

Acute GN

The glomerulus (kidney filter) is under immune attack, and its leaky barrier is letting blood and protein spill into the urine.

THE STORY IN ONE SENTENCE

The glomerulus (kidney filter) is under immune attack, and its leaky barrier is letting blood and protein spill into the urine.

“Acute glomerulonephritis (GN) means the glomerulus—the kidney's tiny filter unit—is inflamed. Red blood cells and protein leak through holes in the damaged filter, turning urine dark brown or tea-colored.”

Normal anatomy — the body's job

Each glomerulus is a ball of capillaries (tiny blood vessels) wrapped in a basement membrane (a thin protein sheet) and covered by podocytes (specialized cells with finger-like foot processes that interlock to form a tight barrier). Blood flows into the glomerulus under pressure, and water, salts, and small waste molecules are pushed through the filter into Bowman space (a cup-shaped chamber that catches the filtered fluid), which becomes urine. Red blood cells, platelets, and large proteins like albumin are too big to pass through the healthy filter, so they stay in the bloodstream.

BODY'S JOB

The glomerulus is the kidney's quality-control gate. It cleans your blood by filtering out waste and excess water while keeping the good stuff—blood cells and proteins—inside your vessels. If you picture a coffee filter that only lets liquid through but traps the grounds, you have the idea. Without this barrier working right, your blood leaks into your urine and waste backs up into your body.

1. Blood enters the glomerulus through the afferent arteriole (the 'in' vessel), pressurizing the capillary tuft.
2. Pressure pushes water, urea, creatinine, glucose, and electrolytes through the three-layer filter: capillary endothelium (inner lining with small holes), basement membrane (protein mesh), and podocyte foot processes (outer guard rail).

3. Filtered fluid (called filtrate) collects in Bowman space, then flows down the tubule to become urine.
4. Blood cells and large proteins stay in the capillaries, exit through the efferent arteriole (the 'out' vessel), and return to circulation.
5. Healthy urine is clear or pale yellow and contains zero red blood cells and only trace protein (less than 150 mg per day).

What breaks

The immune system attacks the glomerular filter, punching holes in the barrier and clogging the capillaries with inflammation. This single break explains why red blood cells and protein leak into the urine, why blood pressure climbs, why urine output drops, and why waste backs up in the blood.

CLINICAL TERM

Immune complexes (clumps of antibody stuck to antigen) or autoantibodies (self-targeting antibodies) deposit in the glomerular capillaries or mesangium (supporting tissue inside the glomerulus) and trigger complement activation (a cascade of immune proteins that drill holes in cell membranes). Inflammatory cells—neutrophils, monocytes, and T lymphocytes—flood into the glomerulus, release enzymes (proteases) and reactive oxygen species (damaging chemicals), and injure the capillary endothelium, basement membrane, and podocytes. The filter barrier becomes leaky, letting red blood cells and albumin escape into Bowman space and then into the urine. Swelling and cellular debris (fibrin, dead cells) narrow or block the capillary lumens, reducing the glomerular filtration rate (GFR, the volume of blood filtered per minute). Common upstream triggers include post-infectious GN (immune complexes form 1–3 weeks after Group A streptococcal pharyngitis or skin infection), IgA nephropathy (abnormal IgA antibodies deposit in the mesangium, often triggered by upper respiratory infection), lupus nephritis (autoantibodies and immune complexes in systemic lupus erythematosus), membranoproliferative GN (MPGN, complement-driven mesangial and endothelial proliferation with basement membrane splitting), ANCA-associated vasculitis (antineutrophil cytoplasmic antibodies cause pauci-immune necrotizing GN with minimal immune deposits), and anti-GBM disease (Goodpasture syndrome, autoantibodies bind collagen IV in the basement membrane, causing linear IgG deposits on immunofluorescence and often pulmonary bleeding (hemorrhage)). The downstream clinical picture—dark urine, high blood pressure (hypertension), swelling (edema), low urine output (oliguria), rising creatinine, and active urinary sediment—flows directly from this broken filter.

How the body compensates

The kidney tries to defend filtration by raising glomerular capillary pressure (through efferent arteriole constriction) and retaining salt and water to keep blood volume up. This compensation can mask the severity of injury for days to weeks, keeping creatinine and blood pressure seemingly stable while glomeruli are silently scarring. Your job is to see the trajectory—not just the snapshot—and catch the crash point before the kidney tips into irreversible failure.

1. {'what': 'Efferent arteriole constriction (narrowing the 'out' vessel)', 'how': 'Angiotensin II tightens the efferent arteriole, raising pressure inside the glomerular capillaries to push more filtrate through the shrinking filter surface. This temporarily props up GFR.', 'cost': 'Higher intraglomerular pressure accelerates damage to already-inflamed capillaries, worsening proteinuria and scarring (glomerulosclerosis).'}
2. {'what': 'Salt and water retention', 'how': 'Reduced GFR signals the juxtaglomerular cells to release renin, activating aldosterone and antidiuretic hormone (ADH). The tubules reabsorb sodium and water, expanding blood volume to maintain blood flow (perfusion) pressure.', 'cost': 'Fluid overload causes swelling (edema) (periorbital, pedal, sometimes pulmonary) and high blood pressure (hypertension), which strains the heart and can trigger heart failure or with high blood pressure (hypertensive) encephalopathy (brain swelling from high pressure).'}
3. {'what': 'Increased cardiac output', 'how': 'The heart pumps harder to circulate the expanded blood volume and compensate for rising vascular resistance.', 'cost': 'This raises myocardial oxygen demand and can unmask or worsen heart failure, especially in patients with pre-existing cardiac disease.'}
4. {'what': 'The dangerous middle', 'how': 'For days to weeks, creatinine may climb slowly (from 1.0 to 1.5 to 2.0 mg/dL), blood pressure stays controlled on medication, and urine output is only mildly reduced. The patient looks stable, and the team may wait and watch.', 'cost': 'Meanwhile, crescents (layers of proliferating epithelial cells and macrophages) are filling Bowman space and compressing capillary tufts. Fibrin is depositing. Podocytes are detaching. Each day of untreated inflammation burns more nephrons into permanent scars.'}
5. {'what': 'Watch for the crash point: rapidly progressive GN (RPGN)', 'how': 'Creatinine doubles in days to weeks, urine output falls below 400 mL/day (oliguria) or stops (anuria), and severe waste buildup in the blood (uremia) symptoms appear—nausea, confusion, pericardial friction rub (scratchy heart sound from inflammation), asterixis (flapping hand tremor), and bleeding from platelet dysfunction.', 'cost': 'Once more than 50% of glomeruli are replaced by crescents and scars, recovery is unlikely. The window for immune suppression (corticosteroids, cyclophosphamide, rituximab, plasmapheresis) is narrow—often only 2–4 weeks. After that, dialysis may be permanent.'}

6. {'what': 'Pulmonary-renal syndromes (anti-GBM, ANCA vasculitis)', 'how': 'Autoantibodies also attack pulmonary capillaries, causing diffuse alveolar bleeding (hemorrhage)—cough, coughing up blood (hemoptysis) (coughing blood), trouble breathing (dyspnea) (shortness of breath), and falling hemoglobin.', 'cost': 'This is a medical emergency. Delayed treatment risks respiratory failure and death within days. Immediate plasmapheresis and immunosuppression are life-saving.'}
7. {'what': 'Trend the trajectory', 'how': 'Plot creatinine, urine output, blood pressure, and urine protein daily. A rising creatinine from 1.2 to 1.8 over three days, even if still below 2.0, is a red flag. A spot urine protein-to-creatinine ratio climbing from 1 to 3 g/g signals worsening leak.', 'cost': '"Waiting for a 'critical' value wastes the only time window when treatment can reverse injury. Early nephrology referral and kidney biopsy (to confirm the GN pattern and guide therapy) are standard of care when acute GN is suspected."}
8. {'what': 'A stable-looking patient on a downhill slope is not stable', 'how': 'Compensation buys time but does not fix the broken filter. It only hides how fast the kidney is failing until the system exhausts its reserve and crashes suddenly.', 'cost': 'By the time the patient is overtly uremic or fluid-overloaded, the chance of renal recovery has often passed. Aggressive early treatment—within the first two weeks—offers the best hope of preserving kidney function.'}

Domino effect

1. Immune complexes or autoantibodies deposit in the glomerular capillaries or mesangium. — These deposits activate complement (C3, C5b-9 membrane attack complex), which punches holes in cell membranes, and recruit neutrophils and monocytes that release proteases, elastase, and reactive oxygen species—all of which chew through the basement membrane and podocyte foot processes.
2. Glomerular inflammation swells the capillary tuft, narrows the lumen, and damages the three-layer filter. — Endothelial cells swell and lose their fenestrations (small pores). The basement membrane becomes irregular, thickened, or split. Podocyte foot processes flatten and detach (effacement). The filter barrier is now leaky and clogged.
3. Red blood cells leak through the broken filter into the urine (hematuria). — Gaps in the basement membrane and missing podocyte bridges allow whole red cells to squeeze into Bowman space. As they travel down the acidic tubules, hemoglobin oxidizes, turning the urine dark brown, tea-colored, or cola-colored (gross blood in the urine (hematuria)). Under the microscope, you see dysmorphic RBCs (twisted, fragmented shapes from squeezing through damaged glomeruli) and RBC casts (clumps of red cells stuck in Tamm-Horsfall protein molds from the tubule), which prove the bleeding is glomerular, not from the bladder or urethra.

4. Albumin and other plasma proteins leak into the urine (proteinuria). — The damaged filter can no longer block large molecules. Proteinuria can range from mild (less than 1 g/day) to nephrotic-range (greater than 3.5 g/day). Severe protein loss drops serum albumin, reducing oncotic pressure (the force that pulls fluid back into capillaries), which worsens swelling (edema) and raises infection risk (immunoglobulins are lost in urine).
5. Glomerular filtration rate (GFR) falls as capillaries swell, collapse, or scar. — Fewer functioning glomeruli and smaller capillary surface area mean less blood is filtered per minute. The kidney cannot clear creatinine, urea, potassium, phosphate, and acid as fast as they are produced, so they accumulate in the blood.
6. Low urine output (Oliguria) (urine output drops below 400 mL per day). — Reduced GFR means less filtrate is made. Tubules also clog with RBC casts, cellular debris, and protein, raising back-pressure and further choking off urine flow. The kidneys hold onto salt and water to defend blood volume, cutting urine output even more.
7. Serum creatinine rises (normal ~0.7–1.2 mg/dL in adults; can climb to 2, 4, 8 mg/dL or higher). — Creatinine is a waste product from muscle breakdown, filtered only by the glomeruli and not reabsorbed. When GFR falls, creatinine clearance falls, so creatinine piles up in the blood. A doubling of creatinine means GFR has roughly halved. Rising creatinine is your bedside measure of worsening kidney function.
8. Salt and water retention trigger high blood pressure (hypertension) (high blood pressure) and swelling (edema) (swelling). — Falling GFR activates the renin-angiotensin-aldosterone system. Aldosterone tells the distal tubule to reabsorb sodium; water follows sodium, expanding blood volume. Higher volume raises blood pressure (often 140–180 systolic or more). Increased hydrostatic pressure (fluid-pushing force) in capillaries, plus low serum albumin (reduced oncotic pressure, fluid-pulling force), drives fluid into tissues—first around the eyes (periorbital swelling (edema), worst in the morning when lying flat) and ankles (pedal swelling), then sometimes the lungs (pulmonary swelling with trouble breathing (dyspnea) and crackles on exam) or abdomen (ascites).
9. Active urinary sediment appears: RBC casts, dysmorphic RBCs, white blood cell casts, and granular casts. — Inflammatory cells and damaged epithelial cells slough into the tubules and get trapped in Tamm-Horsfall protein, forming casts—cylindrical molds of the tubule lumen. RBC casts are a dead-giveaway sign of (pathognomonic) (signature proof) of glomerulonephritis. WBC casts suggest interstitial inflammation or infection. Granular casts (muddy brown) are from dead tubular cells and appear with acute tubular tissue death (necrosis), but in GN they mix with red and white cell casts, creating a 'nephritic' sediment pattern.

10. If untreated, crescents form in Bowman space and compress the glomerular tuft. — Severe injury breaks the basement membrane, and fibrin leaks into Bowman space. Parietal epithelial cells proliferate, and macrophages pile up, forming a crescent-shaped mass that wraps around the capillary tuft and crushes it. More than 50% crescents (on biopsy) defines crescentic or rapidly progressive GN (RPGN)—creatinine can double in days, and without urgent treatment (pulse steroids, cyclophosphamide, rituximab, plasmapheresis), the kidney progresses to end-stage renal disease (ESRD, permanent dialysis dependence) in weeks to months.
11. Severe waste buildup in the blood (Uremia) develops as waste products accumulate: nausea, fatigue, confusion, pericarditis, bleeding, itching (pruritus) (itching). — When GFR falls below $\sim 15 \text{ mL/min/1.73 m}^2$ (stage 5 chronic kidney disease), urea, creatinine, potassium, phosphate, acids, and middle-molecule toxins (beta-2 microglobulin, indoxyl sulfate) build up. Uremic toxins inflame the pericardium (pericardial friction rub, chest pain), irritate the brain (uremic encephalopathy with confusion, asterixis, seizures), and impair platelet function (causing bruising, nosebleeds, GI bleeding). Itching comes from phosphate deposits and immune dysregulation. Severe high potassium (hyperkalemia) (potassium greater than 6.5 mEq/L) can stop the heart. This is the crash point: without dialysis, the patient will die.
12. All findings—dark urine, high blood pressure (hypertension), swelling (edema), low urine output (oliguria), rising creatinine, active sediment, severe waste buildup in the blood (uremia)—trace back to the upstream immune attack on the glomerular filter. — Once you see the mechanism, the clinical picture stops being a random list of abnormalities and becomes a logical cascade. The immune system damages the filter. The filter leaks blood and protein. Filtration slows. Waste backs up. The kidney tries to compensate by retaining salt and water, which causes high blood pressure and swelling. Compensation fails. The kidney scars. Understanding this sequence lets you predict what will happen next and intervene before the window for recovery closes.

Symptoms · what the patient feels, and why

- Cola-colored or tea-colored urine (blood in urine you can see): The immune system attacks the kidney's tiny filters and tears holes in them, so red blood cells slip through into the urine. As the cells sit in acidic urine, their iron-carrying protein (hemoglobin) rusts and turns the urine dark brown—like cola or tea.
- Puffy face and swollen ankles (edema): The damaged kidneys cannot get rid of salt and water, so both pile up in the blood and push fluid out into the tissues—especially around the eyes and feet where gravity and loose tissue make swelling easier. Also, protein leaks out in urine, so blood has less pulling power to keep fluid inside vessels.

- New high blood pressure or worsening of existing high blood pressure: Swollen, inflamed kidney filters cannot clean blood well, so the kidneys panic and hold onto extra salt and water to try to keep pressure up and keep filtering. But this extra volume raises blood pressure throughout the body.
- Much less urine than usual (oliguria—less than about 2 cups a day): The tiny filter units in the kidneys are swollen and clogged with debris from damaged cells, so fluid cannot pass through easily. Less fluid filtered means much less urine comes out.
- Feeling very tired and generally unwell (malaise): When kidneys fail to clean the blood, waste chemicals (creatinine, urea, acids) build up and poison every cell in the body, slowing down energy factories (mitochondria) and making you feel exhausted and sick.
- Dull ache in the back or sides (flank pain): The kidney swells rapidly from inflammation and fluid buildup, stretching the thin, tight capsule (outer shell) that wraps it. That capsule is packed with pain nerves, so stretching hurts.
- Foamy or bubbly urine: Large amounts of protein slip through the torn kidney filters and leak into urine. Protein acts like soap—it makes bubbles when urine splashes into the toilet.
- Coughing up blood (hemoptysis) along with blood in urine (pulmonary-renal syndrome): In rare, severe types of glomerulonephritis (anti-GBM disease and ANCA vasculitis), the immune system attacks the thin membranes in both the kidney filters and the lung air sacs at the same time, tearing holes in both and causing bleeding in kidneys and lungs together.
- Kidney waste number (creatinine) climbing fast—up by more than 0.3 in 48 hours or doubling in a week: Severe, rapidly spreading inflammation destroys many filter units quickly (rapidly progressive GN). Kidneys lose their cleaning power faster than the body can adapt, so waste chemicals pile up in the blood at dangerous speed.
- Confusion, nausea, or a scratchy sound when the heart beats (pericardial rub)—signs of severe waste buildup in the blood (uremia): When kidneys fail badly, toxic waste products (urea, creatinine, acids) flood the blood and poison the brain (causing confusion), irritate the stomach (causing nausea), and inflame the sac around the heart (pericardium), making a scratchy friction sound.

Focused exam

- Dark cola-colored urine: This color comes from red blood cells leaking through damaged glomeruli (the tiny kidney filters). It tells you the immune attack is actively damaging the filter right now.
- New high blood pressure: When glomeruli become inflamed, the kidney holds onto salt and water to try to keep filtering. That extra fluid pushes up blood pressure. New high blood pressure in acute GN warns you the kidneys are overloaded with fluid and complications may be coming.

- Swelling in face, hands, and legs: Damaged glomeruli let protein leak into the urine. Losing protein lowers the pull that keeps fluid inside blood vessels, so fluid shifts out into body tissues. That causes the puffiness, called swelling (edema).
- Red blood cell casts and misshapen RBCs on urine microscopy: Red blood cell casts are clumps of RBCs that formed inside kidney tubules. Misshapen RBCs got squeezed through damaged glomeruli. Together they prove the bleeding source is the glomerulus itself, not the bladder or lower urinary tract.
- Rising creatinine and low urine output: Inflamed, swollen glomeruli filter blood slowly. Creatinine, a waste product normally cleared by kidneys, builds up in the blood. Low urine output means the kidneys are not producing much urine because the filters are clogged.
- Coughing up blood with blood in urine at the same time: When the same immune attack damages lung capillaries and kidney glomeruli together, it is called pulmonary-renal syndrome. This combination is a medical emergency requiring immediate immune suppression to prevent lung and kidney failure.

Diagnostics · every test answers a question

- Urinalysis with microscopy → Is there blood or protein in the urine, and where in the kidney is it coming from?
- Serum creatinine and blood urea nitrogen (BUN) → How well are the kidneys filtering waste right now?
- Complement levels (C3 and C4) → Is the complement system being consumed by immune complex formation?
- Anti-streptolysin O (ASO) titer and anti-DNase B → Was there a recent strep infection that could have triggered post-strep GN?
- Antinuclear antibody (ANA) and anti-double-stranded DNA (anti-dsDNA) → Could lupus be causing the kidney inflammation?
- Antineutrophil cytoplasmic antibodies (ANCA): MPO and PR3 → Is this rapidly progressive GN from ANCA-associated vasculitis?
- Anti-glomerular basement membrane (anti-GBM) antibody → Is this Goodpasture syndrome, an emergency that destroys kidneys and lungs fast?
- Kidney biopsy with immunofluorescence and electron microscopy → What specific type of GN is this, and how much scarring is already present?

Treatment logic

- ACE inhibitor (such as lisinopril) or ARB (such as losartan) to control blood pressure and reduce protein leak → Lowers pressure inside the glomeruli by relaxing the blood vessel leaving the filter. This reduces protein leakage and slows progression of chronic kidney disease. Per KDIGO 2021, target blood pressure < 120/80 mmHg if tolerated and proteinuria present.
- Loop diuretics (such as furosemide) and salt restriction for volume overload → Removes excess salt and water that the inflamed kidneys cannot excrete. This lowers blood pressure, reduces swelling, and prevents fluid in the lungs that blocks oxygen exchange. Restrict sodium to < 2 grams per day.
- Corticosteroids (methylprednisolone IV 500–1000 mg daily for 3 days, then oral prednisone 1 mg/kg/day) for immune suppression → Suppresses the immune system so it stops making antibodies and immune complexes that deposit in the glomeruli. This reduces inflammation, lets swelling resolve, and allows the glomerular filter to recover function.
- Cyclophosphamide (oral 2 mg/kg/day or IV 0.5–1 g/m² monthly) or rituximab (375 mg/m² weekly for 4 doses or 1 g on days 1 and 15) for severe or rapidly progressive GN → Cyclophosphamide kills rapidly dividing immune cells. Rituximab wipes out B cells that make harmful antibodies. Both stop the immune attack at its source. Per 2021 KDIGO and 2021 ACR/Vasculitis Foundation guidelines, used in ANCA vasculitis, lupus nephritis, and other aggressive GN when kidney function is falling rapidly.
- Plasmapheresis (plasma exchange, typically 7 sessions over 14 days, 60 mL/kg per session) for anti-GBM disease or severe ANCA-associated rapidly progressive GN → Physically removes circulating harmful antibodies and immune complexes from the blood before they deposit in glomeruli. Buys time for steroids and cyclophosphamide or rituximab to stop new antibody production. Per KDIGO 2021, plasmapheresis is standard for anti-GBM disease and considered in severe ANCA GN with dialysis-dependent AKI or pulmonary bleeding (hemorrhage).
- Antibiotics (such as penicillin V 250–500 mg four times daily or amoxicillin 500 mg three times daily for 10 days) if active strep infection is present → Kills the strep bacteria so no new strep pieces are released. This stops new immune complex formation. In post-strep GN, the inflammation usually resolves on its own once the infection is cleared, and most patients recover full kidney function within weeks to months.

- Renal replacement therapy (hemodialysis or peritoneal dialysis) if severe AKI develops → Removes uremic toxins (waste products such as urea and creatinine), excess potassium, and fluid that the damaged kidneys cannot clear. Prevents life-threatening high potassium (> 6.5 mEq/L) that stops the heart, fluid in the lungs, confusion from toxin buildup, severe too much acid in the blood (acidosis) ($\text{pH} < 7.1$), and pericarditis. Indications are summarized as AEIOU: Too much acid in the blood, Electrolyte abnormalities, Ingestion (toxin), Overload (fluid), Severe waste buildup in the blood (Uremia).

Medications

ACE inhibitor (lisinopril, enalapril) or ARB (losartan, valsartan) · Blood pressure medicines that protect the kidney filters

These drugs block a hormone called angiotensin II (a chemical that squeezes blood vessels tight). When you block this hormone, the tiny artery leaving each kidney filter relaxes and opens wider. That drops the pressure inside the filter—like opening a valve to reduce pressure in a pipe. Lower pressure means less protein is forced through the damaged filter wall into the urine, and the filter is less likely to scar over time. They do NOT fix the immune attack; they only protect filters that are still working from being crushed by high pressure.

1. Step 1: Normally, when blood pressure drops or the kidney senses low salt, special cells release renin (an enzyme).
2. Step 2: Renin chops a liver protein into angiotensin I (a weak signal).
3. Step 3: ACE (angiotensin-converting enzyme) in the lungs and blood vessels cuts angiotensin I into angiotensin II (a powerful squeezer).
4. Step 4: Angiotensin II clamps down blood vessels, raises blood pressure, and tells the adrenal gland to release aldosterone (a hormone that holds onto salt and water).
5. Step 5: ACE inhibitors block step 3—no angiotensin II is made. ARBs block step 4—angiotensin II is made but cannot dock on its receptor. Either way, vessels stay open, pressure drops, and less protein leaks.

SAFETY WATCH

Do NOT give if the patient is making no urine (anuric) or very little urine with creatinine climbing fast—these drugs can make kidney function worse in that setting. · Do NOT give if potassium is 5.5 or higher—ACE inhibitors and ARBs raise potassium by blocking aldosterone, and high potassium can stop the heart. · Check potassium and creatinine 1 week after starting. A small creatinine rise (up to 30% from baseline) is expected and okay; a jump above 30% means stop the drug. · Watch for a dry cough (from ACE inhibitors—switching to an ARB usually fixes it) and angioedema (sudden swelling of lips, tongue, or throat—stop the drug immediately and give epinephrine if airway is closing). · Do NOT use ACE inhibitors and ARBs together—no extra benefit and doubles the risk of high potassium and kidney injury.

Corticosteroid (prednisone, methylprednisolone) · Immune system suppressors

Steroids are synthetic versions of cortisol (a hormone your adrenal glands make to calm inflammation). They flood into immune cells—especially T cells and macrophages—and turn OFF the genes that tell those cells to attack. This stops new immune cells from being called into the kidney and stops the ones already there from releasing chemicals that punch holes in the glomerular filter. Think of it as hitting the emergency brake on the immune attack. The damaged filters stop getting worse, and some can heal if the attack is stopped early enough.

1. Step 1: In acute GN, immune complexes (clumps of antibody stuck to antigen) or antibodies lodge in the glomerular basement membrane (the filter wall).
2. Step 2: These trigger complement proteins (part of the immune system) to activate, which recruits neutrophils and macrophages into the glomerulus.
3. Step 3: Those white blood cells release enzymes (proteases) and reactive oxygen molecules (like bleach) that chew through the filter.
4. Step 4: Steroids enter the immune cells and block the genes that make those enzymes and signals, so the attack slows down.
5. Step 5: Fewer new immune cells arrive, less damage happens, and the filter gets a chance to repair.

SAFETY WATCH

Check blood sugar every day—steroids push glucose up, especially in people with diabetes or pre-diabetes. You may need to start or increase insulin. · Watch for infections—steroids suppress the immune system, so fever, cough, or wound redness must be taken seriously. Check for tuberculosis (TB skin test or blood test) and hepatitis B before starting long-term steroids. · Long-term use (more than 2 weeks) can cause bone thinning (osteoporosis), stomach ulcers, high blood pressure, weight gain (especially in the face and belly), mood swings, and muscle weakness. · Do NOT stop steroids suddenly after weeks of use—taper the dose slowly or the adrenal glands (which stopped making their own cortisol) will not restart in time, and the patient can go into shock. · Give a proton pump inhibitor (omeprazole, pantoprazole) if the patient has ulcer history or is also taking NSAIDs, to protect the stomach.

Cyclophosphamide · Chemotherapy drug used as an immune suppressant

Cyclophosphamide is a drug that sticks to the DNA (the instruction manual) inside dividing cells and scrambles it, so the cell cannot copy itself and dies. Immune cells that make antibodies (B cells) divide quickly, so this drug kills them off. Fewer B cells means fewer new antibodies attacking the kidney. It is used in severe, rapidly progressive GN—especially ANCA vasculitis and lupus nephritis—where you need to shut down antibody production fast to save the kidneys.

1. Step 1: Cyclophosphamide is a prodrug (inactive until the liver changes it). The liver converts it into active metabolites (phosphoramidate mustard and acrolein).
2. Step 2: These metabolites enter dividing cells and attach cross-links to DNA strands—like gluing the pages of a book together so you cannot read them.
3. Step 3: When the B cell tries to divide, the DNA cannot unzip and copy itself, so the cell dies (apoptosis).
4. Step 4: With fewer B cells, less antibody is made, the immune attack weakens, and the kidney gets a chance to heal.
5. Step 5: The drug also hits T cells (which help B cells) and other white cells, so the whole immune response is turned way down.

SAFETY WATCH

Check a complete blood count (CBC) every week—cyclophosphamide kills bone marrow cells, so white blood cells, red blood cells, and platelets all drop. If white cells fall below 3,000 or neutrophils below 1,000, hold the dose and consider growth factor (filgrastim) to boost the marrow. · Give mesna (a bladder protector) with each dose—acrolein (a toxic byproduct) concentrates in the bladder and can cause bleeding-driven (hemorrhagic) cystitis (severe bladder bleeding). Mesna binds acrolein and neutralizes it. Also tell the patient to drink extra water and urinate often. · Watch for infections—the immune system is suppressed, so even a cold can turn into pneumonia. Any fever above 100.4°F needs urgent evaluation and blood cultures. · Cyclophosphamide can cause permanent infertility (especially in people over 30) by damaging eggs or sperm. Discuss egg or sperm banking before starting if the patient may want children later. · It raises the long-term risk of bladder cancer and leukemia—lowest effective dose for the shortest time is the rule. · Do NOT give live vaccines (MMR, varicella, yellow fever) while on cyclophosphamide—the patient cannot fight off even the weakened virus.

Rituximab · Monoclonal antibody (targeted immune suppressant)

Rituximab is a laboratory-made antibody (a protein designed to stick to one target). Its target is CD20 (a marker on the surface of B cells). When rituximab docks onto CD20, it tags the B cell for destruction—either the immune system's natural killer cells eat it, or the cell's membrane ruptures. Within days, nearly all B cells in the blood and lymph tissue are gone. No B cells means no new antibodies attacking the kidney. It is used in ANCA vasculitis, lupus nephritis, and some cases of membranous nephropathy (a different type of glomerular disease). It is an alternative to cyclophosphamide—fewer harsh side effects, especially for people who want to preserve fertility.

1. Step 1: B cells are the immune cells that make antibodies. In ANCA vasculitis and lupus, these antibodies attack the kidney's small blood vessels and filters.
2. Step 2: B cells carry a marker protein called CD20 on their outer membrane—like a name tag.
3. Step 3: Rituximab is an antibody shaped to fit CD20 perfectly. When you infuse rituximab into the blood, it floats around until it finds a B cell and locks onto CD20.
4. Step 4: Once tagged, the B cell is destroyed by three mechanisms: (a) natural killer cells recognize the rituximab tag and punch holes in the B cell, (b) complement proteins (part of the immune system) assemble on the tag and rupture the cell, (c) the tag sends a death signal into the cell (apoptosis).
5. Step 5: With B cells gone, no new antibodies are made, the immune attack weakens, and the kidney can begin to heal.

SAFETY WATCH

Screen for hepatitis B before starting—rituximab can wake up dormant hepatitis B virus hiding in the liver, causing sudden liver failure. If the patient is hepatitis B positive, give antiviral medicine (entecavir or tenofovir) during and after rituximab. · Premedicate with acetaminophen and diphenhydramine (Benadryl) before each infusion to reduce infusion reactions (fever, chills, throat tightness, rash, low blood pressure). Give the first infusion slowly in a monitored setting—severe reactions (airway swelling, severe low blood pressure) are rare but can happen in the first 30 minutes. · Rituximab suppresses the immune system—watch for infections, especially pneumonia and sinus infections. Some centers give preventive (prophylactic) antibiotics (Bactrim) to prevent *Pneumocystis pneumonia* if the patient is on steroids too. · Check immunoglobulin levels (IgG) every few months—rituximab can cause hypogammaglobulinemia (low antibodies), which makes infections more likely. If IgG is very low and infections keep happening, you may need to give IV immunoglobulin (IVIG) replacement. · Rarely, rituximab can cause progressive multifocal leukoencephalopathy (PML)—a brain infection caused by JC virus. Watch for new confusion, weakness, or vision changes and get an urgent brain MRI if they appear. · Do NOT give live vaccines while B cells are depleted—wait at least 6 months after the last rituximab dose.

Plasmapheresis (plasma exchange) · Procedure, not a drug—removes antibodies from the blood

Plasmapheresis is a machine process that separates your blood into cells (red cells, white cells, platelets) and plasma (the liquid part that carries antibodies, clotting factors, and other proteins). The machine keeps your cells, throws away the plasma (which contains the harmful antibodies), and replaces it with clean donor plasma or albumin (a safe protein solution). This physically removes circulating antibodies—especially anti-GBM antibodies (in Goodpasture disease) and ANCA antibodies (in severe vasculitis). It is used when the antibody level is so high and the kidney damage so fast that you cannot wait for immunosuppressant drugs to work.

1. Step 1: In anti-GBM disease or severe ANCA vasculitis, antibodies circulate in the blood at high levels and continuously deposit in the glomerular filter and lung capillaries.
2. Step 2: A large-bore IV or central venous catheter (a tube in a neck, chest, or groin vein) is placed to pull blood out fast enough for the machine.
3. Step 3: Blood flows into the apheresis machine, which spins it at high speed (like a centrifuge). Heavier cells settle to the bottom; lighter plasma floats to the top.
4. Step 4: The machine discards the plasma (which contains the antibodies) and replaces it with donor plasma (frozen plasma from a blood bank) or 5% albumin solution (a protein made from donated blood).

5. Step 5: The cleaned blood (cells + replacement fluid) flows back into the patient. One session removes about 50–70% of circulating antibodies. Treatments are usually done daily or every other day for 1–2 weeks.

SAFETY WATCH

Requires a central line (a catheter in a large vein)—risk of infection, bleeding at the site, blood clots in the vein, and rarely puncture of the lung (pneumothorax) during placement. · Plasmapheresis removes clotting factors along with antibodies—watch for unusual bleeding (nosebleeds, bruising, blood in urine or stool). Check PT/INR and fibrinogen levels; replace clotting factors if needed. · It removes immunoglobulins (your normal antibodies that fight infection)—the patient is at higher risk for infections. Some centers give IVIG (intravenous immunoglobulin) replacement after a series of treatments. · Citrate (a chemical used to keep blood from clotting in the machine) binds calcium—can cause tingling around the mouth, muscle cramps, or rarely seizures from low calcium. Give IV calcium if symptoms appear. · Allergic reactions to donor plasma or albumin—rash, itching, fever, rarely anaphylaxis (severe allergic reaction with airway swelling and shock). Premedicate with diphenhydramine if the patient has a history of reactions. · Low blood pressure (Hypotension) (low blood pressure) during the procedure—common if the patient is volume-down or on high-dose blood pressure medicines. Monitor vitals every 15 minutes. · Do NOT do plasmapheresis in post-streptococcal GN or IgA nephropathy—no benefit, and it removes helpful antibodies along with the useless ones.

Antibiotics (penicillin or amoxicillin for group A Streptococcus) · Antibiotics—kill bacteria

Antibiotics are used ONLY if the infection that triggered the acute GN is still active. In post-streptococcal GN (the most common infection-triggered type), group A Streptococcus (the bacteria that causes strep throat) infects the throat or skin 1–3 weeks before kidney symptoms appear. By the time you see the kidney problem, the infection is usually gone, and the GN is caused by immune complexes (clumps of antibody stuck to leftover bacterial antigen) depositing in the kidney—NOT by live bacteria in the kidney. So you give antibiotics ONLY if the throat or skin culture is still positive or if the patient still has active strep symptoms (sore throat, fever, skin sores). The antibiotic kills the bacteria and stops more antigen from being made, but it does NOT treat the kidney damage itself—that heals on its own over weeks to months.

1. Step 1: Group A Streptococcus infects the throat (pharyngitis) or skin (impetigo, cellulitis). The immune system makes antibodies against bacterial proteins (antigens).
2. Step 2: Some of those antibodies stick to bacterial antigens and form immune complexes (clumps).

3. Step 3: These complexes float in the blood and get trapped in the glomerular filter because they are too big to pass through.
4. Step 4: Trapped complexes activate complement (attack proteins), which calls white blood cells into the kidney. Those cells release enzymes that damage the filter, causing blood in the urine (hematuria) (blood in urine), proteinuria (protein in urine), and kidney swelling.
5. Step 5: If the infection is still active, giving penicillin kills the bacteria, stops new antigen from being made, and prevents more immune complexes from forming. If the infection is already gone, antibiotics do nothing for the kidney—the immune complexes are already there, and the kidney will heal on its own as they are cleared.

SAFETY WATCH

Check for penicillin allergy before giving—ask about past rash, hives, lip swelling, or trouble breathing after penicillin or related antibiotics (amoxicillin, ampicillin, cephalosporins). If true allergy, use azithromycin or a cephalosporin (if no severe reaction history). · Do NOT give antibiotics if the throat and skin cultures are negative and the patient has no active infection—you only expose the patient to side effects (diarrhea, rash, yeast infections) and promote antibiotic resistance. · Penicillin can rarely cause interstitial nephritis (a different kidney problem where the antibiotic itself inflames the kidney)—watch for worsening kidney function, fever, rash, and eosinophils (a type of white cell) in the urine. Stop the antibiotic if this happens. · Amoxicillin can cause a maculopapular rash (flat red spots with small bumps) in patients with mononucleosis (Epstein-Barr virus)—not a true allergy, but avoid amoxicillin if mono is suspected.

Dialysis (hemodialysis or peritoneal dialysis) · Procedure, not a drug—replaces kidney function

Dialysis is a machine (hemodialysis) or a process using the belly lining (peritoneal dialysis) that does the kidney's three main jobs: (1) removes waste products (urea, creatinine) that build up and cause confusion, nausea, and pericarditis (inflammation of the heart sac), (2) removes extra fluid that floods the lungs and causes shortness of breath, and (3) fixes blood chemistry—lowers potassium (which can stop the heart) and raises blood pH if it is too acidic. Dialysis does NOT heal the kidney—it buys time while you treat the immune attack with steroids or immunosuppressants. In post-strep GN, most patients recover kidney function and come off dialysis; in rapidly progressive GN (ANCA, anti-GBM, lupus), some need dialysis permanently if too many filters are destroyed before treatment works.

1. Step 1: In severe acute GN, so many glomeruli (filters) are destroyed or blocked by inflammation that the kidney cannot filter blood. Creatinine and urea rise, potassium climbs, acid builds up, and fluid overloads the lungs.

2. Step 2: Dialysis is started if the patient meets AEIOU criteria: (A) Too much acid in the blood (Acidosis)—blood pH below 7.1 and not responding to IV bicarbonate, (E) Electrolyte disturbance—potassium above 6.5 mEq/L and EKG shows peaked T waves (a heart rhythm danger sign), (I) Ingestion—certain toxins like methanol or ethylene glycol that dialysis can remove, (O) Overload—severe fluid overload with pulmonary edema (fluid flooding the lungs) (crackles in lungs, low oxygen) not responding to diuretics, (U) Severe waste buildup in the blood (Uremia)—waste buildup causing altered mental status, seizures, or pericarditis (chest pain, friction rub on exam).
3. Step 3: In hemodialysis, blood flows on one side of the membrane, dialysate flows on the other. Waste and potassium move from blood (high concentration) to dialysate (low concentration) by diffusion. Fluid is pulled from blood by ultrafiltration (pressure gradient). Clean blood returns to the body.
4. Step 4: In peritoneal dialysis, dialysate in the belly pulls waste and fluid from capillaries in the peritoneal membrane by diffusion and osmosis (the dialysate has high sugar, which draws water out of blood).
5. Step 5: After hours to days of dialysis, waste levels drop, potassium normalizes, acid is cleared, and fluid is removed—the patient feels better and buys time for kidney recovery.

SAFETY WATCH

Hemodialysis requires vascular access—either a temporary catheter (risk of infection, blood clots, bleeding at the site) or a permanent AV fistula (takes 6–12 weeks to mature; can clot or get infected). · During hemodialysis, watch for low blood pressure (hypotension) (low blood pressure from pulling fluid too fast), muscle cramps (from electrolyte shifts), chest pain (from rapid fluid removal stressing the heart), and rarely dialysis disequilibrium syndrome (brain swelling from urea dropping too fast—causes confusion, seizures; prevented by starting dialysis gently in patients with very high urea). · Hemodialysis removes some medications (antibiotics, antivirals)—dose after dialysis or give extra dose. · Peritoneal dialysis catheter is a permanent hole in the belly—risk of peritonitis (infection of the fluid and belly lining). Teach the patient sterile technique. Watch for cloudy fluid, belly pain, or fever—those mean infection; drain the fluid, send it for cell count and culture, and start antibiotics (usually cefazolin plus ceftazidime or an aminoglycoside, given into the dialysate). · Peritoneal dialysis uses fluid with high sugar (dextrose)—can raise blood glucose, cause weight gain, and over months can damage the peritoneal membrane (called sclerosing peritonitis—membrane thickens and stops working). · Anticoagulation (heparin) is used in hemodialysis to keep blood from clotting in the machine—watch for bleeding, especially if the patient is on plasmapheresis or has low platelets from cyclophosphamide. · Do NOT delay dialysis if criteria are met—high potassium (hyperkalemia) and pulmonary edema (fluid flooding the lungs) can kill in hours.

Red flags

- Coughing up blood along with blood in urine—warns of pulmonary-renal syndrome; needs urgent kidney biopsy and immune-suppressing drugs to save kidneys and lungs
- Kidney waste number (creatinine) rising fast (more than 0.3 in 48 hours or doubling in a week)—signals rapidly progressive GN; permanent kidney damage can happen in days without treatment
- Very little or no urine output (oliguria or no urine output (anuria))—means acute kidney injury; needs urgent kidney specialist and may need dialysis to clean the blood
- Uremic symptoms (confusion, pericardial rub, seizures)—show life-threatening toxin buildup from kidney failure; emergency dialysis may be needed
- Severe high blood pressure with headache, vision changes, or chest pain—with high blood pressure (hypertensive) emergency damaging brain, eyes, or heart; must lower pressure quickly in hospital

Nursing priorities

1. Monitor urine output every hour using a Foley catheter or strict intake-and-output record, and report if less than 30 mL per hour (720 mL per day). — Low urine output (Oliguria) (low urine output) means the glomeruli are failing to filter waste and the patient is at immediate risk for high potassium (hyperkalemia) (high potassium that stops the heart), fluid overload with pulmonary edema (fluid flooding the lungs) (water in lungs), and severe waste buildup in the blood (uremia) (waste buildup causing confusion and seizures); hourly tracking catches rapid decline before life-threatening complications occur.
2. Check blood pressure every 4 hours and notify the provider immediately if systolic is above 160 or diastolic above 100. — Acute GN causes volume overload (too much fluid in blood vessels) and activates the renin-angiotensin system (hormone system that raises blood pressure); uncontrolled high blood pressure (hypertension) (high blood pressure) can trigger with high blood pressure (hypertensive) encephalopathy (brain swelling with seizures), heart failure, or stroke within hours.
3. Assess for signs of fluid overload every shift: listen to lung sounds for crackles, check for pitting swelling (edema) in ankles and sacrum, measure daily weight at the same time each morning. — Damaged glomeruli cannot excrete sodium and water, so fluid accumulates in tissues (edema) and lungs (pulmonary swelling (edema)); weight gain of more than 2 pounds in a day signals dangerous fluid retention, and lung crackles mean pulmonary edema (fluid flooding the lungs) requiring urgent diuretics and possible dialysis to prevent respiratory failure.

4. Draw blood for creatinine and potassium levels as ordered (usually daily), and report creatinine rise of 0.3 mg/dL or more in 48 hours, or potassium above 5.5 mEq/L. — Rising creatinine (kidney waste marker) signals rapidly progressive GN where glomeruli are scarring permanently and treatment must be escalated immediately to save kidney function; high potassium (hyperkalemia) (high potassium) causes fatal cardiac arrhythmias (irregular heartbeat) and requires urgent treatment with insulin-dextrose, calcium, or dialysis.
5. Place the patient on a strict low-sodium diet (2 grams or less per day) and fluid restriction (usually 1 to 1.5 liters per day or 500 mL above previous day urine output). — Sodium causes the kidneys to hold onto water, worsening swelling (edema) and high blood pressure (hypertension); fluid restriction prevents volume overload when the kidneys cannot excrete excess water, reducing risk of pulmonary edema (fluid flooding the lungs) and allowing diuretics to work more effectively.
6. Monitor for signs of severe waste buildup in the blood (uremia) (waste buildup): confusion, drowsiness, nausea, metallic taste, or asterixis (flapping hand tremor when wrists are extended). — When glomeruli fail, urea and other toxins accumulate in the blood causing uremic encephalopathy (brain dysfunction); early severe waste buildup in the blood (uremia) symptoms signal need for urgent dialysis before the patient develops seizures, coma, or pericarditis (heart-sac inflammation that can cause cardiac tamponade (the heart squeezed by fluid around it)).
7. Inspect urine color each void and test for blood and protein using dipstick; notify provider if urine turns darker or protein level increases. — Worsening blood in the urine (hematuria) (blood in urine turning from pink to cola-colored) and increasing proteinuria (protein in urine) indicate more severe glomerular damage; this progression may prompt kidney biopsy to identify the specific GN type and guide immune-suppression therapy.
8. Educate the patient to avoid NSAIDs (ibuprofen, naproxen), nephrotoxic drugs (aminoglycoside antibiotics, contrast dye), and to report any new rash, fever, or worsening symptoms immediately. — NSAIDs reduce kidney blood flow and worsen acute kidney injury; nephrotoxic drugs cause additional glomerular damage when kidneys are already failing; new systemic symptoms (rash, fever) may signal vasculitis or lupus flare requiring urgent escalation of immune suppression to prevent irreversible organ damage.

Sources

- KDIGO 2021 Clinical Practice Guideline for the Management of Glomerular Diseases
- American Society of Nephrology (ASN)
- National Kidney Foundation (NKF)
- Cochrane systematic reviews on glomerulonephritis

Last reviewed: 2026-07-07