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

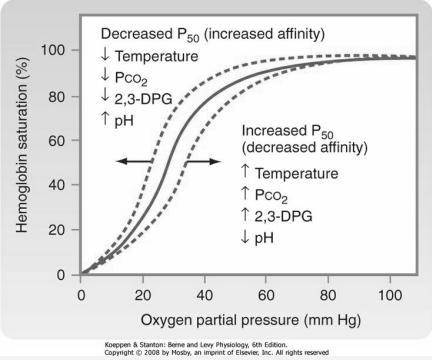
Shunt: *blood bypasses alveoli w/o getting O_2*

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!

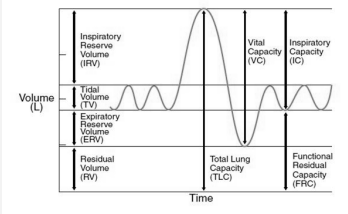
Capnography

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

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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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