Pulmonary Patient Care Problems

"I 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**
   - Cardiomyopathies
   - **Pulmonary Hypertension**
E. Vascular Issues

A. **Acute Pulmonary Embolus**
B. Acute Respiratory Failure
C. Acute Lung Injury (ALI/ARDS)
D. **Cor Pulmonale**
E. **Pneumothorax**
F. **Hemothorax**

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

CSC

- Air Leak Syndromes
- Pulmonary Vasodilators

Air Leak Syndromes

Pneumothorax
Pneumopericardium
Pneumomediastinum

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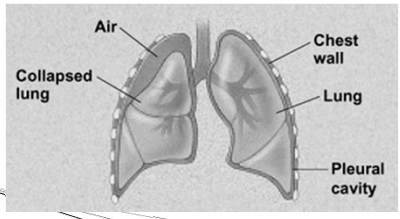
Pneumothorax

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



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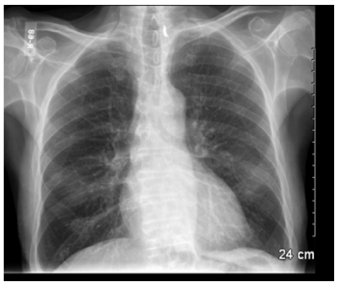
Normal Chest X-ray

- Pleural is only able to be identified if separated from the thoracic lining by fluid or air



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- Left Pneumothorax on CT scan
- 7-16 AK

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Pneumothorax

- Diminished or absent lung sounds over the affected lung
- Dyspnea
- Tachypnea
- Acute pain on affected side of the chest
- Decreased $Sp0_2$ & $p0_2$
- Subcutaneous emphysema
- Black area over lung field with no lung markings on CXR

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 disection (CABG pt)
- Treatment:
  - Chest tube insertion if greater than 10 – 15 %
  - If tension pneumothorax ---- it is a medical **EMERGENCY** and needs **immediate** needle decompression

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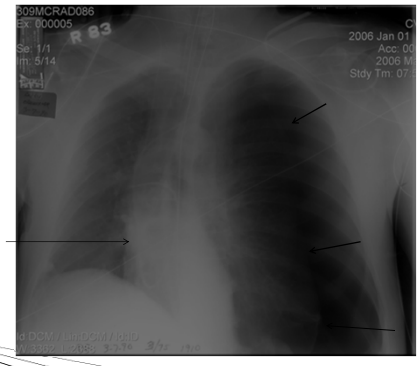
Tension Pneumothorax

- Distended neck veins
- Hypotension
- Tracheal deviation

Note compressed swan ganz



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Classifications of air leak syndromes

1. Primary pneumothorax
2. Secondary pneumothorax
3. Iatrogenic pneumothorax
4. Pneumomediastinum
5. Pneumopericardium
6. Hydropneumothorax

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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

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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

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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

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PSP Treatment

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

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PSP Treatment

- If after 6 hours the pneumothorax reabsorbs, patient may be sent home
- Needs to live close to emergency medical center if d/c in 6 hours.

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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

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PSP: Persistent Air leak after 3 days

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

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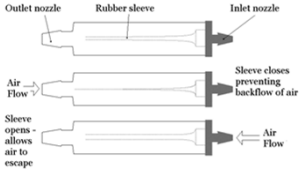
Heimlich Valve

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



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Video Assisted Thoracosopy (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

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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

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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

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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

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Dx: Spontaneous Pneumothorax

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

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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

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Medical workup

- Found underlying asthma

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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"

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Another year later --- age 20

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

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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

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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

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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

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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

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SSP: Prevention of recurrence

- Video-Assisted Thoracoscopy (VAT) with stapling of blebs and pleural abrasion.
- Chemical pleurodesis
- Pleural Blood Patch
- Heimlich valve

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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

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PMH

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

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- BP 136/77
- HR 134, regular
- RR 32
- Temp 97 oral
- SpO2 91% on 15 liters nonrebreather
- Pain 7/10

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- Patient did not go to surgery for decoritication due to pulumonary hypertension – poor surgical candidate
- Sent home with Heimlich valve

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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

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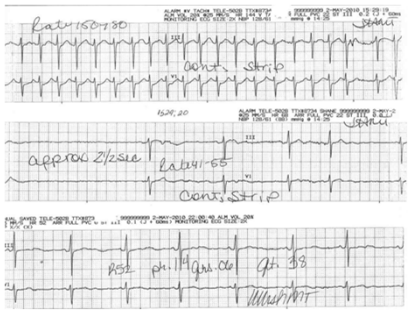
Case Study

- 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.

- Diagnosis: Tachybrady Syndrome
- Treatment : Pacermaker insertion



- 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 shest
- No lung sounds on left side
- CXR ordered

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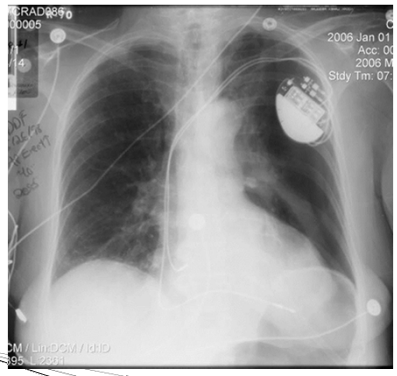

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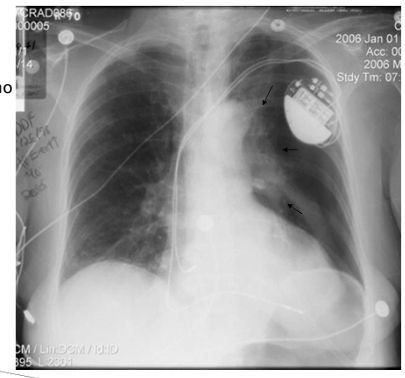
- Left pneumo from pacer insertion



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Iatrogenic pneumothorax

- Medical procedure resulting in traumatic pneumothorax

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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

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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

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Iatrogenic & Traumatic Pneumothorax Treatment

- Needle Aspiration
- Chest Tube insertion
- Recurrence is not usually a factor

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Open Communicating Pneumothorax

- Also called Sucking Chest Wound
- Air enters the intrapleural space through the chest wall
- Cause: Penetrating trauma

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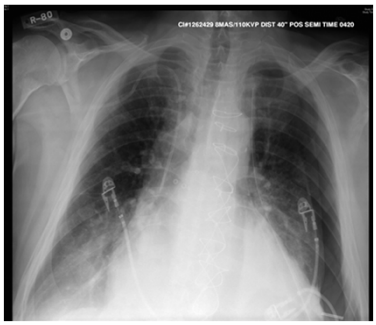
- Patient became severely dyspnic after CXR.
- CT was accidentally disconnected from bottle during CXR.



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Pneumomediastinum

- Air in the mediastinal soft tissues
- Pneumothorax may occur secondary to pneumomediastinum

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Pneumomediastinum Causes

- Rupture of alveoli
- Acute production of high intrathoracic pressures (inhalational 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

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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.

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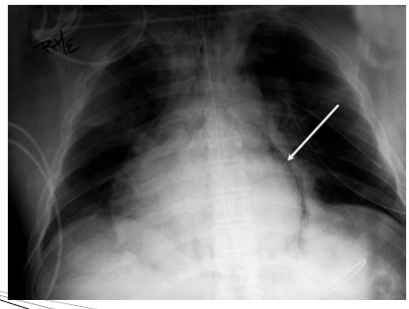
Pneumomediastinum after severe vomiting, Cardiopulmonary arrest → OR for repair of ruptured esophagus



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Pneumopericardium

- Air in the pericardial sac
- Same hemodynamic instability as tamponade

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Tension Pneumothorax & Pneumopericardium

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

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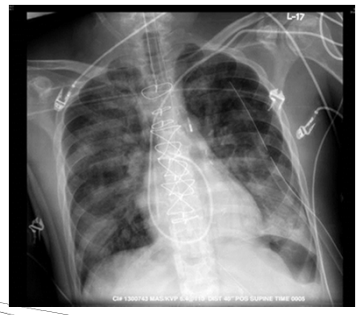
After chest tube inserted Pneumothorax & Pneumopericardium starting to resolve

- Pt (MR)



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

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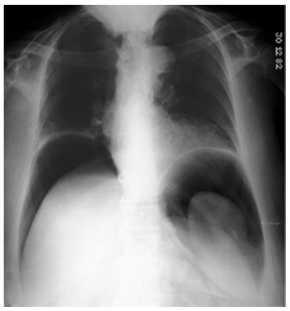
Pneumoperitoneum

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



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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

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Air Leak Syndromes: Be Prepared to immediately assist to insert a chest tube!

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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!

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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

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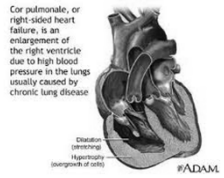
Other Pulmonary Problems

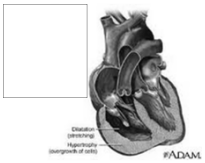
Cor Pulmonale

- 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



Cor Pulmonale

Pathophysiology



1. Increase in pulmonary vascular resistance
2. Causes increase in pulmonary pressures
3. Results in increased RV workload
4. RV increases

Enlargement of RV from ↑ pulmonary resistance

Cor Pulmonale

Clinical Presentation

- Right sided Heart Failure
  - JVD
  - Hepatomegaly
  - Peripheral edema
- Jugular venous palpitation
  - Associated with prominent "a" wave secondary to ↓ RV compliance
- Prominent V wave on right atrial tracing from tricuspid regurgitation
- 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

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 (PGE1, PGI2)
  - PDE1 (phosphodiesterase enzyme)
- Inhaled
  - Any of the above IV medications
  - Nitric oxide
  - Prostacyclin (PGI1, Epoprosternol, Flolan) or derivative Iloprost

Pulmonary specific vasodilators

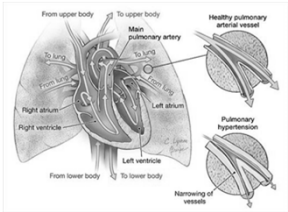
Polycythemia (HCT > 60%)

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

Unknown

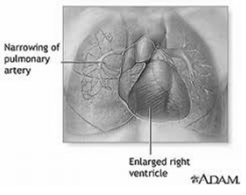
Pulmonary Hypertension

- 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.



Pulmonary Hypertension

- Primary
  - A rare disease that affects one to two people per million in the USA every year.
  - Most likely seen in women between the ages of 21 and 40
    - Oral contraceptives a risk factor
- Secondary
  - Arises as a result of some other underlying disease or factor
    - COPD, PE, MS, Tricuspid regurgitation, HIV. congenital defects – ASD/VSD



Comorbidity for Cardiac Surgery!

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

Comparison of Systemic and Pulmonary Vasculature

Systemic	Pulmonary
▸ Thick walled ▸ Heavily muscled ▸ Nondistensible ▸ Narrow lumina ▸ Dilate in response to acidemia & hypoxemia	▸ Thin walled ▸ Scant smooth muscle ▸ Distensible ▸ Wide lumina ▸ Constrict in response to acidemia & hypoxemia

Source: Moser & Riegel, Cardiac Nursing 2008

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

Pulmonary vasoconstriction, ↑ PVR , RV hypertrophy

Secondary Pulmonary Hypertension

Pathophysiology

Active
1. Hypoxemia → pulmonary vasoconstriction
   - *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^{-5}
- RV hypertrophy and right sided valvular signs and symptoms

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

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.cm5

Know Normal Values!

Parameter	Normal Values
Cardiac Output (CO)	4 – 8 l/min
Cardiac Index (CI)	2.5 – 4.2 l/min/m^2
Right atrial pressure (CVP)	0 – 8 mmHg
Pulmonary artery pressure (PAS/PAD)	15 – 30/6 –12 mmHg
Pulmonary artery occlusive pressure	4 – 12 mmHg
Systemic vascular resistance (SVR)	770 – 1500 dyne/sec/cm^5
Pulmonary vascular resistance (PVR)	20 – 120 dyne/sec/cm^5
Stroke Volume (SV)	60 –130 mL/beat
Stroke Volume Index (SVI)	30 – 65 mL/beat/m^2
Arterial oxygenation saturation	95 – 100 %
Venous oxygenation saturation	60 – 80 %

Source: Sited in Cardiac Surgery 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

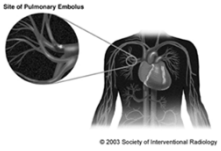
↓ PAP and PVR

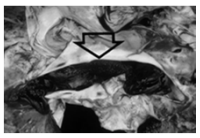
Factors That Decrease Pulmonary Vascular Resistance

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 accessary 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!

Marathon Runners create a training plan

- Create your study plan…