

Pleural Effusion and Empyema

Fluid has pooled between the lung and chest wall. Sample it to learn why. Drain it if it is infected, thick, or will not go away by treating the upstream cause.

THE ONE-LINE TRUTH

Fluid has pooled in the space between the lung and the chest wall, squeezing the lung so it cannot fill with air.

The chain — how it unfolds

1. Fluid pools in the pleural space, taking up room where air should be — why: One of four breaks occurs: pressure pushes fluid out (heart failure, fluid overload), protein in blood drops (cirrhosis, nephrotic syndrome), vessel walls get leaky from inflammation (pneumonia, cancer, PE, autoimmune disease), or lymph drains get blocked (cancer, torn thoracic duct). Fluid that would normally stay balanced now piles up between the lung and chest wall.
2. The lung on that side cannot expand fully — why: The growing pool of fluid presses on the lung from the outside, squeezing it like a hand around a balloon. The alveoli (tiny air sacs where oxygen crosses into blood) in the compressed part of the lung collapse, so less surface area is available for gas exchange.
3. Oxygen going into the blood drops; the patient feels short of breath — why: With part of the lung squeezed shut, each breath brings in less oxygen. The brainstem detects falling oxygen and rising carbon dioxide in the blood and triggers the sensation of trouble breathing (dyspnea) (air hunger), making the patient feel like they cannot get enough air.
4. The diaphragm has to work much harder; breathing becomes exhausting — why: The diaphragm (the dome-shaped muscle under the lungs) has to push down against the weight of fluid pressing from above. Instead of gliding smoothly, it is lifting a heavy load with every breath. Accessory muscles in the neck and ribs are recruited, and the patient sits upright to use gravity to help.

5. If bacteria invade the fluid, white blood cells flood in and the fluid turns to pus — why: If bacteria from a nearby pneumonia or from the bloodstream seed the pleural fluid, neutrophils (the body's first-line infection fighters) pour into the space, releasing enzymes and acid as they kill bacteria. Glucose in the fluid drops (the white cells burn it for energy), pH falls below 7.2 (lactic acid from the battle), and lactate dehydrogenase (LDH, a marker of cell breakdown) rises. The fluid becomes thick, cloudy pus — an empyema.
6. Low pH and thick pus mean the fluid will not clear without drainage — why: Once pH drops below 7.2 or the fluid becomes loculated (trapped in pockets by sticky fibrin), antibiotics alone cannot reach the bacteria or clear the pus. A chest tube or surgical washout (video-assisted thoracoscopic surgery, VATS) is needed to drain the infection and let the lung re-expand.
7. If empyema is not drained, thick scar tissue forms and traps the lung — why: After about two weeks, fibroblasts (scar-making cells) move into the infected space and lay down thick collagen, forming a tough rind around the lung called a fibrothorax. The lung becomes trapped in scar tissue and cannot expand even after the infection is gone. Surgical decortication (peeling off the scar) is then the only way to free the lung.
8. Every finding — dull percussion, quiet breath sounds, shortness of breath — traces back to fluid squeezing the lung — why: When you tap the chest over fluid, it sounds dull instead of hollow because fluid does not resonate like air. Breath sounds are muffled or absent because air is not moving in the compressed lung below. The patient is short of breath because the working lung volume is smaller. None of this is random; every sign points to one thing: fluid is where air should be, and the lung is trapped.

Spot it — what you see, and why

- Shortness of breath that gets worse when lying flat: The fluid pools in the chest and takes up space where the lung should expand, so the lung cannot fill with air properly and you feel like you cannot catch your breath.
- Sharp chest pain that gets worse when you breathe in or cough: The pleura (the thin sac that wraps the lung) is swollen and rubbing against the chest wall, which triggers pain nerves. Breathing in stretches the inflamed layers together and makes it hurt more.
- Dull sound when you tap on the chest over the fluid: Normally the air-filled lung sounds hollow when you tap it. Fluid is thick and dense, so it blocks the sound wave and makes a flat, dull thud instead.
- Quiet or absent breath sounds at the bottom of the lung: The fluid sits at the bottom of the chest because of gravity, pushing the lung up and away from the chest wall. Air cannot move through the compressed lung tissue, so you hear no breath sounds where the fluid sits.

- Less chest vibration when you place your hand on the chest while the patient talks: Normally the sound of the voice travels through air in the lungs and makes the chest wall buzz. Fluid muffles and absorbs the vibration, so you feel less buzzing (this is called decreased tactile fremitus).
- A rubbing or grating sound when you listen to the chest, especially early on: Before fluid builds up or in dry pleuritis, the inflamed pleural layers rub directly against each other with every breath, making a creaky, scratchy noise called a pleural friction rub.

Red flags — act now

- Trachea (windpipe) shifted away from the side with fluid — means very large a fluid collection (effusion) or tension, need urgent drainage
- Fever, foul-smelling fluid, or pus on aspiration — means empyema (infected fluid), needs chest tube and antibiotics right away
- Re-expansion pulmonary edema (fluid flooding the lungs) after draining more than 1-1.5 liters too fast — lung fills with watery fluid and oxygen drops; drain slowly and stop if cough or chest tightness starts
- Fluid keeps coming back after drainage — may mean cancer, tuberculosis, or heart failure is not controlled; needs full work-up

Treat it — in this order

1. Thoracentesis (needle drainage) for diagnostic and therapeutic purposes → Removes fluid pushing on the lung so the lung can expand again and the patient can breathe easier. It also gives you a sample to test: transudate versus leaked fluid (exudate), infected versus sterile, malignant versus benign. Maximum safe removal is 1.5 liters per session to avoid re-expansion pulmonary edema (fluid flooding the lungs) (fluid flooding the lung when it re-inflates too fast).
2. Chest tube drainage for empyema or complicated parapneumonic a fluid collection (effusion) → Drains infected or loculated fluid continuously so the lung can expand and the infection can clear. Keeps the pH from dropping further (low pH means bacteria are winning) and lets antibiotics reach the infection.
3. Antibiotics (empiric then culture-directed) for empyema or parapneumonic a fluid collection (effusion) → Kills bacteria in the pleural space and blood. For community-acquired empyema, cover *Streptococcus pneumoniae*, *Staphylococcus aureus*, and oral anaerobes (from aspiration) — typical regimen is ceftriaxone plus metronidazole or ampicillin-sulbactam. For hospital-acquired empyema, cover MRSA and *Pseudomonas* — vancomycin plus piperacillin-tazobactam or cefepime. Duration is usually 2 to 4 weeks total (IV then oral).

4. Intrapleural fibrinolytics: tissue plasminogen activator (tPA) 10 mg plus DNase 5 mg instilled twice daily for 3 days via chest tube → Breaks down fibrin strands (from clotting) and DNA (from dead white cells) that wall off the pus into pockets. This turns thick, trapped fluid into liquid that can drain through the tube. The MIST2 trial showed tPA plus DNase together reduces the need for surgery and shortens hospital stay.
5. Treat the upstream cause: diuretics (furosemide) for heart failure, antibiotics for pneumonia, nephrology consult for nephrotic syndrome, oncology consult for malignancy → Fixes the root problem so new fluid stops forming. Diuretics lower venous pressure (heart failure). Antibiotics clear lung infection (parapneumonic a fluid collection (effusion)). Treating cancer or boosting albumin (in liver or kidney disease) reduces the leak.

Your top priorities at the bedside

1. Check oxygen saturation every 1 to 2 hours and give oxygen to keep SpO2 above 90 percent — why: Fluid compresses the lung so less alveoli (air sacs) can exchange oxygen; low oxygen in the blood (hypoxemia) (low oxygen) damages organs fast and you must correct it before the fluid is drained
2. Position the patient sitting upright at 45 to 90 degrees or leaning forward on a bedside table — why: Gravity pulls fluid down and forward when sitting, opening more space in the back and top of the lung for air to enter and improving diaphragm (breathing muscle) movement
3. Monitor respiratory rate, work of breathing, and use of accessory muscles (neck and shoulder muscles) every 2 to 4 hours — why: Increased respiratory rate above 24, retractions (skin sucking in), or accessory muscle use means the patient is tiring out and may need higher support like BiPAP (mask pressure) or intubation (breathing tube)