falls (kidneys are being starved).'}}
4. {'step': 'Kidneys activate RAAS (renin-angiotensin-aldosterone system) to hold onto sodium and water, trying to refill the tank and boost pressure.', 'why': 'Low pressure signals the kidneys to release renin, which triggers a hormone cascade that tells the kidneys to keep salt and water, raises blood volume, and squeezes vessels even tighter—this takes hours to days to fully kick in.'}
5. {'step': 'Anaerobic metabolism begins in underperfused cells, producing lactate.', 'why': 'Cells that don't get enough oxygen switch from normal energy production (which needs oxygen) to an emergency backup (which doesn't), but the backup is inefficient and makes lactate as waste—rising lactate is the chemical SOS that cells are suffocating.'}
6. {'step': 'Vital signs may stay near-normal during compensated shock (systolic BP might be 90–100, heart rate 100–120), masking how close the patient is to decompensation.', 'why': 'The body's backup systems are working overtime to prop up pressure and flow, so numbers look okay even though organs are on the edge—this is the dangerous 'stable but sliding' phase where teams can be fooled into thinking the patient is fine.'}
7. {'step': 'Decompensation hits when the backup tricks run out: blood pressure crashes, heart rate may paradoxically slow or become very fast and weak, lactate spikes, urine stops, mental status drops (confusion, lethargy), and organs begin to fail.', 'why': 'The heart can't beat any faster, vessels are squeezed as tight as they'll go, and there's no more reserve left—once compensation breaks, the system collapses quickly and multi-organ failure (MOF) begins, with mortality climbing steeply every hour.'}

8. {'step': 'Every minute with MAP below 65 mmHg in septic shock raises the risk of death and permanent organ damage.', 'why': 'Organs need a minimum blood flow (perfusion) pressure to get blood flow—below MAP 65, kidneys, liver, gut, and brain start to die, and even if you fix the shock later, the damage may be irreversible (acute kidney injury, liver failure, brain injury, gut tissue death (necrosis)).'}
9. {'step': "Look at the trend (is pressure falling, is lactate rising, is urine output dropping) rather than a single snapshot, because a 'stable' patient on a downward slope is not truly stable.", 'why': "Shock is dynamic—what matters is the direction and speed of change; a patient with BP 95 who was 110 an hour ago and 100 thirty minutes ago is crashing, even though 95 doesn't sound terrible in isolation."}

Domino effect

1. One of the three upstream things breaks: tank (volume loss), pump (heart failure), or pipes (vessels dilate or get blocked). — This is the single root cause—everything else that follows is the body's reaction to this one break, so finding and fixing this upstream problem is the only way to stop the cascade.
2. Oxygen delivery to cells drops because blood flow or oxygen content falls. — Cells need a steady stream of oxygen to make energy (ATP); when delivery falls below what cells need, they can't do their jobs and start to fail.
3. Cells switch to anaerobic metabolism (backup fuel pathway that doesn't need oxygen), and lactate piles up as waste. — Anaerobic metabolism is like running a car on fumes—it keeps the engine sputtering for a little while but makes toxic exhaust (lactate); rising serum lactate (normal <2 mmol/L, shock often >4) is the lab's red flag that cells are suffocating.
4. Baroreceptors sense low pressure and trigger sympathetic surge: heart rate climbs, vessels squeeze tight, and blood flow is pulled away from skin, gut, and kidneys to protect brain and heart. — The body rations blood like a city in drought rations water—non-essential services (skin color, gut motility, kidney filtering) are cut to keep the critical infrastructure (brain, heart) running as long as possible.
5. Skin becomes cold, pale, and clammy in cardiogenic and hypovolemic shock (vasoconstriction); or warm and flushed early in distributive shock (vasodilation) before it later turns cold. — Skin blood flow (perfusion) and temperature are the physical exam's roadmap to the type of shock: if vessels are squeezed tight (hypovolemic, cardiogenic, late septic), skin is cold and pale because blood is being kept away; if vessels are wide open (early septic, anaphylactic, neurogenic), blood pools in the skin so it looks warm and red even though pressure is low.

6. Kidneys reduce urine output (oliguria, <0.5 mL/kg/h) as they hold onto salt and water, and RAAS activation begins. — Low flow to the kidneys makes them think the body is dehydrated, so they clamp down on urine production to try to keep every drop of fluid in the tank and boost blood volume and pressure back up—but if the real problem is a broken pump or wide-open pipes, adding fluid won't fix it and may even make things worse (fluid overload in cardiogenic shock).
7. Brain blood flow (perfusion) starts to fall, causing confusion, agitation, or lethargy. — The brain is usually the last organ to lose blood flow, so altered mental status is a late and ominous sign that even the body's highest-priority organ is now starving—this often signals impending decompensation.
8. Multi-organ dysfunction begins: acute kidney injury (AKI), liver enzyme rise (hepatic starved blood flow (ischemia)), gut starved blood flow (lactic too much acid in the blood (acidosis) worsens, risk of gut barrier breakdown and bacterial translocation), and myocardial dysfunction (even non-cardiogenic shock can cause secondary heart injury from poor coronary blood flow (perfusion)). — Once cells go without oxygen for more than a few minutes to hours (depending on the organ), they start to die; kidneys can't filter waste (creatinine rises), liver can't process toxins (ammonia, bilirubin rise), gut wall breaks down (bacteria leak into blood, worsening sepsis), and even the heart muscle gets stunned from low coronary flow, creating a vicious cycle.
9. If the upstream break is not fixed, the system spirals: worsening too much acid in the blood (acidosis) (from lactate and kidney failure) makes the heart beat poorly, vessels stop responding to squeeze signals, and the patient progresses to refractory shock and death. — Too much acid in the blood (Acidosis) (pH dropping below 7.2-7.3) poisons the heart and blood vessels so they can't respond to the body's own adrenaline or to medicines we give (pressors like norepinephrine stop working), creating a point of no return where no amount of fluids or drugs can bring pressure back up and organs shut down irreversibly.

Symptoms · what the patient feels, and why

- Fast heart rate (tachycardia): The heart beats faster to pump more blood and oxygen to the body when blood pressure drops or there is not enough blood. It is like a pump working overtime to keep up.
- Low blood pressure (hypotension): Not enough blood moves through the tubes (vessels) in your body. This happens because there is too little blood, the tubes are too wide and loose, or the heart cannot pump hard enough.
- Cold, clammy, pale skin: Blood vessels in the skin squeeze tight to save blood for the brain and heart. Less blood reaches the skin. It is like closing side roads so more cars can stay on the main highway.

- **Weak or absent pulses:** Low blood pressure means each heartbeat pushes out less blood. The pulse feels very weak or you cannot feel it at all in your wrist or feet.
- **Confusion or agitation:** The brain is not getting enough oxygen because blood is not flowing well. It is like a phone battery running too low and starting to act weird.
- **Very little or no urine (oliguria or no urine output (anuria)):** The kidneys need strong blood flow to clean the blood and make urine. When blood pressure drops, the kidneys hold onto water to try to keep blood volume high.
- **Fast, shallow breathing (tachypnea):** The body breathes faster and lighter to take in more oxygen and get rid of carbon dioxide. Tissues are starving for oxygen. It is like gasping for air after you run hard.
- **Mottled or blotchy skin (livedo reticularis):** Blood flow is uneven and weak in the tiny blood vessels in the skin. This makes a purple or patchy pattern. It is like water stains on fabric when the flow is not smooth.

Focused exam

- **Skin temperature and color:** When shock starts, the body pulls blood away from skin to protect the brain and heart. Cold, pale, clammy skin means the body is saving blood for vital organs. This happens in cardiogenic shock (heart cannot pump well) or hypovolemic shock (not enough blood). Warm, flushed skin early in shock means blood vessels opened too wide and blood pools in the skin. This happens in distributive shock like sepsis or anaphylaxis. One skin finding tells you which broken piece to fix first.
- **Neck veins — flat or bulging (jugular venous distension, JVD):** Flat neck veins in shock usually mean the tank is empty — not enough blood volume, so veins have nothing to fill them (hypovolemic shock). Bulging, full neck veins mean blood is backing up because the heart cannot pump it forward (cardiogenic shock) or something is squeezing the heart and blocking it (obstructive shock, like a blood clot in the lung or fluid around the heart). This tells you if the problem is an empty tank or a stuck pump.
- **Breath sounds and work of breathing:** Crackles (wet popping sounds) in the lungs in shock point to cardiogenic shock — the heart backed up, pressure built up in lung vessels, and fluid leaked into air sacs. Clear lungs in shock point to hypovolemic or distributive shock. Fast, deep breathing in any shock means cells are running on anaerobic metabolism (making energy without oxygen), which produces lactate and makes blood acidic. The lungs speed up to blow off carbon dioxide and try to balance the acid.

- Blood pressure and pulse: Shock is defined as mean arterial pressure (MAP) under 65 mmHg — at that point, organs do not get enough blood flow. A fast pulse (tachycardia) in shock is the body trying to pump more blood per minute to make up for low pressure. A slow pulse (bradycardia) in shock is a danger sign — it means the heart is failing, a medication is blocking it, or something is crushing the heart. In distributive shock early on, the pulse may be fast but pressure still drops because blood vessels have relaxed too much.
- Urine output: In shock, kidneys get less blood so they make less urine. The body also holds onto salt and water to try to keep blood volume up. Urine output less than 0.5 mL per kilogram per hour (for example, less than 35 mL per hour in a 70 kg adult) means kidneys are not getting enough blood and organ failure is starting. This is one of the earliest measurable signs that shock is real.
- Mental status — alert, confused, or sleepy: The brain is a priority organ in shock, so the body keeps blood flowing to it as long as possible by pulling blood away from skin, gut, and kidneys. Confusion, sleepiness, or agitation in shock means blood flow to the brain is now failing. This is a late sign and means shock is severe — the body has run out of ways to compensate.

Diagnostics · every test answers a question

- Serum lactate → Are tissues getting enough oxygen, or are cells running on anaerobic metabolism (making energy without oxygen)?
- Complete blood count (CBC) with hemoglobin and hematocrit → Is there enough red blood cells to carry oxygen, or has the patient lost blood?
- Basic metabolic panel (BMP) — sodium, potassium, creatinine, blood urea nitrogen (BUN) → Are the kidneys getting enough blood, and is the body holding onto salt and water to protect blood volume?
- Arterial blood gas (ABG) → Is the blood getting enough oxygen, and is the body trying to compensate for acid buildup from shock?
- Blood cultures (two sets from different sites before antibiotics) → Is an infection in the blood causing distributive (septic) shock?
- Electrocardiogram (ECG) → Is the heart having a heart attack or dangerous rhythm that is causing cardiogenic shock?
- Chest X-ray → Is there fluid in the lungs from heart failure, a collapsed lung, or signs of infection?
- Point-of-care ultrasound (POCUS) or echocardiogram → Is the heart squeezing well, is it filling with blood, or is something blocking it?

Treatment logic

- Identify the type of shock by physical exam: Check neck veins (full veins = heart or obstructive problem), listen to lungs (crackles = heart failure backing up), look at skin (cold and pale = hypovolemic or cardiogenic; warm and flushed = distributive like sepsis). → Naming the upstream broken piece tells you which treatment will actually work. A septic patient needs antibiotics and norepinephrine to tighten blood vessels, not just fluids. A bleeding patient needs blood products and surgery to stop the bleed, not pressors. A heart-attack patient needs the blocked artery opened fast. Each type of shock has a different fix, so guessing wrong wastes time and can harm the patient.
- Hypovolemic shock (bleeding or dehydration): Give IV crystalloid fluids rapidly (30 mL per kg in the first hour, about 2 liters in an average adult), give packed red blood cells if hemoglobin is under 7 g/dL or actively bleeding, and find and stop the bleeding source (surgery, endoscopy, or clotting products like tranexamic acid). → Replacing lost volume fills the tank back up so the heart has blood to pump. Blood pressure rises, organs get blood flow again, lactate drops, and kidneys start making urine. The body stops rationing blood away from skin and gut. If the patient lost blood, giving red cells also restores oxygen-carrying capacity.
- Distributive shock — sepsis: Give IV crystalloid fluids (30 mL/kg in first hour), start broad-spectrum antibiotics within 1 hour of recognizing septic shock (guideline target per Surviving Sepsis Campaign), draw blood cultures before antibiotics, add norepinephrine (a vasopressor that tightens blood vessels) if MAP stays under 65 mmHg after fluids, and find and remove the source of infection (drain abscess, remove infected catheter). → Fluids fill the widened vascular space, norepinephrine squeezes blood vessels back to normal width and pushes blood back to the center where organs need it, and antibiotics kill the bacteria that triggered the immune chemicals causing the shock. Blood pressure rises, lactate drops, and organs start working again.
- Distributive shock — anaphylaxis: Give intramuscular epinephrine 0.3–0.5 mg immediately (into the thigh), lay the patient flat and elevate legs, give IV fluids rapidly, give inhaled albuterol if wheezing, give IV antihistamines (diphenhydramine) and corticosteroids (methylprednisolone), and remove the allergen trigger if possible. → Epinephrine reverses the allergic reaction by tightening blood vessels, opening airways, and stopping the immune cells from releasing more histamine. Blood pressure rises, airway swelling goes down, and shock reverses within minutes. Fluids support blood volume while epinephrine works.

- **Cardiogenic shock:** Open blocked arteries fast (emergency cardiac catheterization with stent placement for STEMI, guideline target door-to-balloon time under 90 minutes), give inotropes like dobutamine (2.5–20 mcg/kg/min) to strengthen the heartbeat, add norepinephrine if blood pressure is still low, use mechanical support (intra-aortic balloon pump or ventricular assist device) if medications are not enough. → Unblocking the artery restores blood flow to dying heart muscle and stops the heart attack. Inotropes make the heart squeeze harder so it can pump more blood forward, which raises blood pressure and delivers oxygen to organs. Mechanical pumps take over part of the heart's job while it heals.
- **Obstructive shock:** Needle decompression (large needle into chest) for tension pneumothorax (collapsed lung squeezing the heart), pericardiocentesis (needle into the sac around the heart) to drain fluid squeezing the heart, thrombolysis (clot-busting drugs like tPA) or surgical/catheter removal for massive pulmonary embolism (a clot lodging in a lung artery) (blood clot blocking the lung arteries). → Removing the blockage releases the squeeze on the heart and lets it fill and pump blood forward again. Blood pressure rises immediately, organs get blood flow, and shock reverses. These are life-saving emergency procedures.
- Monitor lactate every 2–4 hours and urine output hourly to know if the body is getting oxygen back; do not chase one number alone — instead ask: Is the upstream break fixed? Is the patient's mental status improving? Are the kidneys making urine again? → Lactate dropping below 2 mmol/L and urine output rising above 0.5 mL/kg/hr prove that cells are getting oxygen again and shock is reversing. These are the body's report card that your treatment matched the real problem. Watching trends instead of single numbers prevents you from being fooled by lab delays or temporary changes.

Medications

Norepinephrine (Levophed) · Vasopressor (blood-vessel squeezer)

Tightens blood vessels that have opened too wide, raising blood pressure so organs get enough flow. Think of it like turning a loose garden hose nozzle tighter so water shoots farther.

1. Norepinephrine lands on alpha-1 receptors on vessel walls
2. This tells the smooth muscle cells in the wall to squeeze
3. The vessel gets narrower (constricts)
4. Blood pressure rises because the same amount of blood is now pushed through narrower pipes
5. Blood flow to vital organs (brain, heart, kidneys) improves

SAFETY WATCH

Can starve fingers, toes, or skin of blood if dose is too high or runs too long—tissue can die
· Must go through a large central vein (central line), not a small arm vein, or it can damage tissue
· Can cause dangerous fast heart rhythms · If blood volume is still low, squeezing empty vessels will not help—give fluids first

Epinephrine (Adrenaline) · Vasopressor and heart stimulant (combined alpha and beta agonist)

Does two jobs at once: squeezes blood vessels to raise pressure AND makes the heart beat stronger and faster. Also relaxes airway muscles. This is the first-line drug for anaphylactic shock (severe allergic reaction).

1. Epinephrine hits alpha receptors and squeezes blood vessels, raising blood pressure
2. It hits beta-1 receptors in the heart, making each beat stronger and faster
3. It hits beta-2 receptors in airway muscles, relaxing them so air can flow
4. Blood pressure climbs, heart pumps more blood per minute, and breathing improves
5. In anaphylaxis, it also stops mast cells from dumping more allergy chemicals (histamine)

SAFETY WATCH

Can cause dangerous heart rhythms, especially if the heart is already irritable · Can raise blood sugar sharply · Can cause severe anxiety, shaking, and chest pain · Wrong dose or route in anaphylaxis (give intramuscular in thigh, NOT intravenous unless in ICU) can be harmful · Rebound low blood pressure when stopped

Dobutamine · Inotrope (heart-muscle strengthener)

Makes heart muscle squeeze harder with each beat, pumping more blood forward. Used in cardiogenic shock when the heart is too weak to push blood out.

1. Dobutamine docks onto beta-1 receptors in the heart wall
2. This triggers more calcium to flood into muscle cells
3. More calcium makes the heart fibers contract harder
4. Each heartbeat ejects more blood (higher stroke volume)
5. Cardiac output (amount of blood pumped per minute) rises, delivering more oxygen to the body

SAFETY WATCH

Can drop blood pressure if vessels are already relaxed—may need a vasopressor alongside it · Increases heart's oxygen demand, so can worsen chest pain or trigger heart attack if coronary arteries are blocked · Can cause fast or irregular heart rhythms · Not helpful and possibly harmful if heart valves are severely leaky or stiff

Normal saline or Lactated Ringer's (crystalloid fluids) · Intravenous fluid resuscitation

Refills the blood-vessel tank with salty water that stays in circulation long enough to restore pressure and flow. First-line treatment for most shock before pressors.

1. Fluid is pushed rapidly through an IV into a vein
2. The salt and water expand blood volume inside vessels
3. Pressure rises, so the heart has more blood to pump forward
4. Organs receive better flow and oxygen delivery improves
5. In distributive shock (sepsis, anaphylaxis), you often need 30 mL per kilogram in the first few hours

SAFETY WATCH

Giving too much can flood the lungs (pulmonary swelling (edema)), especially in heart failure or kidney failure · Can dilute blood, dropping red cell and platelet counts · Large volumes of normal saline can cause high chloride and too much acid in the blood (acidosis); Lactated Ringer's is often safer · Must monitor closely with repeat exams and sometimes ultrasound or pressure monitors

Packed red blood cells (PRBCs) · Blood product transfusion

Replaces lost red blood cells to restore oxygen-carrying capacity. Used in bleeding-driven (hemorrhagic) shock (bleeding shock) when hemoglobin drops dangerously low.

1. Donated red cells are matched to the patient's blood type and infused through an IV
2. New red cells increase hemoglobin, the oxygen-carrying protein
3. More oxygen is picked up in the lungs with each breath
4. More oxygen is delivered to starving organs (brain, heart, kidneys)
5. Tissue oxygen debt begins to reverse

SAFETY WATCH

Transfusion reactions (fever, chills, severe allergic reaction, lung injury) · Infection risk (very low with modern screening) · Volume overload if given too fast in patients with weak hearts · Destroying red blood cells (Hemolytic) reaction if wrong blood type is given—can be fatal · Immunosuppression with large volumes (massive transfusion)

Vasopressin · Vasopressor (non-catecholamine)

Squeezes blood vessels through a different receptor than norepinephrine, often added when norepinephrine alone is not enough in septic shock. Think of it as a backup squeezer.

1. Vasopressin binds to V1 receptors on vessel walls
2. This triggers calcium release inside smooth muscle cells
3. Muscle contracts, narrowing the vessel
4. Blood pressure rises
5. Works even when other receptors are worn out (receptor fatigue) from too much norepinephrine

SAFETY WATCH

Can severely constrict blood flow to skin, gut, and limbs—risk of tissue death · Can cause dangerously low sodium if used in high doses for a long time · Can trigger chest pain by squeezing heart arteries · Lower doses are safer (usually 0.03–0.04 units/min); do not escalate like other pressors

Milrinone · Inotrope and vasodilator (phosphodiesterase-3 inhibitor)

Strengthens heart contractions and relaxes blood vessels at the same time. Used in cardiogenic shock, especially when blood is backing up into the lungs.

1. Milrinone blocks an enzyme (phosphodiesterase-3) that breaks down a signal molecule called cAMP
2. More cAMP stays in heart cells, leading to more calcium and stronger contractions
3. More cAMP in vessel walls causes relaxation, so vessels widen
4. Heart pumps harder, and afterload (resistance the heart pumps against) drops
5. Net effect: more blood moves forward, less backs up into lungs

SAFETY WATCH

Can cause dangerous drop in blood pressure, especially if patient is not fluid-filled first · Can trigger irregular heart rhythms (arrhythmias) · Cleared by kidneys—dose must be lowered in kidney failure or drug accumulates · Not for patients whose vessels are already too wide (sepsis, anaphylaxis)

Hydrocortisone (corticosteroid) · Steroid (glucocorticoid)

Calms overwhelming inflammation and helps blood vessels respond better to pressors. Added in septic shock when high-dose pressors are still not enough. Also replaces missing cortisol if adrenal glands have failed.

1. Hydrocortisone enters cells and binds to steroid receptors
2. It turns off genes that make inflammatory proteins (cytokines)
3. Inflammation cools, so vessels stop leaking and become less floppy
4. Vessels become more sensitive to norepinephrine again (receptor up-regulation)
5. Blood pressure stabilizes with lower pressor doses

SAFETY WATCH

Raises blood sugar (hyperglycemia)—needs insulin · Increases infection risk with long-term use · Can cause bleeding ulcers, confusion, and muscle weakness · Do not stop suddenly—must taper when shock resolves or adrenal crisis can occur · Only use in refractory septic shock, not routine

Broad-spectrum antibiotics (e.g., piperacillin-tazobactam, meropenem, vancomycin) · Antimicrobials

Kill or stop the growth of bacteria causing the infection that triggered septic shock. Treating the root cause is the only way to truly reverse septic shock.

1. Antibiotic enters the bloodstream and reaches infected tissues
2. It attacks bacteria by breaking their cell walls, stopping protein-making, or blocking DNA copying
3. Bacteria die or stop multiplying
4. Immune system cleans up debris
5. Cytokine storm calms, vessels tighten back up, and shock begins to reverse

SAFETY WATCH

Allergic reactions (rash, anaphylaxis, especially with penicillins) · Kidney damage (especially aminoglycosides, vancomycin) · Clostridioides difficile (C. diff) diarrhea from killing good gut bacteria · Seizures with high-dose beta-lactams in kidney failure · Must give within ONE hour of recognizing septic shock (Surviving Sepsis Campaign guideline)

Red flags

- Blood pressure stays low even after you give fluids through the IV tube
- The person is confused, very sleepy, or cannot wake up all the way
- Skin is cold, sweaty, and blotchy or has a blue color
- Urine output drops to almost nothing (less than 0.5 mL per kg per hour)
- Blood lactate level is high and going up (above 4 mmol/L). This shows tissues are not getting enough oxygen

Nursing priorities

1. Place the patient on a cardiac monitor and pulse oximeter, and get a full set of vital signs including blood pressure in both arms, heart rate, breathing rate, temperature, and oxygen saturation every 5 to 15 minutes — Shock changes fast. Frequent vital signs let you see if the person is getting better or worse. A difference in blood pressure between arms can mean aortic dissection (a tear in the main artery), which is a cause of obstructive shock. The monitor catches dangerous heart rhythms that happen when the heart does not get enough oxygen.
2. Start two large-bore IV lines (18-gauge or bigger) immediately and prepare to give rapid IV fluid boluses as ordered, usually 30 milliliters per kilogram of crystalloid solution like normal saline or lactated Ringer solution in the first hour — Large IV catheters (tubes) let you give fluids fast. Most shock types need quick fluid replacement to fill the blood vessels and raise blood pressure so organs get oxygen. Two IV lines give a backup if one stops working and let you give blood products and medicines at the same time. Crystalloid fluids (salt water solutions) are the first choice because they are safe and move into blood vessels quickly.

3. Give high-flow oxygen by non-rebreather mask at 10 to 15 liters per minute to keep oxygen saturation above 94 percent, or prepare to assist breathing with a bag-valve mask if the patient cannot protect their airway or breathe well — In shock, blood carries less oxygen to tissues because circulation is poor. Extra oxygen raises the amount dissolved in blood and helps prevent cell death. If the person is very confused or too weak to breathe deeply, their airway can close or they can breathe in vomit. Assisting breaths pushes oxygen into the lungs until a breathing tube (endotracheal intubation) can be placed.
4. Insert a urinary catheter (Foley catheter) and measure urine output every hour, with a goal of at least 0.5 milliliters per kilogram per hour — The kidneys need good blood flow to make urine. Urine output is one of the best bedside measures of whether organs are getting enough blood. If urine drops below 0.5 milliliters per kilogram per hour (about 30 milliliters per hour in an average adult), it means the kidneys are not getting enough oxygen and other organs are probably failing too. This tells you the treatment is not working yet.
5. Draw blood quickly for laboratory tests including complete blood count (CBC), lactate level, blood glucose, kidney function tests (creatinine and BUN), liver tests, and blood type and crossmatch if bleeding is suspected — Lactate (lactic acid) builds up when cells do not get enough oxygen and switch to a less efficient way of making energy. A lactate above 4 millimoles per liter means shock is severe. Hemoglobin (the oxygen-carrying protein in red blood cells) shows if the person lost blood. Blood glucose can be very low in septic shock or adrenal crisis. Kidney and liver tests show if organs are starting to fail. Typing blood early saves time if transfusion is needed.
6. Assess skin temperature, color, and capillary refill by pressing on the fingernail or kneecap for 5 seconds and watching how fast color returns; check if neck veins are flat or bulging; listen to lung sounds for crackles or wheezes — The physical exam tells you what type of shock is happening. Cold, pale, clammy skin with flat neck veins means hypovolemic shock (not enough blood volume). Cold skin with bulging neck veins means cardiogenic shock (heart failure) or obstructive shock (something blocking blood flow). Warm, flushed skin means distributive shock like sepsis or anaphylaxis. Lung crackles mean fluid is backing up from a weak heart. Capillary refill longer than 3 seconds means blood is not reaching small vessels.
7. Keep the patient flat or in Trendelenburg position (head lower than feet) if blood pressure is very low and no signs of heart failure are present, and keep the patient warm with blankets but do not overheat — Lying flat helps blood return to the heart and brain when blood pressure is dangerously low. Tilting the head down (Trendelenburg) moves even more blood toward the heart temporarily. Do not use this position if the person has lung crackles or bulging neck veins because extra fluid will flood the lungs. Shock makes the body cold because blood flow to skin decreases. Warming prevents hypothermia (low body temperature), which makes shock worse by slowing all body functions.

8. Prepare emergency medicines at the bedside including epinephrine for anaphylaxis, vasopressors like norepinephrine for low blood pressure that does not respond to fluids, and have the crash cart and intubation equipment immediately available — Shock can become life-threatening in minutes. If anaphylaxis is the cause, epinephrine (adrenaline) given in the muscle (0.3 to 0.5 milligrams) reverses airway swelling and opens blood vessels in seconds. If blood pressure stays low after 30 milliliters per kilogram of IV fluids, vasopressors (medicines that tighten blood vessels like norepinephrine) are needed to squeeze vessels and raise pressure so the brain and heart get blood. Intubation equipment must be ready because shock patients can stop breathing suddenly when they get too tired or their brain does not get enough oxygen.

Sources

- Surviving Sepsis Campaign 2021 (SCCM/ESICM)
- AHA/ACC Shock and Cardiac Care guidelines
- ATLS (Advanced Trauma Life Support) 10th edition
- Cochrane systematic reviews on fluid resuscitation

Last reviewed: 2026-07-07