Pulmonary Patient Care Problems
“Can't Breathe” Air Leak Syndromes
Pulmonary Hypertension
Cor pulmonale

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CMC
A. Acute Coronary Syndrome
B. Dysrhythmias
C. Heart Failure
D. Other Cardiac Issues
  1. Cardiomyopathies
  2. Pulmonary Hypertension
  3. Vascular Issues
E. Acute Pulmonary Embolus
F. Acute Respiratory Failure
G. Acute Lung Injury (ALI/ARDS)
H. Cor Pulmonale
I. Pneumothorax
J. Hemotorax

Cardiac Patient Care Problems (47%)
Other Patient Problems (21%)

CSC
- Air Leak Syndromes
- Pulmonary Vasodilators

Air Leak Syndromes
Pneumothorax
Pneumopericardium
Pneumomediastinum

Pneumothorax
- Air in the pleural space that inhibits complete lung expansion
- A thin, white line represents the displaced visceral pleura

Normal Chest X-ray
- Pleural is only able to be identified if separated from the thoracic lining by fluid or air
Pneumothorax

- Causes:
  - Direct injury to the lung during surgery
  - Line insertion causing tear in lung
  - Baratrauma during positive pressure ventilation
  - Occurs more on left due to LIMA dissection (CABG pt)
- Treatment:
  - Chest tube insertion if greater than 0 – 15%
  - If tension pneumothorax ----- it is a medical EMERGENCY and needs immediate needle decompression

Tension Pneumothorax

- Distended neck veins
- Hypotension
- Tracheal deviation
Note compressed swan gazz

Classifications of air leak syndromes
1. Primary pneumothorax
2. Secondary pneumothorax
3. Iatrogenic pneumothorax
4. Pneumomediastinum
5. Pneumopericardium
6. Hydropneumothorax

Primary Spontaneous Pneumothorax (PSP)

- Occurs without a precipitating event in a person who does not have lung disease
- Actually, most individuals with PSP have unrecognized lung disease
**Primary Spontaneous Pneumothorax**

- **Incidence**
  - 7.4 per 100,000
  - Greater in men than women
- **Risk Factors**
  - Smoking
  - Family History
  - Marfan’s Syndrome
  - Homocystinuria
  - Thoracic endometriosis

**PSP Clinical Presentation**

- Usually occurs at rest
- Sudden onset of dyspnea and pleuritic chest pain
- Symptoms related to the volume of air in the pleural space
- **Hypoxemia**
- Rarely hypercapnia – no underlying lung disease
- Acute respiratory alkalosis if pain, anxiety and hypoxemia
- Age = early 20’s, rare after 40

**PSP Treatment**

- **Initial**
  - Removal of air from the pleural space
  - Needle aspiration, if small
  - Chest tube, if large
  - Supplemental oxygen
- **Subsequent**
  - Preventing reoccurrence
  - Reoccurrence is 35 – 54%

**PSP Treatment: Supplemental Oxygen**

- Air in the pleural space is reabsorbed when the communication between the alveoli and the pleural space (air leak) closes.
- Supplemental oxygen markedly increases the rate of reabsorption

**PSP: Persistent Air leak after 3 days**

1. Heimlich valve
2. Infusing autologous blood into the pleural space
3. Video-Assisted Thoracoscopy (VAT) to oversee the area of the leak and perform pleurodesis
Heimlich Valve

- One way valve
- Can be discharged
- Call 911 if sudden sharp chest pain and severe shortness of breathe

Video Assisted Thoracoscopy (VATS) Pleurodesis

- Pleurodesis:
  - Mechanical or chemical irritation between the parietal and the visceral layers of the pleura to close off the space between them and prevent further air or fluid from accumulating

Pleurodesis

- Mechanical
  - Parietal pleurectomy
  - Laser abrasion of the parietal pleura
  - Pleural abrasion with dry gauze
- Chemical
  - Intrapleural instillation of a chemical irritant – usually tetracycline derivative or talc

Case Study

- 18 y/o female walking up a hill and felt a “pop” in chest
- Abruptly becomes SOB and severe stabbing pain in left chest area
- Couldn’t take deep breaths
- Pain eventually subsided and whole lung area felt weak and bruised

Next day

- Walking on college campus and had to stop 2 - 3 times during the walk
- Breathing was labored and pain was stabbing.
- Came to ED

Dx: Spontaneous Pneumothorax

- 90% collapse of left lung
- Chest tube inserted
- Resolved after several days
- No family history
PMH

- Looking back as a senior was running sprints on a really cold windy day. I felt something "pop" in my chest and couldn't take deep breaths.
- Stopped running, went home, rested. Just felt "tight/bruised" feeling.
- Now questions if it was a small pneumothorax.
- Had a few more of these episodes in HS

Medical workup

- Found underlying asthma

A year later...

- Walking, Abruptly becomes SOB and severe right chest pain
- Dx: spontaneous right pneumothorax (90%)
- Chest tube inserted
- Took 10 days to resolve
- "There was just a moment when I just knew that it had closed"

Another year later --- age 20

- Tubing in the ocean waves
- Sudden stabbing pain in left lung
- Xray: 10% pneumothorax that resolved on its own.

Treatment

- Inhalers for asthma and steroid inhaler for next 10 years
- Kinesiologist: natural supplements to boost the adrenal system
- Now at age 42, off inhalers and has not had any further episodes

Secondary Spontaneous Pneumothorax (SSP)

- A pneumothorax that occurs as a complication of an underlying lung disease
- Can be a complication of any lung disease. Most often occurs with:
  - COPD
  - Pneumocystis jirovecii infection
  - Cystic fibrosis
  - Tuberculosis
SSP Clinical Presentation
- C/O of dyspnea and chest pain on the same side as the pneumothorax
- Symptoms more severe than with PSP as SSP patients have less pulmonary reserve due to the underlying lung disease.
- Persistent air leaks are more common and tend to persist longer than PSP

SSP Treatment
- Should be hospitalized: diminished pulmonary reserve increases their risk for adverse outcomes.
- Initial Treatment
  - Chest tube insertion
  - Chest tube should remain in place until a procedure if performed to prevent recurrent SSP

SSP: Prevention of recurrence
- Video-Assisted Thoracoscopic (VAT) with stapling of blebs and pleural abrasion.
- Chemical pleurodesis
- Pleural Blood Patch
- Heimlich valve

Case Study # 2
63 y/o white male (RK) comes to ED with SOB and left sided chest pain for the past hour
- Woke up “feeling weird” and felt very SOB
- The left sided chest pain, which does not radiate, started when the SOB started.
- The pain is mildly sharp and stabbing in quality

PMH
- COPD – wears continuous oxygen at home
- CHF
- AAA repair
- Hx PE
- PVD
- Idiopathic thrombocytopenia purpura
- Antiphospholipid antibody syndrome
- Recurrent small bowel syndrome

BP 136/77
- HR 134, regular
- RR 32
- Temp 97 oral
- SpO2 91% on 15 liters nonrebreather
- Pain 7/10
Patient did not go to surgery for deoritication due to pulmonary hypertension – poor surgical candidate
Sent home with Heimlich valve

PSP and SSP – high risk activities

- Patients with resolving pneumothorax should be cautioned not to fly until intrapleural air has completely resolved.
- Deep sea diving should be avoided unless thoracotomy or pleurodesis has been performed

Case Study

Ms Syncope came to the ED because of an episode of lightheadedness today that caused her to fall to the ground. There was no actual LOC.
She was working in the garden at the time and also had a mild pressure sensation over her chest which is still present in ED.

It is 6 hours post Ms Syncope’s pacemaker insertion via the left subclavian.
She is complaining of dyspnea and pain on left side of chest
No lung sounds on left side
CXR ordered
**Iatrogenic Pneumothorax**
- Medical procedure resulting in traumatic pneumothorax

**Iatrogenic Pneumothorax Causes**
- Transthoracic needle aspiration procedures
- Subclavian and supraclavicular needle sticks
- Thoracentesis
- Mechanical ventilation related to peak airway pressures
- Pleural biopsy
- Transbronchial lung biopsy
- CPR
- Tracheostomy

**Traumatic Pneumothorax**
- Blunt trauma from motor vehicle accident, falls, blows to chest, penetrating chest trauma, or blast injuries results in tear in pleura and causes pneumothorax

**Iatrogenic & Traumatic Pneumothorax Treatment**
- Needle Aspiration
- Chest Tube insertion
- Recurrence is not usually a factor

**Open Communicating Pneumothorax**
- Also called Sucking Chest Wound
- Air enters the intrapleural space through the chest wall
- Cause: Penetrating trauma
Pneumomediastinum
- Air in the mediastinal soft tissues
- Pneumothorax may occur secondary to pneumomediastinum

Pneumomediastinum Causes
- Rupture of alveoli
- Acute production of high intrathoracic pressures (inhaled drug use)
- Smoking marijuana
- Inhalation of cocaine
- Asthma
- Respiratory tract infection
- Vomiting or severe coughing
- Mechanical ventilation
- Trauma or surgical disruption of the oropharyngeal, esophageal, or respiratory mucous

Pneumomediastinum Clinical Presentation
- May or may not have symptoms
- SQ emphysema
- Hammas sign
  - Precordial crunching noise synchronous with the heart beat
- Severe chest pain below the sternum that may radiate to the neck or arms
- Hypotension may occur due to compression of the veins from the air.

Pneumopericardium
- Air in the pericardial sac
- Same hemodynamic instability as tamponade
Tension Pneumothorax & Pneumopericardium

- Pt (MR) on ECMO
- BP dropped
- PAS/PAD & CVP pressures equalized within a few minutes

Mediastinal chest tubes can cause air to enter into mediastinum or pericardium to cause pneumomediastinum or pneumopericardium

Pneumoperitoneum

- The presence of air within the peritoneal cavity.
- Most common cause is a perforation of the abdominal viscus — a perforated ulcer

In Summary Air Leak Syndromes

- PSP
  - no underlying lung disease
  - Seen in young adults
- SSP
  - Usually caused by underlying lung disease
  - More severe due to already compromised lung state
  - Both may need treatment to prevent recurrence
  - Apex chest tubes for pneumos as air rises
  - Keep suction on chest tubes

Air Leak Syndromes: Be Prepared to immediately assist to insert a chest tube!
Nursing Care of Chest Tubes

- Bubbling in the water seal chamber indicates air leak
- If suction is ordered for PSP or SSP, keep suction going even when ambulating!

PSP and SSP – high risk activities

- Patients with resolving pneumothorax should be cautioned not to fly until intrapleural air has completely resolved.
  - Deep sea diving should be avoided unless thoracotomy or pleurodesis has been performed

Clinical manifestations

- Enlargement of the right ventricle (either dilatation or hypertrophy) from pulmonary pathology
- Diseases of the lung like COPD
- Diseases of the pulmonary circulation
  - Pulmonary hypertension
  - Thromboembolic disease

Other Pulmonary Problems
Enlargement of RV from ↑ pulmonary resistance

Clinical Presentation
- Right sided Heart Failure
  - JVD
  - Hepatomegaly
  - Peripheral edema
- Jugular venous pulsation
  - Associated with prominent ‘a’ wave secondary to ↓ RV compliance
- Prominent V wave on right atrial tracing from tricuspid regurgitation
- Right sided failure symptoms

Cor Pulmonale

Clinical Management
- Oxygen – pulmonary vasodilator
  - ↓ PVR and ↑ RV stroke volume
- Diuretics – if congested
- Inotropes may be used with vasodilators
- Phlebotomy if polycythemia (HCT > 60%)

Pulmonary specific vasodilators
- IV
  - Nitroglycerin
  - Sodium nitroprusside (Nipride)
  - Prostaglandins (PG1, PG2)
  - PDE1 (phosphodiesterase enzyme)
- Inhaled
  - Any of the above IV medications
  - Nitric oxide
  - Prostacyclin (PG1, Epoprostenol, Flolan) or derivative iloprost

Polycythemia (HCT > 60%)
- Polycythemia may result from an increased erythropoietin (EPO) production in response to chronic hypoxia
  - COPD, HF, pulmonary hypertension, sleep apnea
- Treatment
  - Phlebotomy

Pulmonary Hypertension
- High blood pressure in the arteries that supply lungs and right side of the heart
  - MPAP > 25 mmHg at rest
  - MPAP > 30 mmHg with exercise
  - PAOP or LAP < 15 mmHg
- One of the most serious, progressive, and potentially life-threatening condition of the pulmonary vascular.

Heart Sounds
- S4
- Palpable left parasternal lift
- Murmurs if tricuspid or pulmonic insufficiency
- Echo
  - Right sided abnormalities
  - EKG
    - Right axis deviation
    - Right atrial enlargement – tall P waves
    - RBBB
    - Right precordial T wave inversion
Normal Pulmonary Vasculature

Pathophysiology

1. Pulmonary system is high-flow, low-pressure and low resistance system
2. Has the ability to enlist unperfused vessels of the pulmonary vascular when needed
3. Small changes in the pulmonary vessels have a profound effect on resistance

Primary Pulmonary Hypertension

Pathophysiology

1. Pulmonary vasoconstriction and hypertrophy of vascular smooth muscle
   - Occurs early
   - May be the result of the initial endothelial cell injury
2. Formation of fibrous constriction around the vessels → intimal thickening
3. Small pulmonary arteries become narrow or obliterated
4. ↑ pulmonary artery resistance (PVR)
5. ↑ workload on right ventricle
6. Right ventricular hypertrophy
7. Right ventricular failure

Secondary Pulmonary Hypertension

Pathophysiology

Active
1. Hypoxemia → pulmonary vasoconstriction
2. ↑ RV workload
3. RV hypertrophy
4. RV failure
Passive
1. Back pressure from LV failure or mitral valve disease
2. Pulmonary vascular engorgement
3. ↑ pulmonary pressures
4. ↑ RV workload
5. RV hypertrophy
6. RV failure

Pulmonary Hypertension

Clinical Presentation

- Dyspnea on exertion
- Limited exercise capacity
- Fatigue
- Weakness
- Ortner syndrome
  - Hoarseness – dilated pulmonary compresses the recurrent laryngeal nerve

- Abnormal pulmonary pressures
  - MPAP > 25 mmHg at rest
  - MPAP > 30 mmHg with exercise
  - PAOP or LAP < 15 mmHg
  - PVR > 250 dynes/sec/cm

- RV hypertrophy and right sided valvar signs and symptoms

- Clinical symptoms

- MPAP > 25 mmHg at rest
- PAOP or LAP < 15 mmHg
- MPAP > 30 mmHg with exercise

Pulmonary Vascular Resistance (PVR)

Definition:
A measurement of impedance to right ventricular ejection.

Equation: \( PVR = \frac{MPA - PCW}{CO} \times 80 \)

Normal Range: 40 – 220 dyne.sec.cm\(^5\)
### Know Normal Values!

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Output (CO)</td>
<td>4 – 8 l/min</td>
</tr>
<tr>
<td>Cardiac Index (CI)</td>
<td>2.5 – 4.2 l/min/m²</td>
</tr>
<tr>
<td>Right atrial pressure (CVP)</td>
<td>0 – 8 mmHg</td>
</tr>
<tr>
<td>Pulmonary artery pressure (PAS/PAD)</td>
<td>15 – 30/6 – 12 mmHg</td>
</tr>
<tr>
<td>Pulmonary artery occlusive pressure</td>
<td>4 – 12 mmHg</td>
</tr>
<tr>
<td>Systemic vascular resistance (SVR)</td>
<td>770 – 1500 dynes/sec/cm²</td>
</tr>
<tr>
<td>Pulmonary vascular resistance (PVR)</td>
<td>20 – 120 dynes/sec/cm²</td>
</tr>
<tr>
<td>Stroke Volume (SV)</td>
<td>60 – 130 mL/beat</td>
</tr>
<tr>
<td>Stroke Volume Index (SVI)</td>
<td>30 – 65 mL/beat/m²</td>
</tr>
<tr>
<td>Arterial oxygenation saturation</td>
<td>95 – 100 %</td>
</tr>
<tr>
<td>Venous oxygenation saturation</td>
<td>60 – 80 %</td>
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(Adapted from Cardiac Sonography Essentials, page 148)

### Pulmonary Hypertension

#### Clinical Management

- Reverse or inhibit the three primary abnormalities of vasoconstriction, smooth muscle proliferation, and vascular remodeling
- ↓ PAP and PVR
- Improve RV function
- Energy conservation methods
- Moderate exercise to avoid overexertion

↓ PAP and PVR

### Factors That Decrease Pulmonary Vascular Resistance

**Pharmacologic Agents**

- Oxygen
- Isoproterenol
- Aminophylline
- Calcium channel blocking agents
- Nitrous Oxide

**Humoral Substances**

- Acetylcholine
- Bradykinin
- Prostaglandin E
- Prostacyclin
- Sildenafil (Viagra)

### PE Symptoms

Refer to Panvascular lecture

**PE - sudden onset**

- Symptoms depend on severity
- Dyspnea/Tachypnea - use of accessory muscles
- Tachycardia
- Pallor or cyanosis
- Sharp, pleuritic chest pain - worse with deep inspiration
- Anxiety - feeling of impending doom

Major PE – one causing hemodynamic instability is an ominous emergency!

### Day 1 – You made it!

![Finish Line](image)

### Marathon Runners create a training plan

- Create your study plan...