

Notes

All body systems depend on adequate O₂

Purpose of breathing: + O₂ & - CO₂

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 O₂ 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 O₂ but not enough blood flow

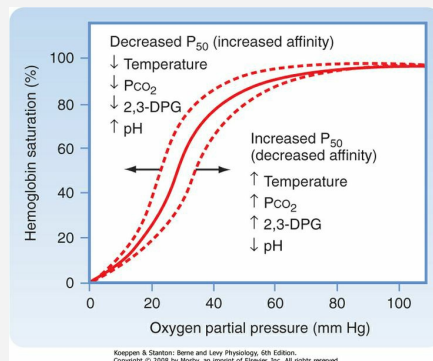
Shunt: blood bypasses alveoli w/o getting O₂

Silent unit: pt can have dead space & shunt

Hypoxemia: not enough O₂ in the blood

Hypoxia: not enough O₂ in the tissues

Oxygen-Hemoglobin Dissociation Curve



Hgb saturation = oximetry

O₂ partial pressure (mm Hg) = paO₂

Don't just get SpO₂ 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 B₂ 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

Diagnostic Evaluation

Laboratory Assessment

- RBC (r/t Hgb transport)
- Hgb
- Sputum (sample for antibiotics, C&S)
- ABG's (pH, CO₂ → 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 O₂ attached to Hgb; SpO₂ or SaO₂

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!

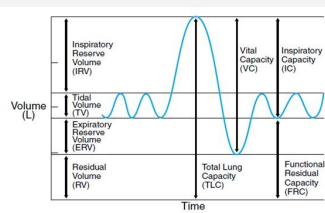
Capnography

Measure of CO₂ in exhaled air, which correlates w/ arterial CO₂

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 O₂ Saturation (SVO₂)

Get from pulmonary arterial line

Purpose: to eval. O₂ 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 autoly (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)*