

Pyelonephritis

Pyelonephritis means fever, pain in the flank (the side of your back), and tenderness when you tap the back over the kidney. Admit the patient if the infection is severe or they cannot take pills. Give IV antibiotics. Use imaging (like a CT scan) to check for blockages or abscesses.

THE ONE-LINE TRUTH

Pyelonephritis is when bacteria (usually from the bladder) travel up into the kidney tissue and cause infection there.

The chain — how it unfolds

1. Bacteria (usually *E. coli*) enter the urethra and multiply in the bladder — why: *E. coli* normally lives in the bowel. It can reach the urethra from the skin near the anus, especially in women (shorter urethra) or after catheter use. Once in the bladder, it attaches to the bladder wall and multiplies in the urine.
2. Bacteria ascend the ureter and invade the kidney tissue — why: Normally, urine flows one way—down—and flushes bacteria out. But if a stone or clot blocks the ureter, urine backs up and carries bacteria with it. Or if the valve at the bladder-ureter junction is weak (VUR), urine and bacteria reflux backward when the bladder contracts. Either way, bacteria reach the renal pelvis and invade the kidney tissue itself.
3. The immune system mounts a strong inflammatory response in the kidney — why: White blood cells (neutrophils and macrophages) detect bacterial toxins (like lipopolysaccharide from *E. coli*) and release cytokines (IL-1, IL-6, TNF-alpha) to call for help. These chemicals dilate blood vessels, increase blood flow, and make vessel walls leaky, so fluid and more white cells pour into the kidney tissue. The kidney swells, stretching the tight capsule around it, which causes sharp pain in the flank (side of the back).
4. The hypothalamus raises body temperature, causing fever — why: Cytokines (especially IL-1) travel through the bloodstream to the hypothalamus (the brain's temperature control center) and reset the thermostat higher. The body shivers and constricts skin blood vessels to generate and trap heat, producing a high fever (often 38.5°C or 101.3°F and above). This fever helps the immune system work better and slows bacterial growth.

5. The kidneys become tender, and the patient feels sick — why: The swollen kidney presses on nerve endings in the capsule and surrounding tissue, causing costovertebral angle (CVA) tenderness—pain when the back over the kidney is tapped. The vagus nerve senses the inflammation and signals the brain's vomiting center, producing nausea and vomiting. The patient may also have burning with urination (dysuria) (burning with urination) if the bladder infection is still present.
6. If untreated, bacteria may spill into the bloodstream or form abscesses — why: If the infection is not controlled with antibiotics, bacteria can break through the kidney tissue into the renal veins and enter the bloodstream (bacteremia). This triggers a body-wide immune alarm (sepsis) with low blood pressure, fast heart rate, confusion, and rapid breathing as the body tries to keep vital organs alive. Or pus may collect in a pocket (abscess) within or around the kidney, which antibiotics cannot reach and which may need to be drained with a needle or surgery.
7. Antibiotics kill the bacteria, and the inflammation resolves — why: IV antibiotics (like ceftriaxone or fluoroquinolones) reach high levels in the blood and urine, killing the bacteria. Once the bacterial load drops, the immune system mops up the remaining germs, cytokine release stops, the fever breaks, and the kidney swelling goes down. If a blockage caused the infection, it must be removed (stone removal, stent placement) so urine can flow freely again and prevent reinfection.
8. The kidney tissue heals, though scarring may occur with severe or repeated infections — why: Mild pyelonephritis usually heals completely. But if the infection was severe or happened multiple times (especially in childhood with VUR), scar tissue can replace normal kidney tissue, reducing the kidney's ability to filter blood and raising the risk of high blood pressure or chronic kidney disease later.

Spot it — what you see, and why

- High fever (often 101°F or higher): Bacteria have climbed from the bladder up into one or both kidneys. The immune system floods the area with white blood cells and releases chemicals called cytokines (alarm signals) that reset the body's thermostat upward to help fight the infection.
- Flank pain (one-sided back pain just below the ribs): The kidney sits tucked behind the belly, below the ribs on each side. When it swells from infection (like a balloon filling with fluid), it stretches the thin capsule wrapped around it, and that triggers sharp pain on that side of the back.
- Chills and shaking: The body raises its core temperature to fight bacteria. Shivering is the muscle's way of making heat quickly, so the person feels freezing cold even though their actual temperature is climbing.

- Nausea and vomiting: The kidneys sit near the gut, and inflammation next door irritates nerves that connect to the stomach. Cytokines in the bloodstream also signal the brain's vomiting center (the area postrema) to trigger nausea.
- Pain or burning when peeing: Bacteria usually start in the bladder before moving up. The bladder lining becomes red and raw (inflamed), so passing urine over it stings like rubbing salt on a scrape.
- Frequent, urgent need to pee (often only small amounts come out): The inflamed bladder wall is extra sensitive and sends 'full' signals to the brain even when only a little urine is inside. The person rushes to the bathroom but can squeeze out only a few drops.

Red flags — act now

- Confusion, extreme drowsiness, or trouble waking up (may mean bacteria are in the bloodstream, causing sepsis)
- Very low blood pressure, racing heart, or cold, clammy skin (signs of septic shock—the body's circulation is failing)
- Vomiting so severe the person cannot keep down fluids or medicine (risk of dehydration and worsening kidney damage)
- No urine output or very little urine over several hours (the infected kidney may be shutting down)
- Pregnancy (pyelonephritis can trigger early labor and harm the baby; always needs hospital treatment)

Treat it — in this order

1. Blood cultures (two sets from different sites), then start IV antibiotics within 1 hour — ceftriaxone 1–2 grams IV daily, or ciprofloxacin 400 mg IV every 12 hours if local resistance is low → Antibiotics kill the bacteria (usually *Escherichia coli*) that climbed into the kidney tissue. Ceftriaxone is a cephalosporin that breaks open bacterial cell walls. Ciprofloxacin is a fluoroquinolone that stops bacteria from copying their DNA. Starting antibiotics fast stops the infection from spreading into the bloodstream and causing sepsis. It also reduces kidney damage from prolonged inflammation.
2. IV fluids — 1–2 liters of normal saline or lactated Ringer's over the first few hours, then maintenance fluids to keep urine output above 0.5 mL per kilogram per hour → Fluids keep blood pressure up and kidneys perfused (fed with blood flow) so they can filter waste and fight infection. Fluids also dilute bacteria in the urine and help flush them out. In sepsis, fluids prevent shock by filling the blood vessels that have relaxed and leaked fluid into tissues.

3. Urgent imaging (renal ultrasound or CT scan) and urology consult for drainage if obstruction or abscess is found — percutaneous nephrostomy (a tube through the skin into the kidney) or ureteral stent (a small tube inside the ureter) to bypass the blockage → Draining trapped urine washes out bacteria and pus, and relieves pressure that is damaging the kidney. A nephrostomy or stent lets urine flow again so antibiotics can reach the infection and the kidney can heal. Without drainage, antibiotics cannot reach bacteria trapped behind a blockage, and the kidney can be permanently damaged or lost.
4. Switch to oral antibiotics after fever is gone for 24–48 hours and the patient can eat and drink — ciprofloxacin 500 mg twice daily, or levofloxacin 750 mg once daily, or trimethoprim-sulfamethoxazole if culture shows sensitivity — for a total of 7 days for uncomplicated cases or 10–14 days for complicated cases (pregnancy, diabetes, immunosuppression, or obstruction) → Oral antibiotics finish killing any bacteria hiding in kidney tissue and prevent relapse. A full course (7–14 days depending on severity) is needed because the kidney is a thick organ where bacteria can hide in tiny pockets. Stopping too early lets bacteria grow back and cause another infection.
5. Hospital admission for IV antibiotics and monitoring for pregnant women, immunocompromised patients (HIV, transplant, chemotherapy), anyone with sepsis signs, or patients who cannot keep down oral antibiotics → Hospital care with IV antibiotics gets medicine into the bloodstream fast and at high levels, which is critical when the infection is severe or the patient is high-risk. Close monitoring (vital signs every few hours, repeat labs) catches worsening sepsis early so doctors can add pressors (medicines to raise blood pressure) or ICU care if needed. This prevents death from septic shock.

Your top priorities at the bedside

1. Draw two sets of blood cultures from different sites before giving any antibiotics, then start IV antibiotics within 60 minutes of triage. — why: Blood cultures catch bacteremia in 20 percent of pyelonephritis cases but only grow the right organism if drawn before antibiotics kill the bacteria. Delayed antibiotics increase mortality in sepsis, so the one-hour window is critical.
2. Check vital signs every 2 hours and measure serum lactate (a blood chemical showing how much oxygen tissues are getting) immediately if fever is above 101 degrees or systolic blood pressure is below 90. — why: High fever with low blood pressure or lactate above 2 means sepsis. These patients need 30 milliliters per kilogram IV crystalloid (salt water) bolus within 3 hours and may need ICU transfer for vasopressors (medicines that raise blood pressure).

3. Start an IV line with at least an 18-gauge catheter and give normal saline at 125 to 200 milliliters per hour unless the patient has heart failure. — why: Fever and vomiting cause hypovolemia (low blood volume) that drops kidney blood flow and worsens kidney damage. Adequate hydration helps antibiotics reach infected tissue and flushes bacteria out through urine.