## Notes

All body systems depend on adequate $O_2$

**Purpose of breathing**: *+ $O_2$ & - $CO_2$*

## 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 $O_2$ 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 $O_2$ but not enough blood flow

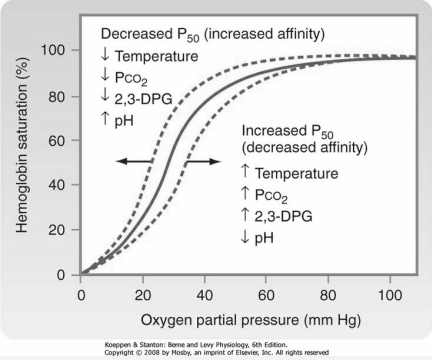
**Shunt**: *blood bypasses alveoli w/o getting $O_2$*

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

**Hypoxemia**: *not enough $O_2$ in the blood*

**Hypoxia**: *not enough $O_2$ in the tissues*

## Oxygen-Hemoglobin Dissociation Curve




**Hgb saturation = oximetry**
**$O_2$ partial pressure (mm Hg) = $paO_2$**
*Don't just get $SpO_2$ 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 $B_2$ 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 adventitous 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, $CO_2$ → 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 $O_2$ attached to Hgb; $SpO_2$ or $SaO_2$

**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!*

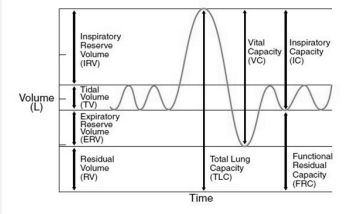
## Capnography

*Measure of $CO_2$ in exhaled air, which correlates w/ arterial $CO_2$*

**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
- Asymmetical 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 O2 Saturation (SVO2)

Get from pulmonary arterial line

**Purpose**: *to eval. $O_2$ 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. bood 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** - *vericose veins, inactivity (spinal cord/hip surgery), restrictive clothing, prolonged travel, obesity*

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

**Venous endothelial disease** - *vericose 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** (antithrombolytic)
- 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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