

Pyelonephritis

A plain-English guide for you and your family

WHAT IS HAPPENING

Your kidneys normally filter blood and make urine, which flows down a thin tube (the ureter) into the bladder and then out when you pee. This one-way flow keeps bacteria flushed out and the kidney clean. Pyelonephritis happens when bacteria—usually *E. coli* from the bowel—travel backward up the ureter and invade the kidney tissue itself. This can happen because something blocks the ureter (like a kidney stone), because a valve at the bladder-ureter junction is weak and lets urine flow backward (vesicoureteral reflux, or VUR), or because the person is vulnerable (pregnancy, diabetes, or a weak immune system). Once bacteria reach the kidney, they multiply in the tissue, triggering the body's alarm system. You get a high fever as the immune system tries to kill the germs, sharp pain in the flank (the side of your back) because the kidney swells and stretches its outer cover, and tenderness when someone taps your back over the kidney (costovertebral angle tenderness). You may also feel sick to your stomach, vomit, and have burning when you pee. If the infection is caught early and treated with antibiotics, the bacteria are killed, the fever breaks, and the kidney heals. But if it is not treated, bacteria can spill into the bloodstream and cause sepsis (a body-wide infection response that can crash blood pressure and harm organs), or pus can collect in a pocket (abscess) that needs to be drained. The key is to recognize the fever and flank pain early, confirm the diagnosis with a urine test and sometimes imaging, and start the right antibiotic quickly so the infection does not spread.

What you might feel

- High fever (often 101°F or higher)
- Flank pain (one-sided back pain just below the ribs)
- Chills and shaking
- Nausea and vomiting
- Pain or burning when peeing
- Frequent, urgent need to pee (often only small amounts come out)
- Cloudy or foul-smelling urine

- Blood in the urine (pink, red, or tea-colored)
- Confusion or sudden weakness (especially in older adults)
- Very low blood pressure or fast heart rate

Call the doctor right away if...

- 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)

What the care team will do

- Draw two sets of blood cultures from different sites before giving any antibiotics, then start IV antibiotics within 60 minutes of triage.
- 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.
- 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.
- Collect a clean-catch urine sample for urinalysis and culture before the first antibiotic dose, and check if urine output is at least 0.5 milliliters per kilogram per hour.
- Monitor temperature every 4 hours and give acetaminophen (Tylenol) 650 milligrams by mouth or IV for fever above 101 degrees.
- Notify the provider immediately if the patient has one-sided flank pain that gets worse despite IV fluids and pain medicine, or if a renal ultrasound or CT shows hydronephrosis (swelling of the kidney from blocked urine).
- Teach the patient to finish the full 14-day antibiotic course even after hospital discharge and return if fever comes back or flank pain worsens.
- Assess pain level every 4 hours with a 0-to-10 scale and give scheduled IV ketorolac (Toradol) 15 to 30 milligrams every 6 hours or opioids if pain is above 6.

Medicines you may be given — and why

Ciprofloxacin (Cipro)

Ciprofloxacin kills bacteria by breaking the DNA inside them. Bacteria (like *E. coli*, the most common cause of pyelonephritis) have a special enzyme called DNA gyrase (like a tiny machine that twists and untwists their DNA so they can copy it and grow). Ciprofloxacin jams this machine, so the bacteria can't copy their DNA, can't divide, and die off. This stops the infection in the kidney.

Ceftriaxone (Rocephin)

Ceftriaxone kills bacteria by breaking down their outer wall. Bacteria build a tough protective shell called the cell wall (like a brick wall around a house) using a chemical lattice called peptidoglycan. Ceftriaxone blocks the enzymes (called penicillin-binding proteins) that glue the bricks together. Without a sturdy wall, the bacteria burst open and die. It works especially well against gram-negative bacteria like *E. coli* and *Klebsiella*, which cause most kidney infections.

Piperacillin-Tazobactam (Zosyn)

This is a two-part antibiotic team. Piperacillin kills bacteria by breaking their cell wall (just like ceftriaxone), but many bacteria have learned to fight back by making an enzyme called beta-lactamase (like a pair of scissors that cuts the antibiotic apart). Tazobactam is a shield—it blocks the beta-lactamase scissors so piperacillin can do its job. Together, they kill a very wide range of bacteria, including resistant gram-negative bugs (like ESBL-producing *E. coli* or *Pseudomonas*) and some anaerobes (bacteria that live without oxygen). This combo is saved for severe infections or patients who are very sick, have other health problems, or may have resistant bacteria.

Levofloxacin (Levaquin)

Levofloxacin works just like ciprofloxacin—it kills bacteria by jamming their DNA machinery. It blocks DNA gyrase and another enzyme called topoisomerase IV (both wind and unwind bacterial DNA so it can be copied). Without these enzymes, the bacteria can't reproduce or repair DNA damage, so they die. Levofloxacin covers gram-negative bacteria (*E. coli*, *Klebsiella*, *Proteus*) and some gram-positive bugs, and it reaches high levels in the urine and kidney tissue.

Cefepime (Maxipime)

Cefepime kills bacteria by breaking down their cell wall, just like ceftriaxone, but it is a fourth-generation cephalosporin, so it resists many beta-lactamase enzymes and covers an even wider range of bacteria. It works especially well against gram-negative bacteria (including

Pseudomonas aeruginosa, which can cause severe kidney infections in hospitalized or catheterized patients) and some gram-positive bacteria. It is often chosen for very sick patients or suspected resistant infections.

Ertapenem (Invanz)

Ertapenem is a very strong antibiotic that kills bacteria by breaking their cell wall, just like penicillins and cephalosporins. But carbapenems are the most resistant to beta-lactamase enzymes—they can punch through almost all the bacteria's defenses. Ertapenem covers a broad spectrum, including ESBL-producing **E. coli** and **Klebsiella** (bacteria that have learned to resist most other antibiotics). It is often used when a patient has had repeated infections, is very sick, or when culture results show resistant bacteria. It is given once daily by IV or IM.

Trimethoprim-Sulfamethoxazole (Bactrim, Septra)

This is a two-drug team that kills bacteria by starving them of folate (a vitamin-like molecule bacteria need to build DNA). Bacteria make their own folate from scratch using a two-step process. Sulfamethoxazole blocks the first step, and trimethoprim blocks the second step. With both steps blocked, the bacteria can't make DNA, can't divide, and die. It works against many gram-negative bacteria (including **E. coli**) and some gram-positive bugs. It is often used for simple, uncomplicated pyelonephritis in areas where resistance is low, but resistance is rising in many places, so it is used less often as a first choice.

Nitrofurantoin (Macrobid, Macrochantin)

Nitrofurantoin kills bacteria in the bladder by damaging multiple parts inside them—it gets activated by bacterial enzymes into toxic byproducts that break DNA, proteins, and cell walls all at once. It concentrates very well in the urine but does NOT reach high levels in the kidney tissue or bloodstream, so it is excellent for bladder infections (cystitis) but NOT recommended for kidney infections (pyelonephritis). Guidelines say NOT to use it for pyelonephritis because it does not get to the kidney tissue where the infection is.

Where this information comes from

- IDSA Clinical Practice Guideline for Acute Uncomplicated Cystitis and Pyelonephritis (2011)
- Surviving Sepsis Campaign International Guidelines (2021)
- UpToDate Clinical Overview: Acute Pyelonephritis
- CDC: Urinary Tract Infection Guidelines

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