

Pneumothorax and Tension Pneumothorax

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THE STORY IN ONE SENTENCE

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“If the pneumothorax is small, watch and wait. If it is large, put in a chest tube to let the air out. If it is a tension pneumothorax, decompress it right now—do not wait for an X-ray—or the patient will die.”

Normal anatomy — the body's job

Each lung is wrapped in a thin, double-layered skin called the pleura. The inner layer sticks to the lung; the outer layer lines the inside of the chest wall. Between them is the pleural space—a hair-thin gap that holds almost no air, only a tiny film of slippery fluid so the layers can slide smoothly when you breathe.

BODY'S JOB

The pleural space is kept at negative pressure (lower than the air pressure outside your body). That negative pressure works like a gentle vacuum, holding the lung open against the chest wall. When your diaphragm (the big breathing muscle under your lungs) pulls down and your ribs lift up, the chest gets bigger. Because the lung is stuck to the chest wall by that vacuum, the lung has to expand too—air rushes in through your windpipe to fill the new space. When you breathe out, everything relaxes and air flows back out. This system only works because the pleural space stays sealed and stays negative.

1. Your diaphragm pulls down and your rib muscles lift the ribs up and out.
2. The chest cavity gets bigger in every direction.
3. Because the pleural space has negative pressure, the lung is glued to the chest wall and must expand when the chest expands.

4. Expanding the lung drops the pressure inside the air sacs below the pressure in your mouth and nose, so air rushes in through your windpipe to fill the lung.
5. When the diaphragm relaxes and the ribs drop, the chest gets smaller, the lung gets gently squeezed, and air flows back out.
6. This cycle repeats every few seconds, all day, without you thinking about it—as long as the pleural seal and negative pressure stay intact.

What breaks

Air gets into the pleural space where it does not belong. Once air is in that space, the negative-pressure vacuum is lost and the lung starts to collapse inward.

CLINICAL TERM

Pneumothorax

How the body compensates

The body tries to keep oxygen delivery and blood pressure steady even as the lung collapses. For a while, vital signs can look almost normal—but that false stability hides how close the patient is to crashing, especially in tension pneumothorax.

1. {'what': 'The healthy lung on the opposite side works harder', 'how': 'Breathing rate goes up and the good lung takes deeper breaths to make up for the collapsed lung. Oxygen levels may stay near normal at first if the patient is young and has no other lung disease.'}
2. {'what': 'The heart beats faster', 'how': 'As oxygen drops or blood return falls, the sympathetic nervous system (the body's fight-or-flight system) releases adrenaline. Heart rate climbs to try to pump more blood per minute and keep blood pressure up.'}
3. {'what': 'Blood vessels squeeze down', 'how': 'Adrenaline also tightens arteries in the skin, gut, and muscles, shunting blood toward the brain and heart—the two organs that must not fail.'}
4. {'what': 'The patient feels air hunger and panic', 'how': 'Low oxygen and high carbon dioxide trigger the brainstem breathing centers and the amygdala (the brain's alarm system), so the patient feels desperate for air and deeply anxious.'}
5. {'what': 'Compensation reaches its limit', 'how': 'In tension pneumothorax, once the vena cava is kinked enough, blood return to the heart drops so low that even a fast heart rate cannot maintain cardiac output. Blood pressure falls sharply, oxygen delivery to the brain fails, and the patient loses consciousness. Cardiac arrest follows within minutes unless the chest is decompressed.'}

Domino effect

1. Air leaks into the pleural space — A bleb bursts, a rib fractures and punctures the lung, a procedure nicks the pleura, or diseased lung tissue tears—any of these breaks the airtight seal and lets air into the space between lung and chest wall.
2. Negative pressure is lost and the lung starts to collapse — The pleural space normally has negative pressure (like a vacuum) that holds the lung open. Once air enters, pressure equalizes and the lung's natural elasticity makes it recoil inward, like a deflating balloon.
3. You feel sudden, sharp chest pain and shortness of breath — The pleura has pain nerves; tearing or stretching it hurts. The collapsed lung cannot take in air, so less oxygen reaches your blood and carbon dioxide builds up—your brainstem senses this and screams for more air.
4. Breath sounds become quiet or absent on the affected side — A stethoscope picks up the sound of air moving in and out of the lung. When the lung is collapsed, no air is moving through it, so you hear nothing—or much less than the other side.
5. In tension pneumothorax, air keeps entering but cannot escape — The tear in the lung acts like a one-way flap valve: it opens when pressure inside the lung is high (during exhalation or a ventilator breath) and lets air out into the pleural space, but it seals shut when pleural pressure tries to push air back—so air is trapped and pressure builds with every breath.
6. Pressure in the pleural space rises above atmospheric pressure — Normally the pleural space is below atmospheric pressure. With a one-way valve, each breath pumps in more air. The space fills like a balloon being blown up inside the chest, and pressure climbs higher and higher.
7. The mediastinum (heart, aorta, vena cava, trachea) is shoved to the opposite side — The high-pressure air acts like a growing mass, physically pushing everything in the middle of the chest toward the other side. You can see the trachea shift away from the pneumothorax on exam, and the heart and great vessels are pushed over on imaging.
8. The superior and inferior vena cava get kinked — These are the large veins that bring blood back to the right side of the heart. When the mediastinum is shoved sideways, the veins are stretched and compressed—like kinking a garden hose—so blood cannot flow through them easily.
9. Neck veins swell (jugular venous distension) — Blood trying to return from the head and arms backs up in the jugular veins because the superior vena cava is kinked. The veins bulge out in the neck, visible even when the patient is sitting up.
10. Blood pressure drops — The kinked vena cava means less blood reaches the heart. The heart can only pump out what it receives (preload), so stroke volume falls, cardiac output falls, and blood pressure drops—this is obstructive shock.

- 11.** The patient becomes confused, then loses consciousness, then arrests — Low blood pressure means the brain is not getting enough oxygen and glucose. Confusion and loss of consciousness happen within seconds to minutes. If the chest is not decompressed immediately, the heart will stop because it has no blood to pump.

Symptoms · what the patient feels, and why

- Sudden sharp chest pain on one side: Air escapes into the space between the lung and chest wall (the pleural space), irritating the pleura (the thin membrane wrapping the lung), which has pain nerves. The sudden stretch and pressure cause a stabbing feeling.
- Shortness of breath: The leaked air takes up room in the chest and squeezes the lung so it cannot fill all the way. Less lung surface means less oxygen gets into the blood, so you feel hungry for air.
- Fast breathing: The body senses low oxygen and tries to fix it by breathing faster and harder, pulling in more air to make up for the collapsed part of the lung.
- Decreased or absent breath sounds on one side (heard with a stethoscope): Air is not moving in and out of the collapsed lung, so the doctor hears silence or very faint sounds when listening to that side of the chest.
- Fast heart rate: Low oxygen triggers the sympathetic nervous system (the body's alarm mode), which tells the heart to pump faster to push more blood and deliver whatever oxygen is left to the organs.
- One side of the chest does not move as much when breathing: The collapsed lung cannot expand, so that side of the rib cage stays still or moves less than the healthy side during each breath.
- Bulging neck veins and very low blood pressure (tension pneumothorax): Air keeps building up under pressure and squeezes the heart and the big veins (the vena cava) that return blood to the heart. Blood backs up into the neck veins (making them swell), and less blood reaches the heart to pump out, so blood pressure drops dangerously.
- Trachea (windpipe) shifted to one side (tension pneumothorax): The trapped air pushes so hard it shoves the heart, windpipe, and other chest structures toward the opposite side. You can sometimes feel or see the bump of the windpipe off-center in the neck.
- Confusion or loss of consciousness (tension pneumothorax): Very low blood pressure and low oxygen mean the brain is not getting enough fuel. Brain cells start to shut down, causing confusion, then fainting or collapse.

Focused exam

- Sudden sharp chest pain that gets worse when you breathe in: Air has leaked into the pleural space (the thin gap between your lung and chest wall). That space is supposed to be empty. When air fills it, the pleura (the slippery lining) gets stretched and irritated. Every time your lung tries to expand, it pulls on that irritated lining, so it hurts.
- Breath sounds quiet or absent on one side of the chest: If air is filling the space around your lung instead of inside it, the lung on that side cannot expand fully. Less air moving in and out means less sound when the doctor listens with a stethoscope. This finding points straight to pneumothorax.
- Hyperresonance—a hollow, drum-like sound when the doctor taps the chest on the affected side: Air trapped in the pleural space acts like a drum. When you tap it, it rings hollow. A normal lung filled with air inside sounds duller. This hollow sound tells you there is extra air where it should not be.
- Neck veins bulging (jugular venous distension), especially in tension pneumothorax: In tension pneumothorax, air keeps leaking in but cannot escape. Pressure builds up and squeezes the vena cava (the big vein that carries blood back to the heart). Blood backs up like water in a clogged pipe, and you see the veins in the neck swell.
- Trachea (windpipe) shifted away from the affected side: In tension pneumothorax, the rising air pressure on the bad side pushes everything in the chest—including the trachea and heart—toward the good side. This shift means pressure is dangerously high and the body cannot balance it anymore.
- Low blood pressure and fast heart rate (tachycardia), especially in tension pneumothorax: When pressure builds inside the chest in tension pneumothorax, it squeezes the vena cava and the heart itself. Less blood returns to the heart, so cardiac output drops and blood pressure falls. The heart speeds up trying to pump harder to make up for it, but it cannot fix the problem on its own.

Diagnostics · every test answers a question

- Upright chest X-ray (posteroanterior and lateral views) → Is there air in the pleural space, and if so, how much of the lung has collapsed?
- Arterial blood gas (ABG) on room air → Is the person getting enough oxygen, and is carbon dioxide building up?
- Bedside ultrasound of the chest (lung point sign, absence of lung sliding) → Can I confirm pneumothorax right now without waiting for an X-ray?
- Chest CT scan (if diagnosis is unclear or recurrent pneumothorax) → Is there a small pneumothorax the X-ray missed, or an underlying lung disease (blebs, bullae, emphysema) causing it?

- Pulse oximetry (continuous oxygen saturation monitoring) → Is oxygen getting into the blood, and is it staying stable?
- Complete blood count (CBC) → Is there infection or bleeding complicating the pneumothorax?

Treatment logic

- Immediate needle decompression (14- or 16-gauge needle at the 2nd intercostal space, midclavicular line) for tension pneumothorax → Puncturing the chest wall with a needle releases the trapped air under pressure. This instantly stops the one-way valve effect and restores blood flow back to the heart. Blood pressure comes back up and the heart can fill again.
- Chest tube (tube thoracostomy) or small-bore pigtail catheter for large pneumothorax (>2 cm) or any symptomatic pneumothorax → A tube drains trapped air continuously and restores the normal negative pressure in the pleural space. Once pressure is restored, the lung re-expands against the chest wall. The pleura can then seal the leak on its own. The tube stays in until the lung stays up and no more air leaks out (usually 24–48 hours of no bubbling in the water seal).
- Observation and supplemental oxygen (or room air) for small (<2 cm), stable, primary spontaneous pneumothorax → Giving 100% oxygen speeds up resorption of trapped air. Normally air in the pleural space is absorbed at about 1.25% of the volume per day. High-flow oxygen replaces nitrogen in the air pocket with oxygen, which dissolves into the blood much faster—up to four times as fast. Small leaks seal on their own if you give the body time and oxygen.
- Video-assisted thoracoscopic surgery (VATS) with pleurodesis (scarring the pleura) or bleb resection (cutting out the weak air sac) → Surgery finds and removes the bleb that burst. Pleurodesis scars the visceral pleura (lung lining) to the parietal pleura (chest wall lining) so the two surfaces stick together permanently. This prevents future air from collecting in the pleural space at that spot. It is recommended after a second pneumothorax on the same side, or after the first one if the person has a high-risk job (pilot, diver) or lives far from a hospital.
- Smoking cessation and activity restriction (no flying, no scuba diving, no heavy lifting) until healed → Stopping smoking restores the elasticity of lung tissue and reduces inflammation that weakens alveoli (air sacs). Over time it lowers the risk of new blebs forming. Avoiding pressure changes (flying, diving) and heavy lifting prevents stress on the healing pleura while it seals.

- Pain control with NSAIDs (ibuprofen, ketorolac) or acetaminophen; avoid opioids if possible
→ Pain medicines reduce inflammation and block pain signals so the person can breathe deeply and cough without hurting. Deep breathing helps the lung re-expand. Opioids are avoided because they slow breathing and can make low oxygen in the blood (hypoxemia) worse.

Medications

Oxygen (supplemental O₂) · Supportive gas therapy

Breathing pure oxygen (or air with extra oxygen) raises the oxygen level in the blood. This creates a concentration difference between the trapped air in the chest (which is mostly nitrogen) and the oxygen-rich blood in the tiny blood vessels lining the chest wall. Nitrogen moves from the trapped air pocket into the blood and is breathed out through the lungs. This speeds up how fast the body reabsorbs the air pocket—normally around 1–2% of the pocket shrinks per day on room air, but oxygen can speed that up to roughly 4 times faster.

1. The patient breathes in air that is richer in oxygen than normal room air (often 100% oxygen or high-flow nasal oxygen).
2. Oxygen fills the tiny air sacs (alveoli) in the lungs and moves into the blood.
3. The blood now has a lot of oxygen and very little nitrogen.
4. Nitrogen from the trapped air pocket in the chest naturally moves toward the area with less nitrogen—the oxygen-rich blood in the chest wall capillaries.
5. The nitrogen enters the bloodstream, is carried back to the lungs, and is breathed out.
6. As nitrogen leaves the air pocket, the pocket shrinks faster than it would on room air alone.

SAFETY WATCH

In patients with severe chronic obstructive pulmonary disease (COPD) who rely on low oxygen to trigger breathing, giving too much oxygen can rarely slow their breathing drive; monitor breathing rate and alertness. · Prolonged high-concentration oxygen (days) can irritate the lungs, but short-term use for pneumothorax is safe. · Always confirm the pneumothorax is small and stable before choosing observation with oxygen instead of a chest tube.

Analgesics (pain relievers: acetaminophen, ibuprofen, or opioids if severe) · Pain management

A pneumothorax—especially after chest-tube placement or needle decompression—causes sharp chest pain. Acetaminophen (Tylenol) blocks pain signals in the brain. Ibuprofen (Advil, Motrin) reduces inflammation at the injury site in the chest lining and blocks pain chemicals

called prostaglandins. Opioids (like morphine or oxycodone) attach to opioid receptors in the brain and spinal cord, turning down the volume on pain signals. Controlling pain helps the patient breathe deeply and cough, which prevents lung collapse and pneumonia.

1. The patient takes or receives the pain medicine by mouth, IV, or injection.
2. The drug enters the bloodstream and travels to its target site.
3. Acetaminophen raises the pain threshold in the brain so pain signals feel less intense.
4. Ibuprofen blocks the enzyme COX (cyclooxygenase), stopping the chest lining from making prostaglandins that trigger pain and swelling.
5. Opioids lock onto mu-opioid receptors, which stop pain signals from moving up the spinal cord to the brain and change how the brain perceives pain.
6. The patient feels less chest pain and can take deeper breaths and cooperate with chest-tube care.

SAFETY WATCH

Ibuprofen can irritate the stomach or raise bleeding risk if the patient is on blood thinners or has kidney disease; use cautiously. · Opioids can slow breathing (respiratory depression), cause constipation, and make the patient drowsy; use the lowest effective dose and monitor breathing rate, especially in elderly patients or those with lung disease. · Acetaminophen is safe in standard doses but can damage the liver if more than 3–4 grams per day (or lower in patients with liver disease or heavy alcohol use). · Always reassess pain regularly; worsening chest pain may signal tension pneumothorax, chest-tube malfunction, or infection.

Red flags

- Very low blood pressure or shock (systolic below 90 mmHg)
- Bulging neck veins with respiratory distress
- Trachea visibly or palpably shifted away from the affected side
- Severe trouble breathing or unable to speak in full sentences
- Confusion, dizziness, or fainting

Nursing priorities

1. Check for tension pneumothorax signs every 15 minutes: blood pressure dropping, heart rate above 120, oxygen saturation falling, neck veins bulging, and if the windpipe (trachea) looks shifted to one side when you look at the neck. — Tension pneumothorax kills in minutes because trapped air squeezes the heart so blood cannot fill it. The heart rate goes up trying to compensate but blood pressure crashes. Tracheal deviation (windpipe pushed sideways) is a late sign meaning the mediastinum (middle chest) is crushed.
2. Place patient sitting upright at 45 to 90 degrees and keep the affected side (collapsed lung side) up if they lie down. — Upright position uses gravity to pull the diaphragm (breathing muscle) down so the lung has more room to expand. The affected side up prevents the good lung from being compressed by body weight.
3. Give high-flow oxygen by non-rebreather mask at 10 to 15 liters per minute if oxygen saturation is below 94 percent or patient has underlying lung disease. — High-flow oxygen washes nitrogen out of the blood and replaces it in the pleural space (area between lung and chest wall). This creates a bigger concentration difference so the trapped air absorbs into blood four times faster.
4. Prepare needle decompression supplies at bedside: 14-gauge or 16-gauge angiocath (big IV needle), alcohol wipes, and gloves. Know the landmark is second rib space at midclavicular line (in line with middle of collarbone). — Tension pneumothorax cannot wait for a chest X-ray or CT scan. Nurses may need to assist with immediate needle decompression. A hissing sound of air escaping confirms the diagnosis and saves the patient's life.
5. Start a large-bore IV (18-gauge or bigger) in case the patient crashes and needs emergency fluids or medicines. — Tension pneumothorax drops blood pressure by squeezing the vena cava (big vein bringing blood back to heart). Fluid boluses through a big IV can temporarily support blood pressure until the air is released.
6. Keep patient NPO (nothing by mouth) if pneumothorax is larger than 2 cm on chest X-ray or if a chest tube or surgery is planned. — Large pneumothorax needs a procedure with sedation. Food or liquid in the stomach increases aspiration (breathing in vomit) risk if the patient needs emergency intubation or if they vomit from pain or anxiety.
7. Monitor the chest tube system every hour: check that tubing has no kinks, water seal chamber bubbles with breathing (shows air escaping lung), and suction level stays at ordered amount (usually minus 20 cm water pressure). — Bubbling in the water seal means the pneumothorax is still leaking air. When bubbling stops for 24 hours, the lung has sealed and the tube can come out. Kinked tubing traps air and turns a simple pneumothorax into tension.

8. Teach patient to report new or worse chest pain, trouble breathing, or feeling like their heart is racing immediately, and never clamp the chest tube unless a doctor orders it for a specific test. — These symptoms mean the pneumothorax is getting bigger or the chest tube is blocked. Clamping a chest tube with an active air leak will create tension pneumothorax in minutes because air keeps leaking but cannot escape.

Sources

- British Thoracic Society (BTS) Pleural Disease Guideline 2010
- CHEST 2018 Pneumothorax Consensus Statement
- American College of Chest Physicians (ACCP)
- Advanced Trauma Life Support (ATLS) 10th Edition

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