Pneumothorax in the Hospital Setting

Definition and Epidemiology

Pneumothorax is the abnormal presence of air in the pleural space, leading to partial or complete lung collapse. It is classified as spontaneous (primary or secondary), traumatic, or iatrogenic, with tension pneumothorax being a life-threatening variant.

Prevalence:

Primary spontaneous pneumothorax (PSP) affects ~7-18/100,000 men and 1-6/100,000 women annually; secondary spontaneous pneumothorax (SSP) is more frequent in COPD (50-70/100,000 in severe COPD).

Risk Factors:

Smoking (20x risk for PSP), tall/thin habitus, COPD, cystic fibrosis, trauma, mechanical ventilation, central venous catheterization.

Rare Demographics:

Marfan syndrome, Birt-Hogg-Dubé syndrome, lymphangioleiomyomatosis (LAM) in young women.

Pathophysiology

Mechanisms:

Air enters the pleural space through a breached visceral pleura (e.g., bleb rupture in PSP), parietal pleura (trauma), or iatrogenic puncture, disrupting the negative intrapleural pressure (-5 to -10 cmH2O) that maintains lung expansion.

Effects:

Lung collapse reduces alveolar surface area, causing V/Q mismatch and hypoxemia. In tension pneumothorax, intrapleural pressure exceeds atmospheric pressure, compressing the mediastinum, reducing venous return, and impairing cardiac output.

Molecular Pathways:

Bleb rupture involves elastin degradation (e.g., MMP-9 upregulation in smokers). Tension physiology triggers cytokine release (IL-6, TNF-α), exacerbating systemic inflammation.

Key Pathway:

Pleural air accumulation → Loss of pleural cohesion → Lung collapse → Hypoxemia; in tension, mediastinal shift → Hemodynamic collapse.

Causes

Category	Common Causes	Rare Causes	Notes
Spontaneous (Primary)	Subpleural bleb rupture, smoking	Birt-Hogg-Dubé syndrome, LAM	PSP: Young males, no lung disease; LAM: Women, chylothorax possible
Spontaneous (Secondary)	COPD, TB, cystic fibrosis	Catamenial (endometriosis), sarcoidosis	SSP: Older, underlying lung disease; catamenial linked to menstrual cycle
Traumatic	Blunt/penetrating chest trauma	Esophageal rupture (Boerhaave)	Trauma: Rib fractures, hemopneumothorax common
Iatrogenic	Central line placement, mechanical ventilation	Lung biopsy, acupuncture	Barotrauma in high PEEP settings

Clinical Presentation

Symptoms:

- Sudden, unilateral pleuritic chest pain (sharp, worse with inspiration)
- Dyspnea, tachypnea
- **Tension:** Severe hypotension, cyanosis, neck vein distension
- **Rare:** Subtle fatigue in small pneumothorax

Exam:

- Asymmetric chest expansion, decreased breath sounds, hyperresonance on affected side
- **Tension:** Tracheal deviation (contralateral), JVD, subcutaneous emphysema
- **Rare:** Hamman's sign (crunching sound in mediastinal emphysema)

Red Flags:

SBP <90 mmHg, SpO2 <88%, cyanosis, tracheal deviation

Labs and Studies

Labs:

- **ABG:** Hypoxemia (PaO2 <60 mmHg), acute respiratory alkalosis (PaCO2 <35 mmHg, pH >7.45)
- **CBC:** Leukocytosis (stress or infection), eosinophilia (rare, e.g., LAM)
- **D-dimer:** Elevated in trauma or secondary causes (e.g., PE)
- **Advanced:** Procalcitonin (if infection suspected), genetic testing (Marfan, Birt-Hogg-Dubé)

Imaging:

- **CXR:** Gold standard; visceral pleural line, absent peripheral lung markings. Tension: Mediastinal shift, diaphragmatic inversion
- **CT Chest:** Detects small pneumothorax, bullae, or rare causes (e.g., LAM, esophageal rupture)
- **Ultrasound:** Absence of lung sliding, barcode sign, lung point; sensitivity 90% in trauma
- **Advanced:** HRCT for SSP (e.g., cystic fibrosis), PET-CT for malignancy-related pneumothorax

Other:

- **EKG:** Tension pneumothorax may show right axis deviation, low QRS voltage, or pseudo-infarction patterns
- **Pleural fluid analysis:** If hemopneumothorax, chylothorax (LAM)

Diagnosis

Criteria:

Clinical presentation (acute chest pain, dyspnea) + imaging confirmation (CXR: pleural line; US: no lung sliding).

Differential:

Pulmonary embolism, myocardial infarction, rib fracture, esophageal rupture.

Flowsheet:

Step 1: Stabilize ABCs: Hypoxia (SpO2 <90%) → High-flow O2; hypotension → Needle decompression if tension suspected

Step 2: CXR: Confirm pneumothorax; measure size (<2 cm rim = small, >2 cm = large)

Step 3: History/Exam: Classify as PSP, SSP, traumatic, or iatrogenic; check for tension (JVD, tracheal deviation)

Step 4: Advanced Imaging: CT if CXR inconclusive, SSP, or rare cause suspected (e.g., LAM)

Step 5: Rule Out Mimics: EKG (MI), D-dimer (PE), CT (esophageal rupture)

Treatment

General Principles:

Restore lung expansion, alleviate symptoms, prevent recurrence, and address underlying causes.

Supportive Care:

- High-flow oxygen (10-15 L/min non-rebreather) to accelerate air reabsorption (4x faster with O2)
- **Pain control:** Ketorolac 15-30 mg IV q6h (avoid in trauma), morphine 2-4 mg IV PRN
- **Positioning:** Semi-Fowler's to reduce dyspnea

Specific Therapies:

- **Small PSP (<2 cm, SpO2 >90%):** Observation, supplemental O2, repeat CXR q12-24h
- **Large PSP or SSP:** Needle aspiration (16G catheter) or small-bore chest tube (14-16 Fr, pigtail catheter)
- **Tension Pneumothorax:** Immediate needle decompression (14G, 2nd intercostal space, midclavicular line), followed by large-bore chest tube (28-32 Fr)
- **Recurrent or Persistent:** Video-assisted thoracoscopic surgery (VATS) with blebectomy and chemical pleurodesis (talc, doxycycline)
- **Rare Causes:** Treat underlying condition (e.g., tamoxifen for LAM, ATT for TB)
- **Advanced:** Autologous blood patch pleurodesis for persistent air leak, bronchial valve for bronchopleural fistula

Monitoring:

- CXR q24h to confirm re-expansion
- Water-seal trial before chest tube removal
- Daily assessment for subcutaneous emphysema, air leak

Complications

Acute:

Tension pneumothorax: Mediastinal compression, shock (mortality 10-20% if untreated)

Re-expansion pulmonary edema: Rapid drainage causes unilateral edema (1-2% risk)

Hemopneumothorax: Bleeding from torn vessels, common in trauma

Long-Term:

Recurrence: 30-50% in PSP without intervention, higher in SSP

Chronic pleural scarring: From repeated pneumothorax or pleurodesis

Rare: Bronchopleural fistula, trapped lung syndrome

Clinical Scenarios

Case 1: Primary Spontaneous Pneumothorax

- Presentation:28 y/o M, smoker, presents with acute left-sided chest pain and shortness of breath for 2 hours. Vitals: BP 125/80, HR 95, SpO2 91%, RR 22. Exam: Decreased left breath sounds, hyperresonance.
- Labs/Studies:**CXR:** 3 cm left apical pneumothorax. ABG: PaO2 68 mmHg, PaCO2 30 mmHg.
- Interpretation:Large PSP, hemodynamically stable.
- Management:Small-bore chest tube (14 Fr), O2 4 L/min, ketorolac 30 mg IV q6h. CXR day 2 shows resolution. Discharge with VATS referral and smoking cessation counseling.

Case 2: Tension Pneumothorax (Iatrogenic)

- Presentation: 65 y/o F, post-central line placement, develops sudden right-sided pain, hypotension (BP 85/50), and cyanosis. Exam: Tracheal deviation left, JVD, absent right breath sounds.
- Labs/Studies: **CXR:** Large right pneumothorax, mediastinal shift. EKG: Right axis deviation.
- Interpretation: Iatrogenic tension pneumothorax, critical.
- Management: Immediate needle decompression (14G, 2nd ICS), then large-bore chest tube (28 Fr). Norepinephrine 5-10 mcg/min. ICU admission. CXR confirms lung re-expansion.

Case 3: Secondary Pneumothorax (Rare Cause)

- Presentation: 35 y/o F with recurrent pneumothorax, history of pneumothorax during menses. Vitals: BP 110/70, HR 88, SpO2 93%. Exam: Decreased right breath sounds.
- Labs/Studies: **CT:** Right pneumothorax, pelvic endometriosis. Pleural fluid: Bloody (catamenial).
- Interpretation: Catamenial pneumothorax (endometriosis-related SSP).
- Management: Chest tube (16 Fr), O2 6 L/min, consult OBGYN for hormonal therapy (GnRH agonist). VATS planned for pleurodesis.

Expert Tips

- Use ultrasound in trauma settings; CXR misses 20-30% of small pneumothoraces
- Avoid large-bore chest tubes in PSP; pigtail catheters (14-16 Fr) are equally effective with less pain
- Suspect catamenial pneumothorax in women with recurrent pneumothorax tied to menses; check pelvic CT
- Monitor for re-expansion edema (dyspnea, unilateral infiltrates) within 24h of chest tube; treat with diuretics, O2
- In SSP, investigate underlying lung disease (e.g., HRCT for cystic fibrosis, alpha-1 antitrypsin levels)
- **Pitfall:** Misinterpreting esophageal rupture as pneumothorax; look for mediastinal air, pleural effusion on CT

Key Pearls

- CXR is first-line; visceral pleural line confirms diagnosis
- Tension pneumothorax requires immediate needle decompression before imaging if unstable

- Small PSP can be managed conservatively with O2; large PSP/SSP needs intervention
- Recurrence risk is high (30-50%) without VATS; counsel on smoking cessation
- Rare causes like LAM or catamenial pneumothorax require multidisciplinary care

References

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ATS/ERS Guidelines: “Pneumothorax Management” (2023)

Chest: “Catamenial Pneumothorax: A Review” (2024)

Thorax: “Ultrasound in Pneumothorax Diagnosis” (2023)

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