

### Notes

All body systems depend on adequate O<sub>2</sub>

**Purpose of breathing:** + O<sub>2</sub> & - CO<sub>2</sub>

### Oxygenation

Includes...

- Ventilation - Gas exchange
- Hgb & RBC transport

**ATP production** is vital for cell activity & life

*Cellular hypoxemia* impairs the cell's energy production, disrupts cell function

Acute lung tissue is at the alveolar-capillary membrane level

### Mechanics of Breathing

Concepts of airway resistance, lung compliance, opposing lung forces

**Inspiration:** chest wall muscles contract, inc. intrapleural pressure = lung expands

**Expiration:** lung deflates passively

### Blood flow through the lungs:

- Bronchial
- Pulmonary: highly vascular capill. network

**Pulse ox:** measures O<sub>2</sub> bound to Hgb (3% plasma, 97% Hgb)

*Smoking* = carboxyHgb binds faster to Hgb

### Ventilation-Perfusion Ratios

V/Q Scans: r/o pulmonary embolus

**Dead space:** lung area has V/Q mismatch

- Do not participate in gas exchange
- Enough O<sub>2</sub> but not enough blood flow

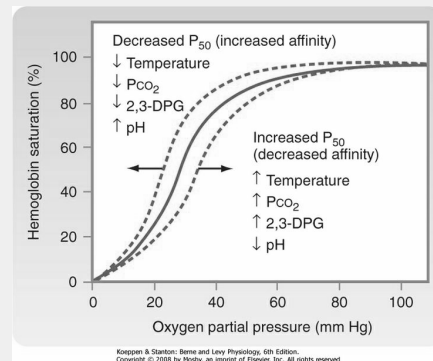
**Shunt:** blood bypasses alveoli w/o getting O<sub>2</sub>

**Silent unit:** pt can have dead space & shunt

**Hypoxemia:** not enough O<sub>2</sub> in the blood

**Hypoxia:** not enough O<sub>2</sub> in the tissues

### Oxygen-Hemoglobin Dissociation Curve



**Hgb saturation = oximetry**

**O<sub>2</sub> partial pressure (mm Hg) = paO<sub>2</sub>**

*Don't just get SpO<sub>2</sub> when acute, get ABG's!*

- pH is important
- Aerobic → anaerobic metabolism → lactic acid buildup
- Oximetry has a +/- 2 margin of error*

### Personal History Assessment

**Smoking (#1)** - how long, how much → might not be ready to hear it but responsible to inform about risks & complications

**Allergies** - year round, don't have to be allergic for things to affect breathing  
- Breathing in cold air is a very powerful irritant! (at least a cough)

**Drug use** - ACEI (cough), amiodarone (cough), beta-blockers (compete for B<sub>2</sub> sites)

**Travel** - TB, outside country, soil

**SES** - what's in home environment, pet hair, heating system in fall/winter

**Family Hx** - genetics (recurr./chronic, acute)

**Occupation** - if mask required, ventilation

### Respiratory Changes w/ Aging

**Chest wall:** stiffer, m/s issues → dec. compliance

**Pharynx & larynx:** muscles atrophy, airways lose cartilage, vocal cords start to slack

**Lungs:** lose elasticity → dec. compliance

**Alveoli:** lose starting at 35yo but breathing not impacted unless chronic disease present

**Pulmonary vasculature:** alveolar-capillary membrane thickens → impairs gas exchange

**Ciliary action:** move mucus & filter grunge (mucociliary exhalade)  
- Cilia paralyzed for 4 hr after every cigarette

### Subjective & Objective Data Assessment

#### SUBJECTIVE DATA

**Cough** - cardinal symptom of respiratory disease (6-8 wk = chronic)

**Sputum** - color? odor? changes? (normal = clear)

**CP** - assoc. w/ other things (GI, MI, etc.)

**Dyspnea:** length? onset? what helps? rate?

#### OBJECTIVE DATA

**General appearance:** visibly dyspneic? using accessory muscles (sternocleidomastoid, trapezius, intercostals)? position to breathe?

**Vital signs:** (later) all affected w/ work of breathing

**Physical assessment:** inspection, palpitation, percussion, auscultation  
- Always want extent to which you hear adventitious breath sounds

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### Diagnostic Evaluation

#### Laboratory Assessment

- RBC (r/t Hgb transport)
- Hgb
- Sputum (sample for antibiotics, C&S)
- ABG's (pH, CO<sub>2</sub> → hypo-/hyperventilating; acidic/acidotic; bicarb.)

Radiography                      CT scan

Pulse ox                              Capnography

PFT's                                  Bronchoscopy

Thoracentesis                      Lung biopsy

V/Q scan                              Etc.

### Radiography

**X-rays:** air = black / everything else = white

**CXR** - infiltrates, infusions, masses

- Daily in ICU for changes

### CT Scan

Thin slices, more specific than radiography

Often w/ contrast (more detailed)

- Assess allergies (shellfish, iodine), kidney function

### Pulse Oximetry

Measure of O<sub>2</sub> attached to Hgb; SpO<sub>2</sub> or SaO<sub>2</sub>

**Normal value: 95-100%**

Value affected by...

- Poor peripheral perfusion/cold
- Nail polish
- Same arm as BP cuff
- Applied correctly?

*Don't diagnose with value!*

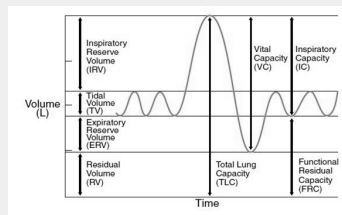
### Capnography

Measure of CO<sub>2</sub> in exhaled air, which correlates w/ arterial CO<sub>2</sub>

**Normal value = 20-40**

Now checking capnography w/ PCA pumps

### Pulmonary Function Tests (PFTs)



R/t volume and flow

Good way to track and trend where pts are

### Bronchoscopy

Insert scope to examine upper & lower airway

Invasive, need consent → time-out!

Therapeutic vs. diagnostic

**Labs:** platelets (CBC), PT/INR (clotting)

**NPO** 4-8 hr before

**Premedicate:** sedation, topical to paralyze cords

**VS & Assessment:** pre- & post-scope, infection, bleeding

- May cause perforation or pneumothorax
- Accessory muscles
- Asymmetrical expansion & breath sounds
- Acutely dyspneic
- Tachypneic
- Hypertensive

### Thoracentesis

Therapeutic (remove fluid) vs. diagnostic

Need consent, comfort pt

*Sterile procedure!*

**Pre & Post:** CXR, check puncture site, s/s of infection, VS, incentive spir. & deep breathe

**Assessment:** pneumothorax, pain on affected side, mediastinal shift → insert chest tube?

Upright, leaning → permits better access

### Lung Biopsy

**Purpose:** to obtain tissue sample for eval.

Various approaches:

- Transbronchial Bx (TBB)
- Endobronchial Bx (EBB)
- Mediastinoscopy
- Open lung Bx (general anesthesia)

Conscious sedation                      Fluoroscopy

**Pre:** CT for depth and density of mass

**Post:** gag reflex, VS (infection), pneumothorax, bleed, hemoptysis

### Ventilation-Perfusion (V/Q) Scan

Does ventilation match perfusion?

- Mismatch = ventilated not always perfused

**Low/moderate/high probability for risk of pulmonary embolus**

**Procedure:** pt gets inhaled nucleotide

### Mixed Venous O<sub>2</sub> Saturation (SVO<sub>2</sub>)

Get from pulmonary arterial line

**Purpose:** to eval. O<sub>2</sub> supply-demand balance

**Normal value = 60-80%**

Venous gas (60-80%) < arterial (80-100%)

- Easier sample, less painful
- What's going on at peripheral level

### Pulmonary Embolism

A collection of matter that enters venous circulation and into the lungs

**DVT's is a big risk!**

#### Pathophysiology:

- 1) Alveolar dead space inc. as blood shunted away
- 2) Vasoactive & bronchoconstrictive substances released → vasoconstriction → dec. blood flow to lungs → worsens PE
- 3) Pulmonary vascular resistance inc.
- 4) Pressure in pulmonary artery inc.
- 5) R ventricle workload inc.
- 6) CO dec. → systemic blood pressure dec.
- 7) Deoxygenated blood moves into arterial circulation → hypoxia & hypoxemia

**Depends on SIZE of blood clot!**

#### PE Risk Factors

Anything causing **venous stasis** - *varicose veins, inactivity (spinal cord/hip surgery), restrictive clothing, prolonged travel, obesity*

**Hypercoagulable** - *obesity, trauma, cancer, factor deficiencies, birth control (estrogen)*

**Venous endothelial disease** - *varicose veins, trauma, surgery, vascular vein disease*

**Smoking** - *inc. fibrinogen = inc. viscosity*

Change in **aging**

#### VIRCHOW'S TRIAD:

- (1) *venous stasis*
- (2) *hypercoagulability*
- (3) *venous endothelial damage/injury*

80-90% come from venous

### PE Clinical Manifestations & Physical Assessment

#### RESPIRATORY

**SOB/dyspnea (worsening)** - *tachypneic, cyanotic, use of accessory muscles, cough, restless, panicky, confused*

#### CARDIAC

**Tachycardia**                      **Early/late HTN**

**Pleuritic CP**                      **EKG changes**

**S3 or S4** (pooling, R-sided workload inc.)

**paCO2 inc.** = acidotic

#### PE Management Goals

1. Improve gas exchange
2. Improve lung perfusion
3. Dec. risk for further clot formation
4. Prevent complications

#### Anti-Coagulation

Administered ASAP for therapeutic effect

Length of time-variable

**Heparin** - usually autely (unless massive)  
 - **-Kinases** (antithrombotic)  
 - Bridge w/ **Warfarin (Coumadin)** - treat 3-6 months but depends on size & risk factors

Other agents:

- **Enoxaparin (Lovenox)**
- **Fondaparinux (Arixtra)**

Newer agents:

- **Rivaroxaban (Xarelto)**
- **Dabigatran (Pradaxa)**
- **Apixaban (Eliquis)**
- **Endoxaban (Savaysa)**

**Pro:** infrequent labs / **Con:** no quick reversal

### PE Diagnostic Evaluation

Suggestive, not definitive

Diagnosed w/ **diagnostic tests, Sx, & labs**

**Labs** - CK, CRP, ESR, D-Dimer

**Radiology/CT, TEE** (cardiac assess)

**V/Q scan** - now more pulm. angiography

**D-Dimer:** *protein fragment active w/ clots*

#### PE Treatment

**O2 therapy** - *fix hypoxemia (vent/mask/NC)*

**Anti-coagulation, Thrombolytic agents**

**Surgery (embolectomy) & Filters** (*break up traveling clots; temporary or permanent*)

**Ekos:** *endo catheter through blood vessels to deliver clot-busting med &/or break up clot*

#### Strategies to Prevent PE's

**Early mobilization, Freq. position changes**

**Active/passive ROM**

**TEDs & SCDs**

**Avoid tight clothes** - *esp. popliteal area*

**Lifestyle changes** - *obesity/wt loss, smoking, birth control, activity, diet (salads), hydration, medic alert bracelets*

**Anti-coagulation therapy** - *PT/INR, UFH*

**Avoid valsalva maneuver** → *laxatives*

**Assessment/eval of peripheral circulation** - *color, temp., & sensation in extremities*

**Bleeding precautions** - *electric razors, hold pressure, scissors & knives*

**Heparin-Induced Thrombocytopenia (HIT):**  
*heparin antibodies develop → bind to pH & activate thrombin (→ develop clots)*

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