Handheld Office Spirometry:

Hypoxia: Steroids, Furosemide or Antibiotics?

The Role of Office Spirometry

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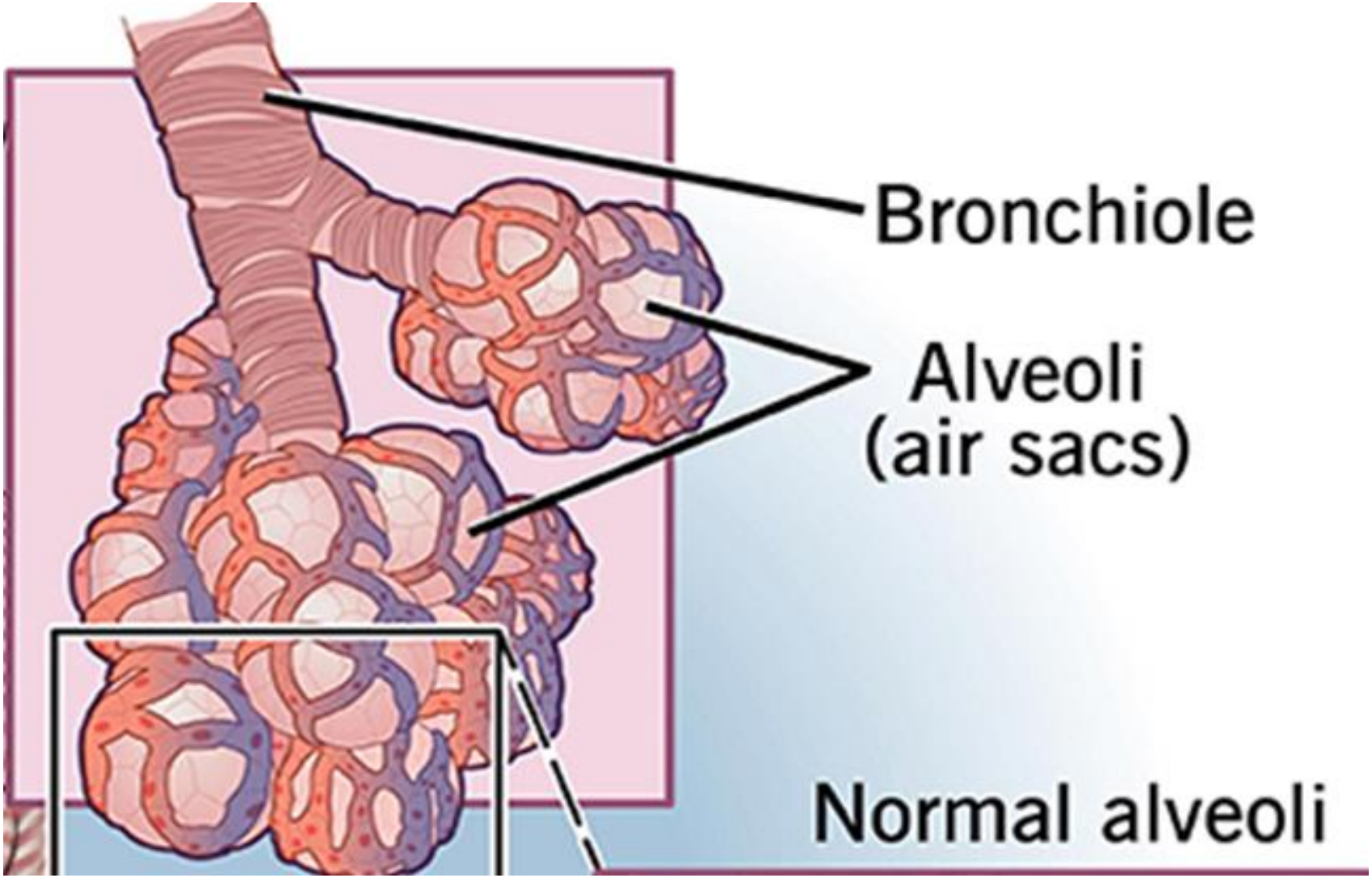
No Financial Disclosures

SOB &/or Hypoxia

- We often anchor on assumptions
  - Wheezing over age 50 is COPD
  - Heart failure does not wheeze
  - No wheezing, no asthma
  - ~1/3-1/2 of the time will be wrong
- 40-50% of the diagnoses of COPD over age 50 are likely wrong or incomplete
- The same can be said for asthma (over diagnosed or underdiagnosed)

Normal Bronchioles

--illustration courtesy of the Cleveland Clinic



The problem

- All that wheezes is not asthma
- All Asthma does not wheeze
- Serious pathology may not have abnormal breath sounds (may sound normal)
- Abnormal breath sounds can mimic several different diseases
- Acute heart failure is the most common missed diagnosis for someone wheezing

Overview

- ❑ Pathophysiology of hypoxia & wheezing
- ❑ Key overlooked physical exam features
- ❑ Intro to Office Spirometry
- ❑ Low resource tips
- ❑ Brief discussion of POCUS overlap in the evaluations
- ❑ Case Scenarios

All that wheezes is not asthma
Not all asthma wheezes

Asthma: Not Wheezing

- **Decreased tidal volume**
  - **Shallow breathing**
  - **Pt exhaustion**
- Poor listening technique
  - Through clothes
  - Cheap stethoscope
  - Too fast
- No current triggers
- Cough-variant

Wheezing: Not Asthma

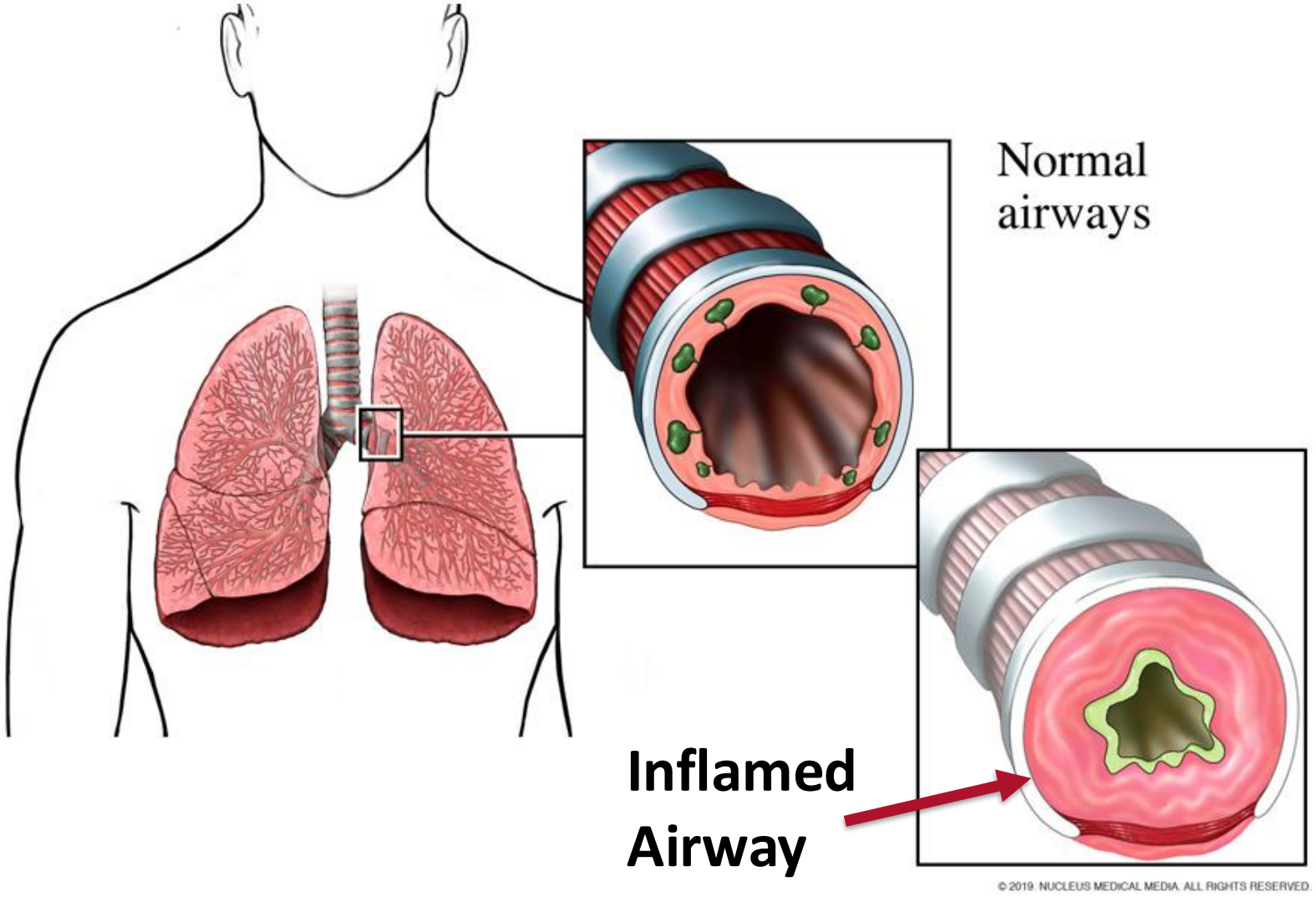
- COPD
- Laryngeal dysfunction
- Upper airway/stridor
  - Anaphylaxis
  - Croup
  - Foreign body
- **Heart Failure-CHF**

Causes of Hypoxia
The Big Three-Five (3-5)

- **Airway** or bronchioles narrowed or obstructed
  - **Asthma-COPD**
- **Alveoli filled** (pus, edema, & more)
  - **Pneumonia**
  - **ASTHMA again (inflammatory soup)**
  - **Heart Failure**
  - **Sepsis** with alveolar leaking/damage
- **Blood flow constriction** (or reduction)
  - **Pulmonary Embolism**
  - Sepsis (low flow/hypotension)
- ***Not uncommonly a mixture***

Causes of Hypoxia
The Big Three-Five (3-5)

- **Alveoli:** starts filling with pus, edema, & more
  - **Pneumonia**
  - ASTHMA/COPD **(inflammatory soup)**
  - **Heart Failure**
  - **Sepsis** with alveolar leaking/damage
- **Bronchioles:** airways narrowed/obstructed
  - **Asthma-COPD**
- **Capillaries:** blocked or reduction of blood flow
  - **Pulmonary Embolism**
  - Sepsis (low pressure/hypotension)
- ***Not uncommonly a mixture***



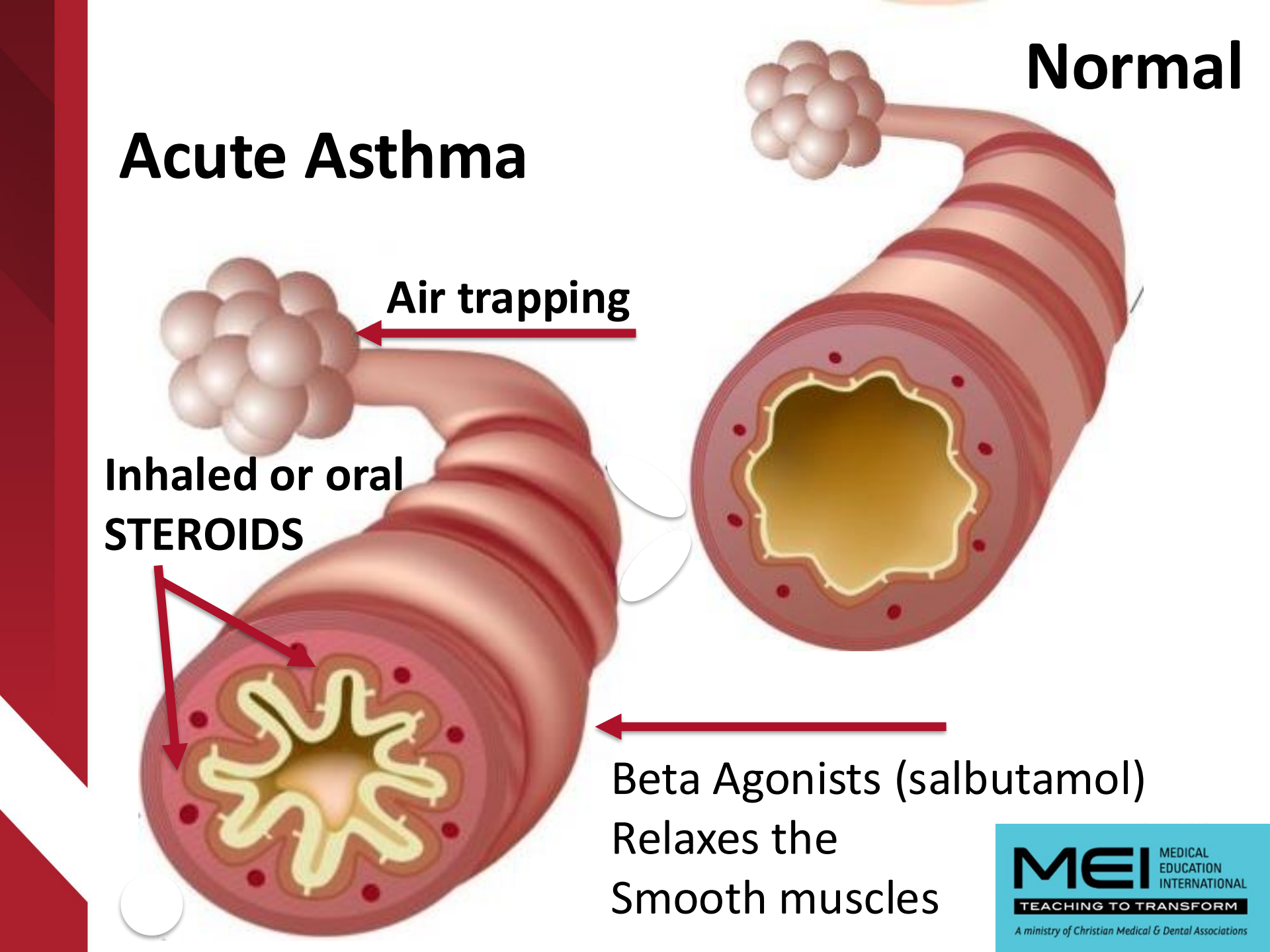
Airway narrowing from an asthma attack. *The image on the left shows the location of the lungs in the body. The middle image is a close-up of a normal airway, and the image on the right shows a narrowed, inflamed airway typical of an asthma attack.* *Medical Illustration Copyright © 2022 Nucleus Medical Media. All rights reserved.external link*

https://www.nhlbi.nih.gov/health/asthma/attacks

Asthma-RAD is PRIMARILY an INFLAMMATORY Disease

- **Early Phase: Bronchospasm-relaxes smooth muscle**
  - **β_2 agonists** (salbutamol, duo-neb, fomoterol)
  - **β_2 agonists: NO ROLE in inflammation**
  - **Must control the inflammation**
- **Secondary/late phase: Inflammatory soup**
  - **Oral/IV steroids stabilize & repair**
- **Asthma & Wheezing:**
  - **May Not be heard with shallow tidal volumes**
  - **Does not "disappear" after age 50 or w/tobacco**
  - **Heart failure can wheeze**
  - **Will have prolonged expiration!**

Acute Asthma



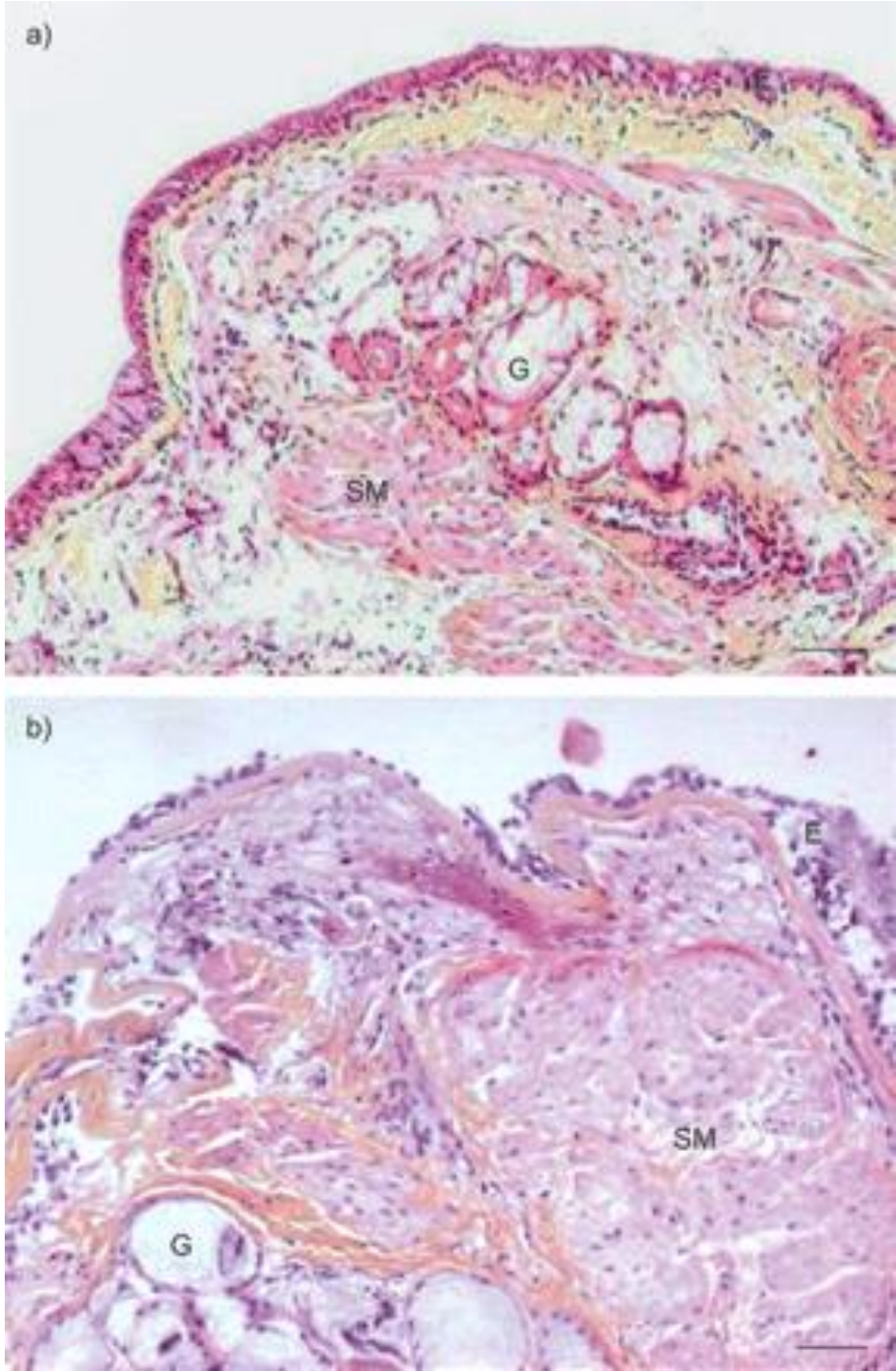
Normal Epithelium

β-agonists & LAMAs

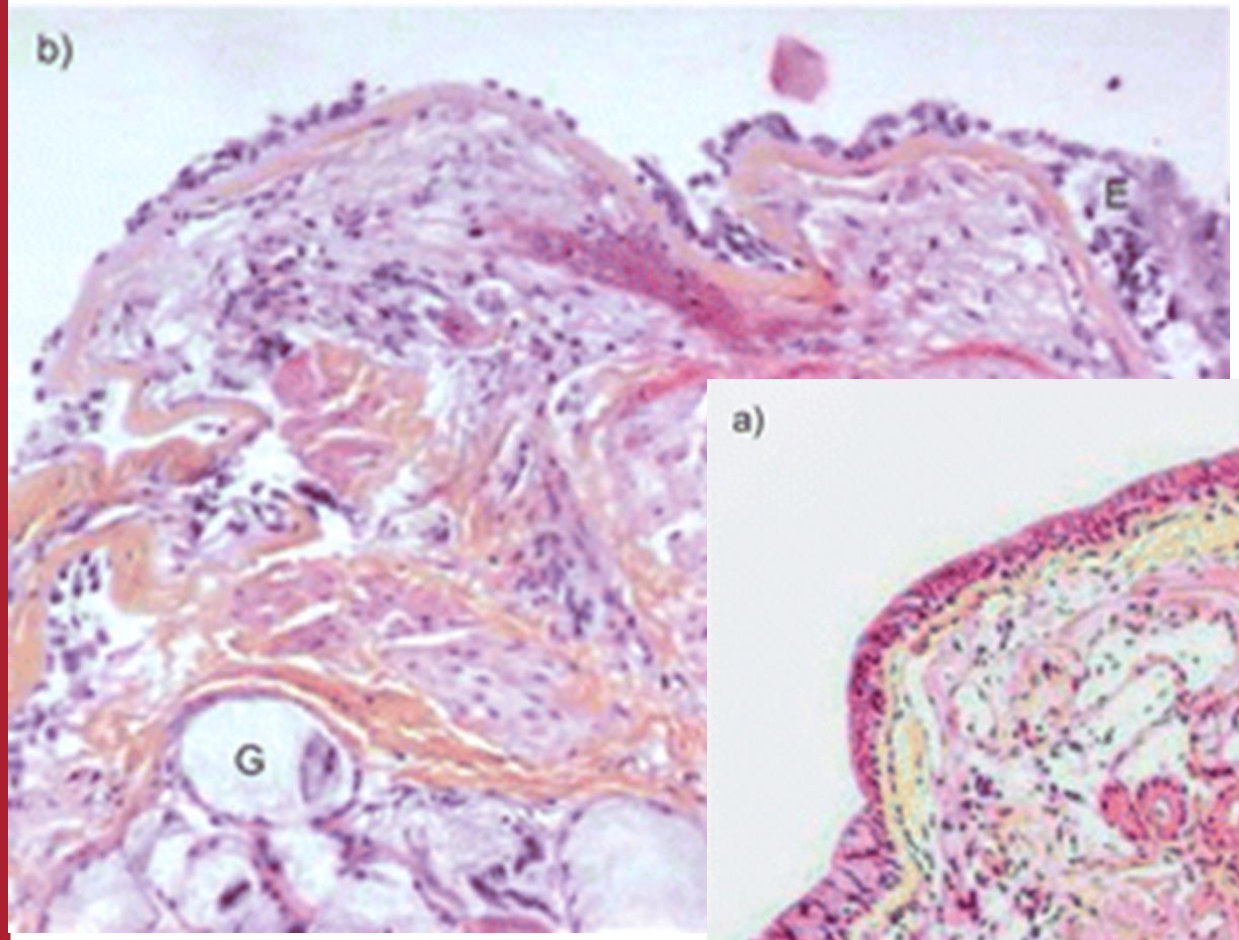
NO EFFECT on inflammation

-Need steroids, oral or ICS to restore to normal epithelium

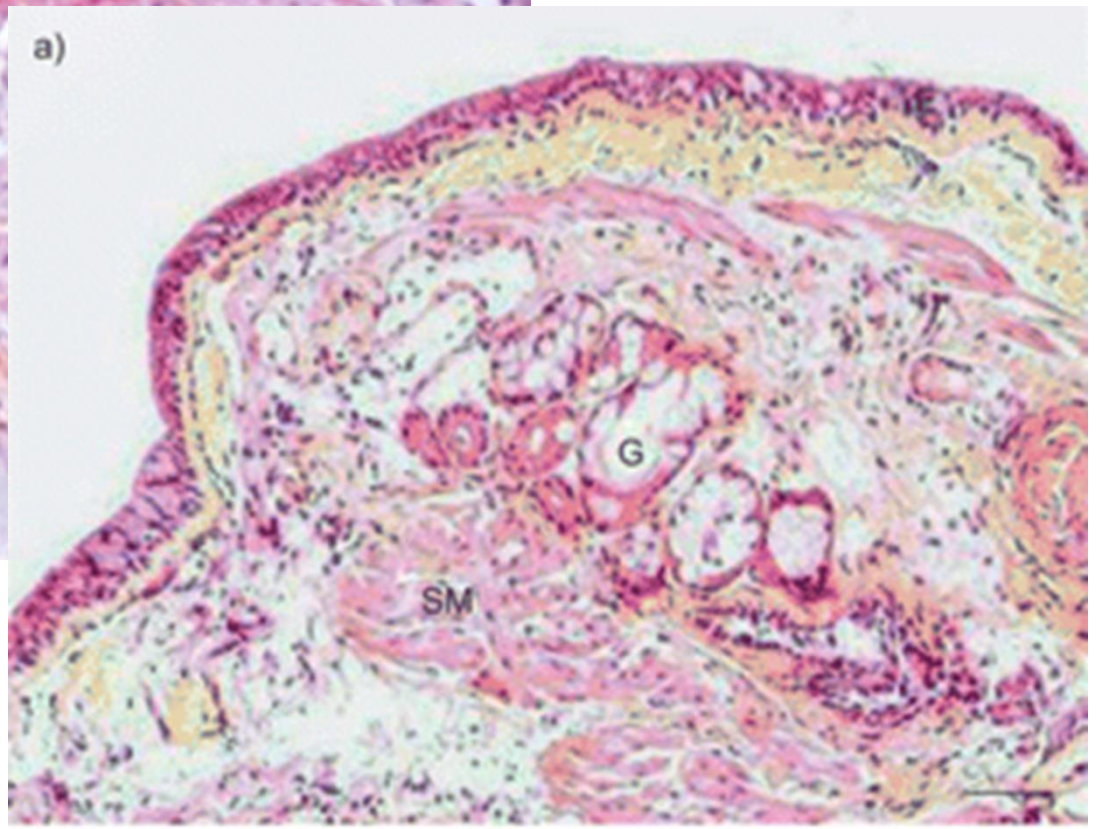
-possible mild effect w/montelukasts



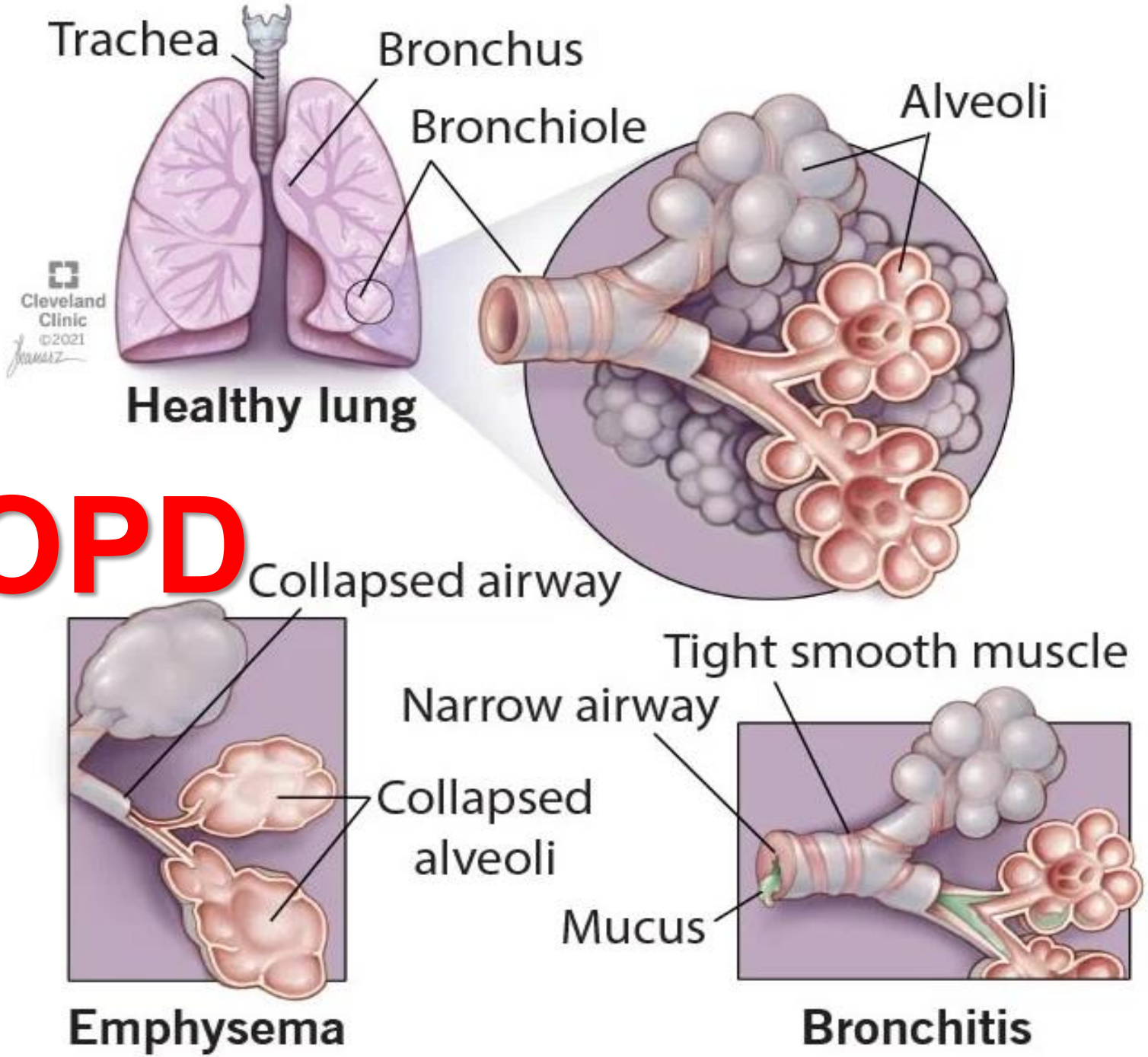
Steroids restore the cilia & epithelial layer - Scarring occurs when ICS are delayed



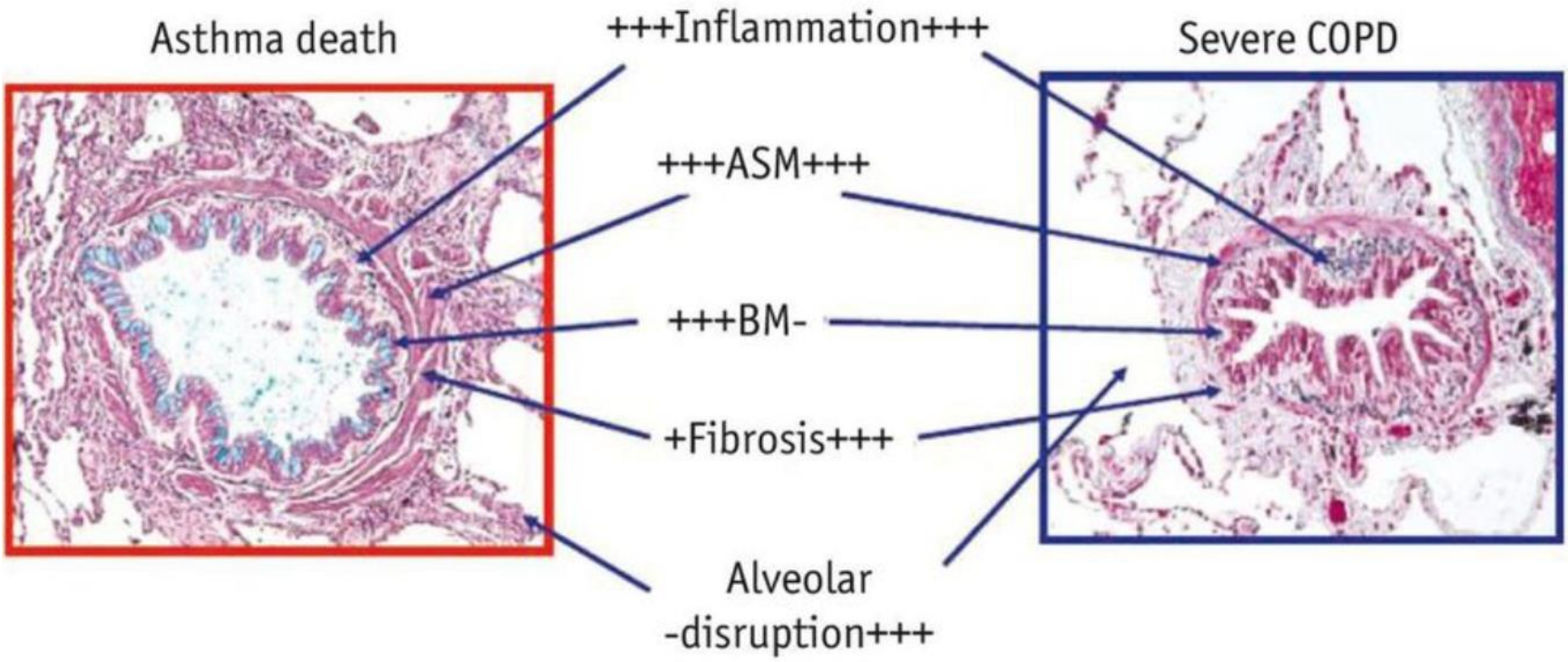
Peak expiratory flows decrease by 5-10% each year of delaying inhaled steroids



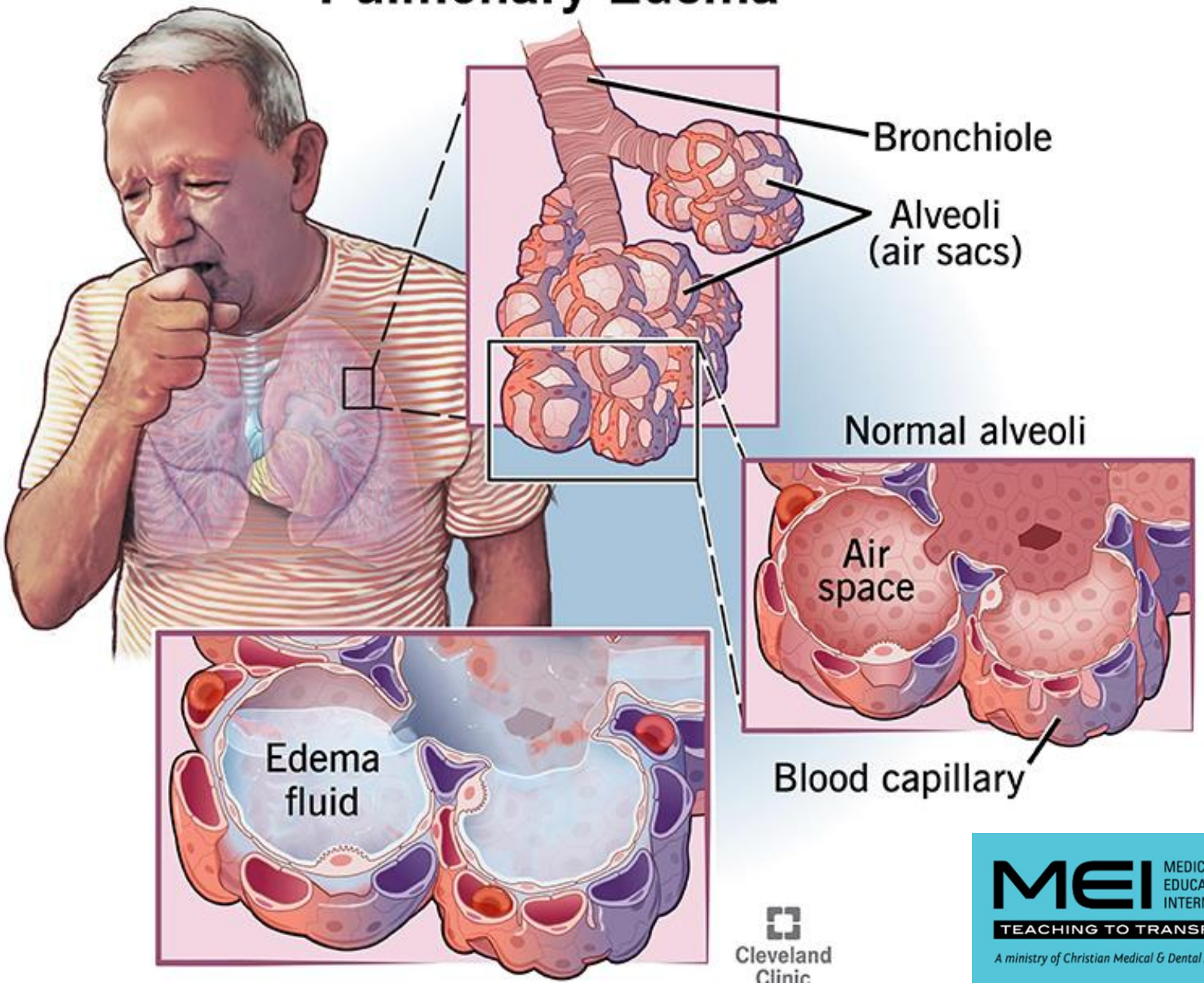
COPD


Trachea
Bronchus
Bronchiole
Alveoli
Cleveland Clinic ©2021
Healthy lung
Collapsed airway
Collapsed alveoli
Emphysema
Tight smooth muscle
Narrow airway
Mucus
Bronchitis

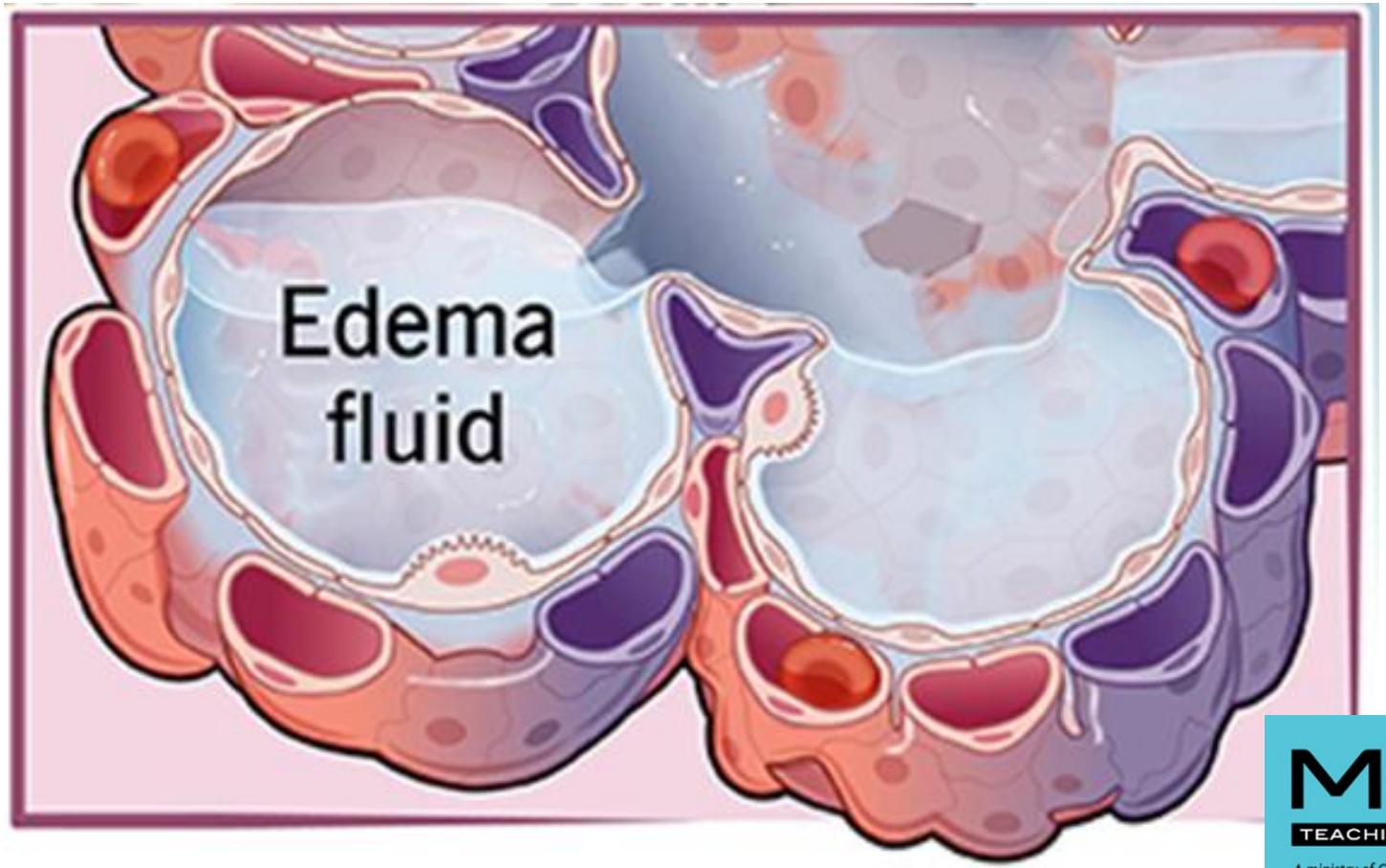
Histopathology Contrasts: RAD & COPD



Pulmonary Edema

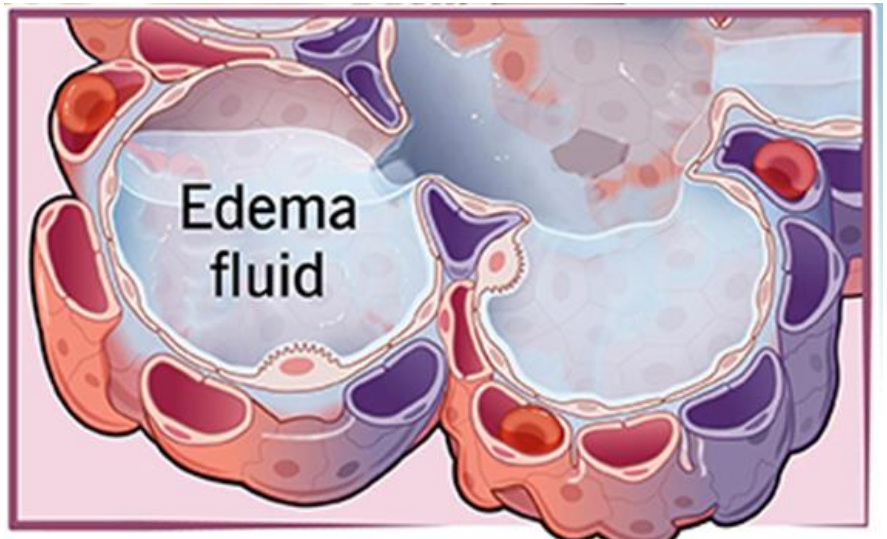


Pulmonary Edema is from "Fluid Overload" from "left sided" heart dysfunction



LV pulmonary edema

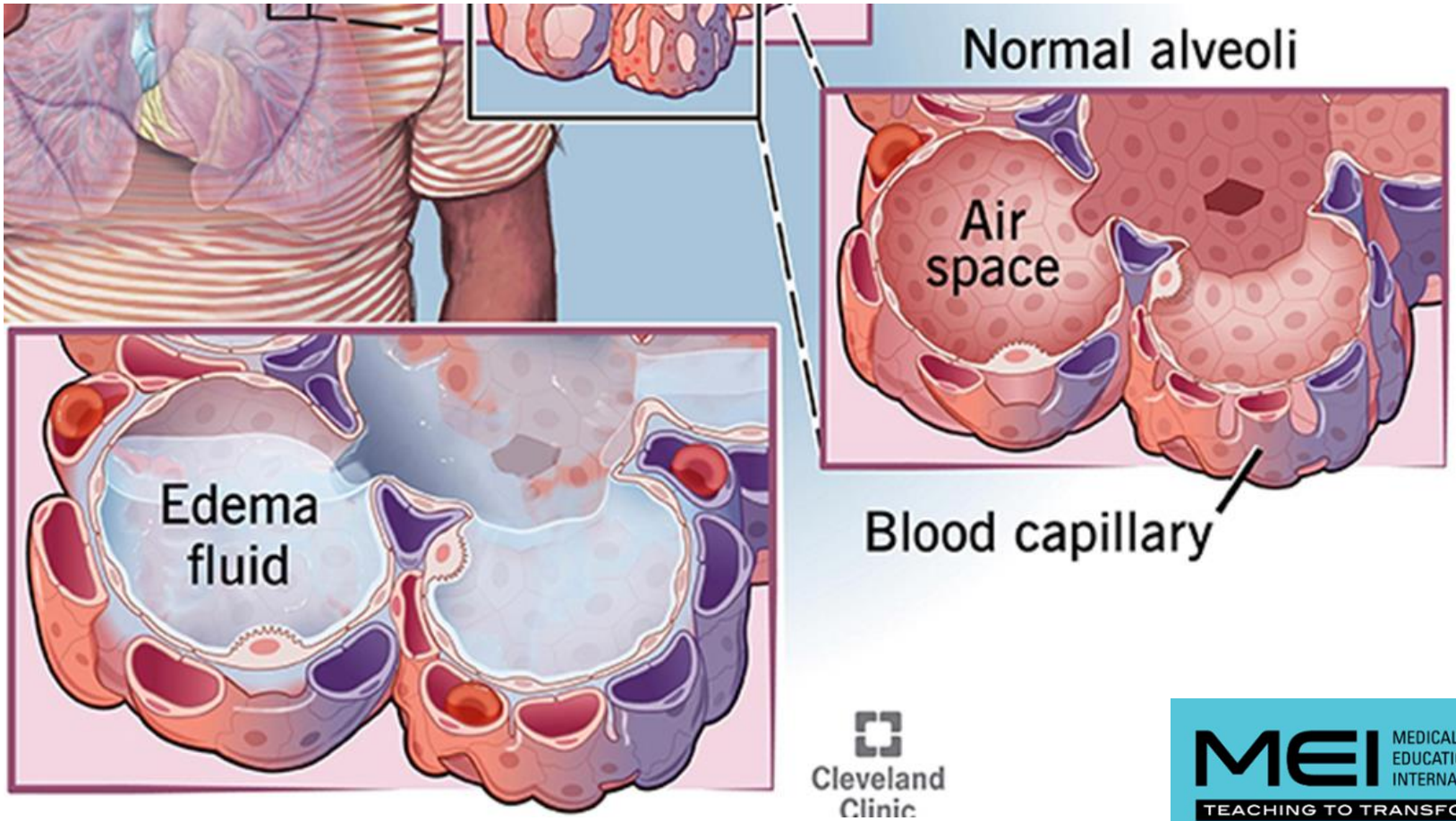
- Reduced ejection fraction
- Left ventricle DYSFUNCTION
  - Can have NORMAL ejection fraction
  - Atrial fibrillation
  - Diastolic dysfunction



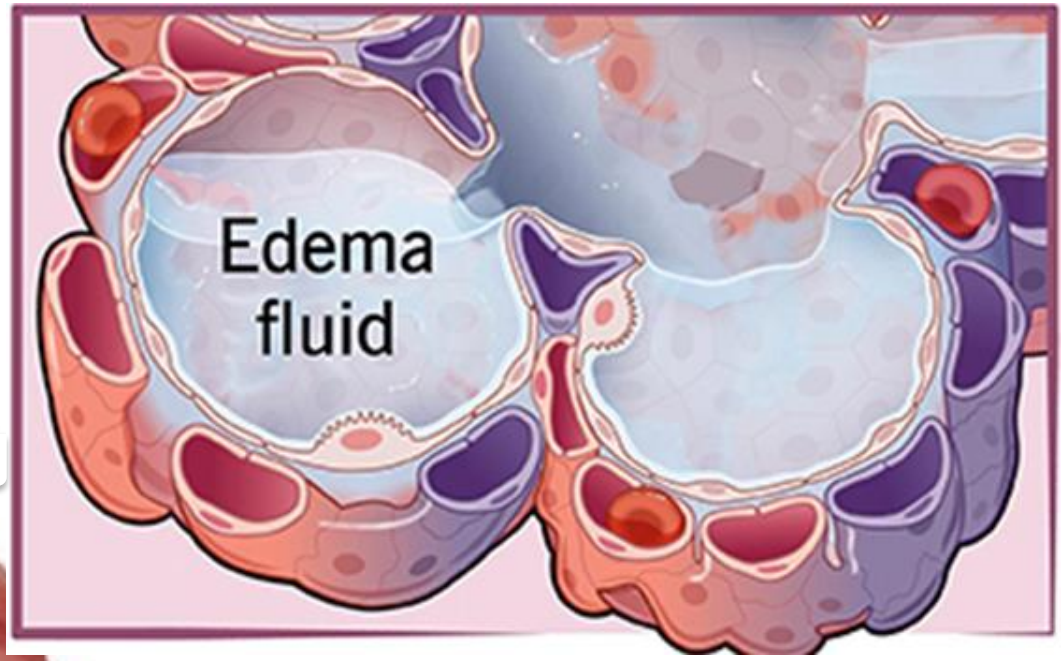
- Volume Overload

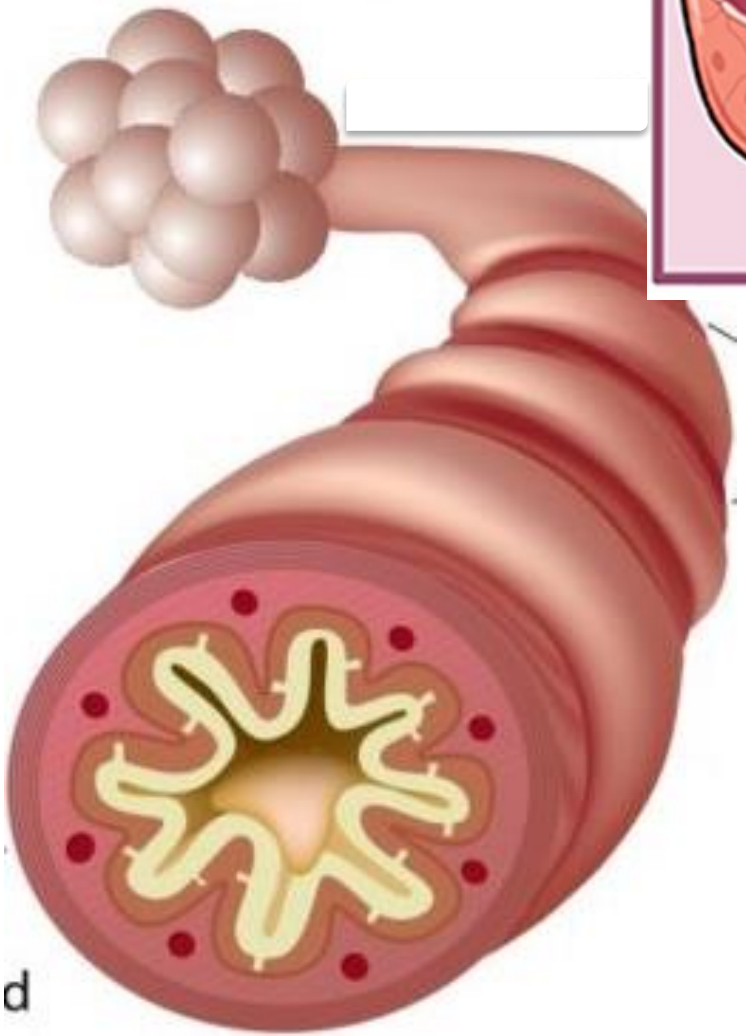
(but also SEPSIS can be a cause, from "leaky" alveoli)

Pulmonary Edema can:
-- crackle, rales or wheeze



BOTH COPD,
(& Asthma)





AND HEART FAILURE CAN WHEEZE!!!

Both can have inspiratory and/or expiratory wheezing

The Forgotten part of the Physical Exam

- While listening to the lungs
  - Is there good flow?
  - Any abnormal sounds?

- Observe
  - HOW LONG for INSPIRATION?
  - HOW LONG for EXPIRATION?
  - The NECK VEINS!

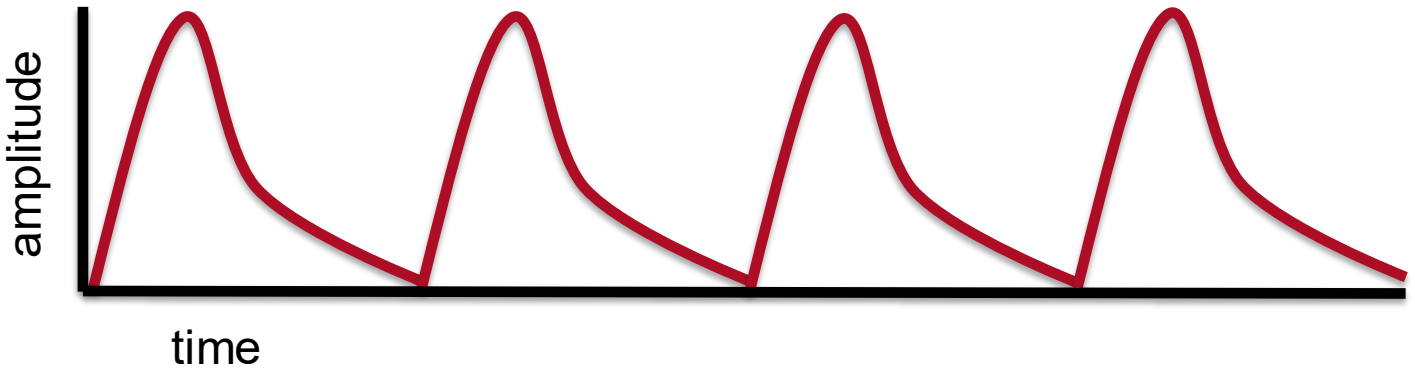
The Forgotten part of the Physical Exam

- **Inspiratory to Expiratory Ratio is key;** helps identify if there is truly an "obstruction"
- The **Neck Veins** are a window to the heart
  - JVP can be missed when "above the jaw"
  - HJR identifies failure without LE edema
- While listening to the lungs
  - Is there good flow? If not, sounds are muffled or absent (or hard with ++BMI's)
  - Abnormal breath sounds can mimic more than one diagnosis

Differentiating the cause of Wheezing between CHF & COPD (as both can wheeze)

Observe the breathing pattern

- **inspiration to expiration ratios are normally ~1:1**



Expiration is **prolonged** with a **COPD exacerbation**.

- **No prolongation** with **heart failure** (Insp:Exp ~1:1)
- *Even though wheezing can be heard in both scenarios!*

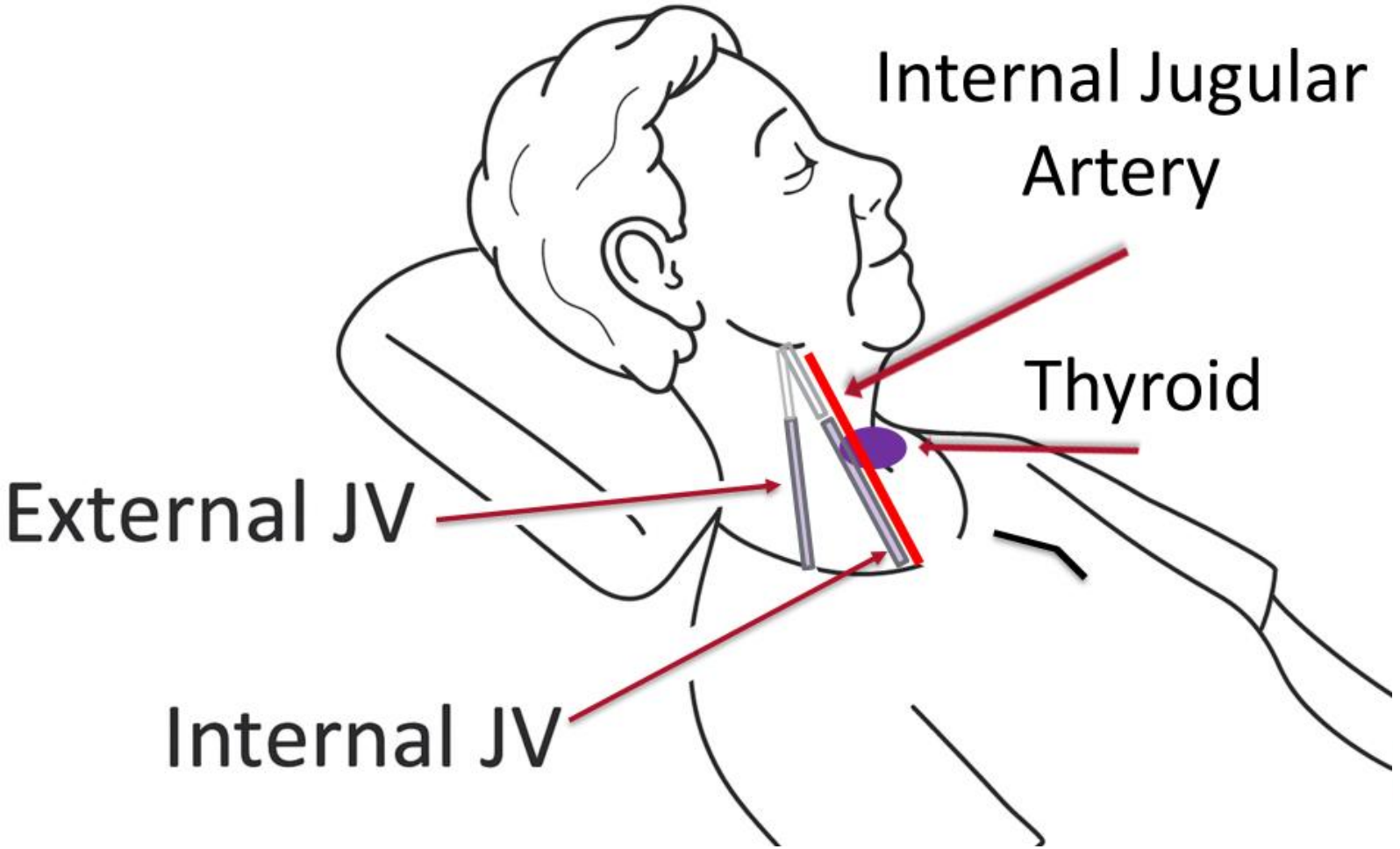
Watch & Observe Carefully the INSPIRatory to EXPIRatory ratio

- Wheezing is not pathognomonic for a COPD exacerbation (suggestive but can fool)
- **1 of 6** COPD exacerbations in the Emer Dept changed to Heart Failure after POCUS
- “Cardiac Asthma” is pleural fluid in the alveoli that have a similar wheeze to COPD
- “Law of LaPlace” (decreased surface tension) can result in a similar insp. to expiratory ratio with Resp Rate into the 30’s
- Portable CXR’s can easily miss heart failure

J-LUX POCUS Protocol:
For hypoxia & vascular volume

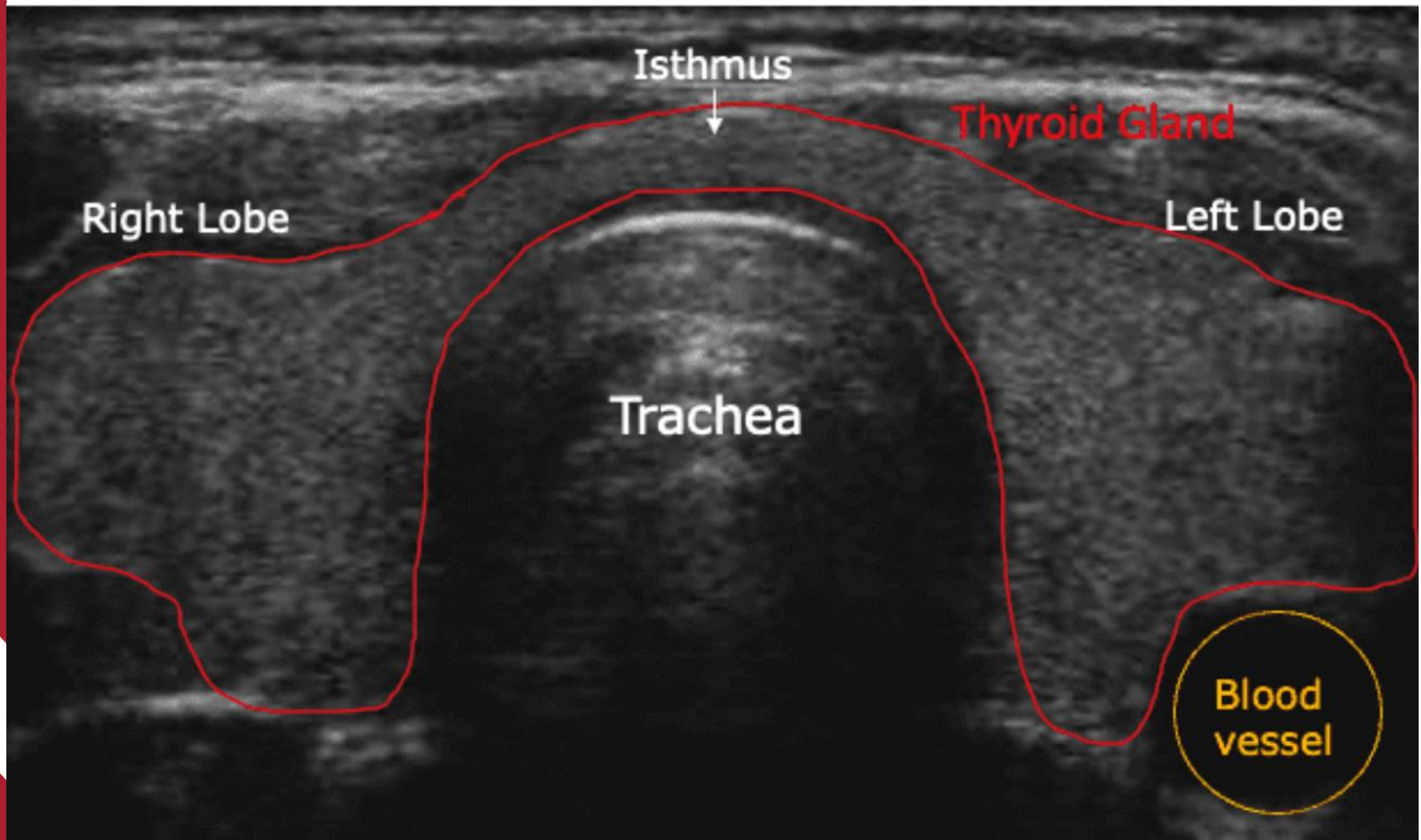
- JVP/HJR: Internal Jugular; clarity w/POCUS
- L Lungs: POCUS Findings in the Lungs:
  - A – Lines; Artifact from Air in lungs (normal)
  - B – Lines; like "Beams of light" thru clouds
  - C – Consolidation-hepatization (pneumonia)
  - D – Diaphragm &/or Dark Fluid (eg effusion)
- U Upper Abdomen, sub-Xiphoid view
  - Ejection Fraction (good or bad EF?)
  - Inferior Vena Cava for Right Atrial pressure
- EXacerbation Eval: synthesize history, exam, labs & imaging for the root cause

POCUS can easily identify the Thyroid, Internal Carotid & Internal Jugular Vein

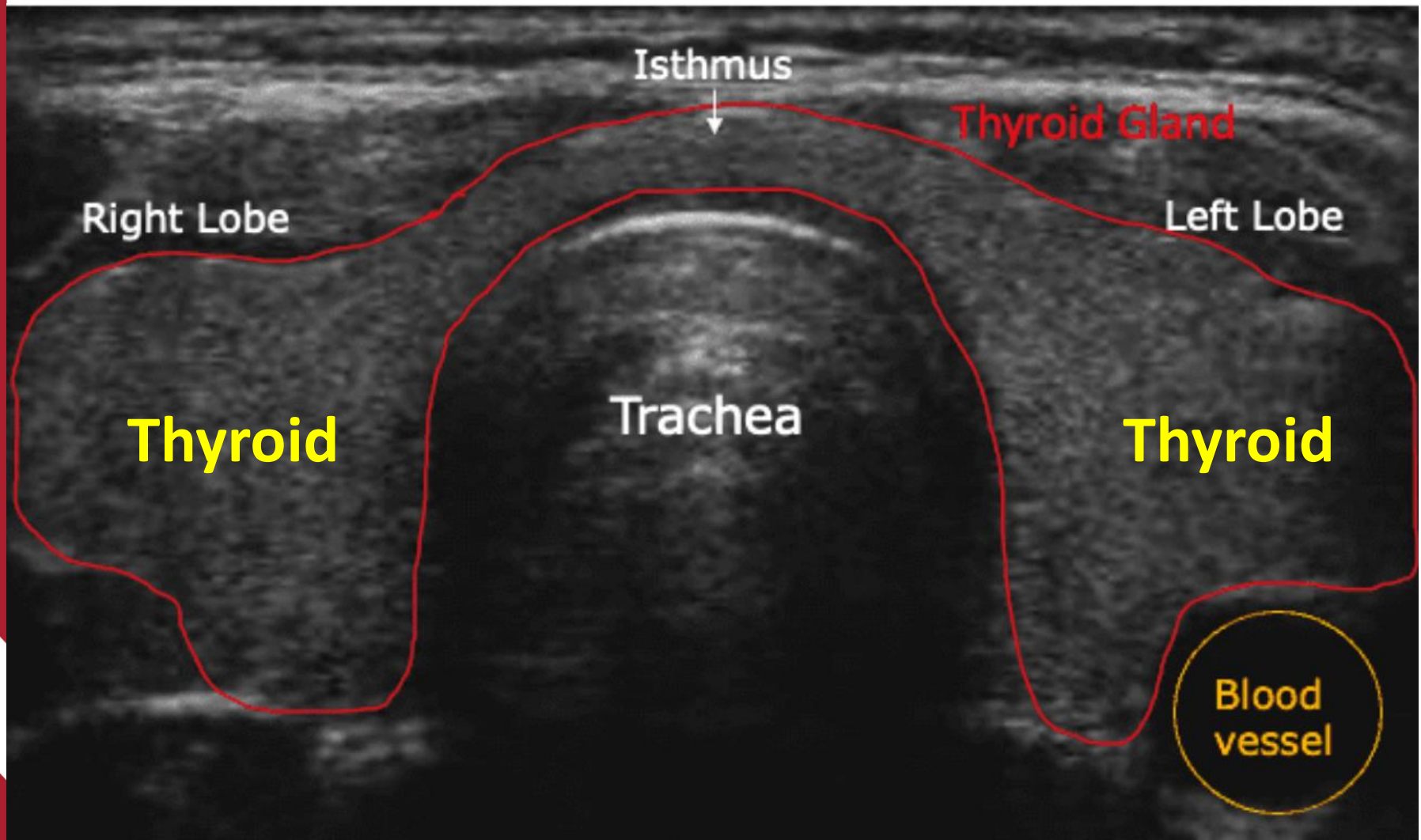


Start in the middle at the trachea

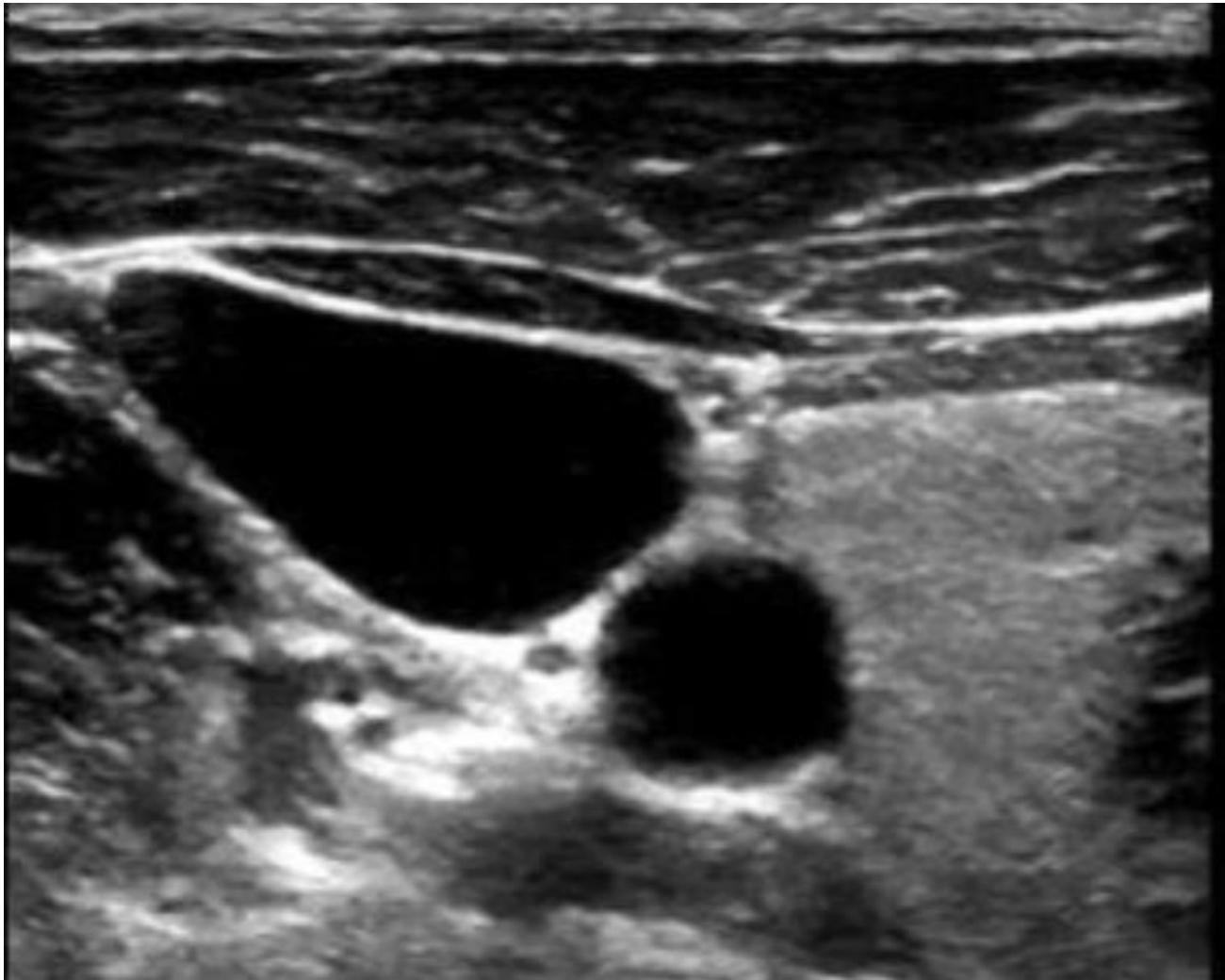
A-lines are seen in the trachea (air)



Thyroid is homogenous &
- adjacent to the thyroid is the
- pulsatile internal carotid artery



The internal jugular can be seen
- with a Valsalva or
- blowing through pursed lips



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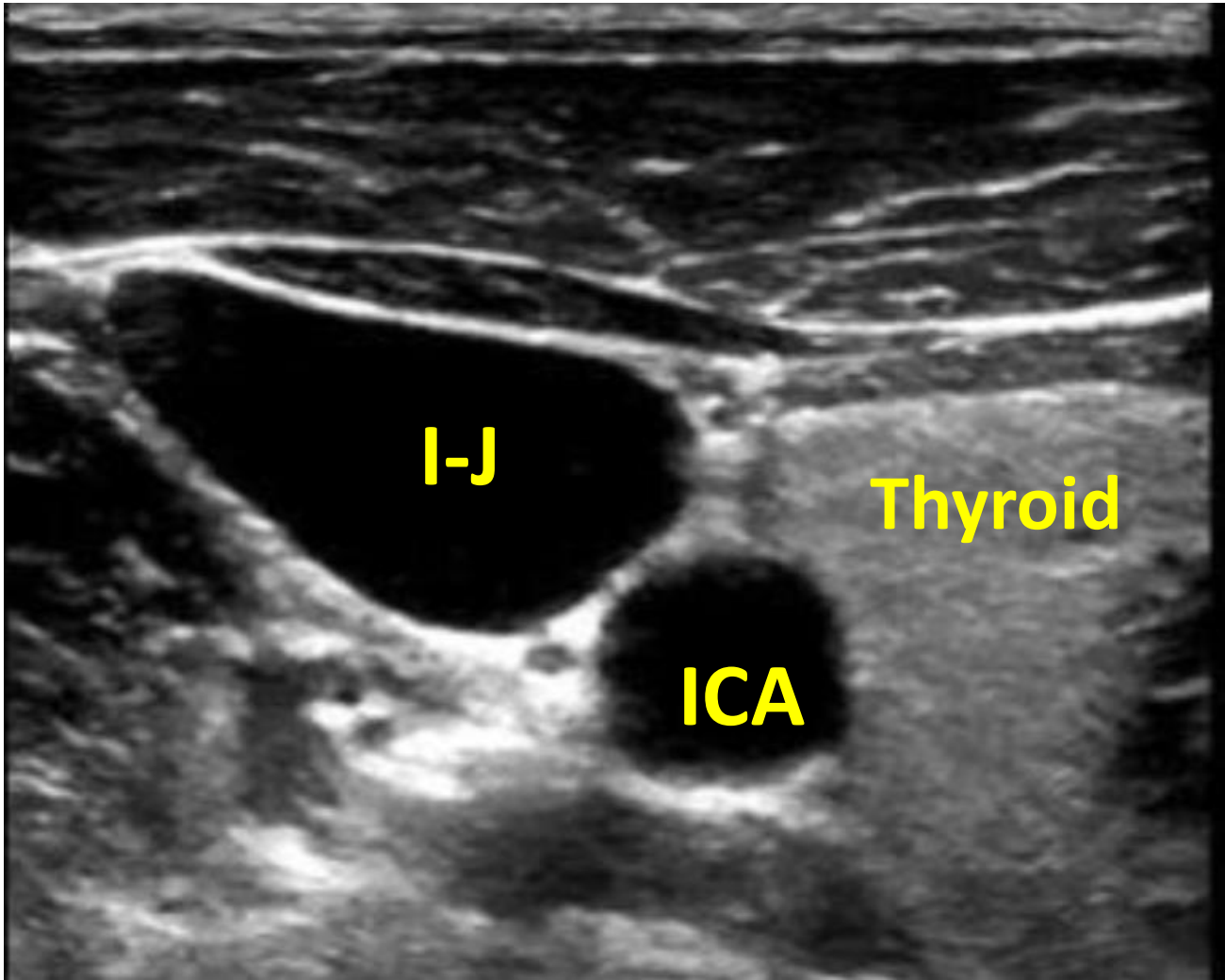

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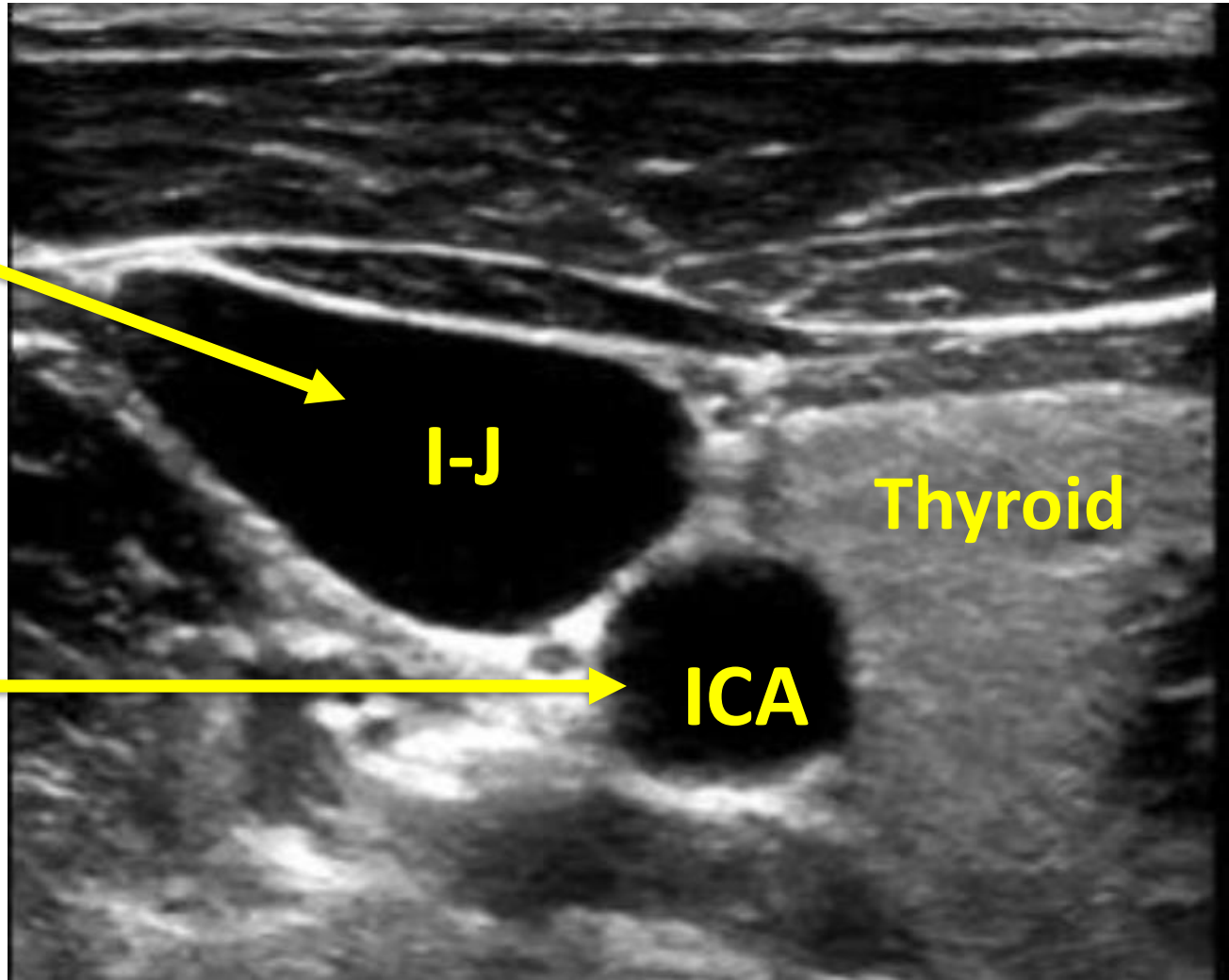
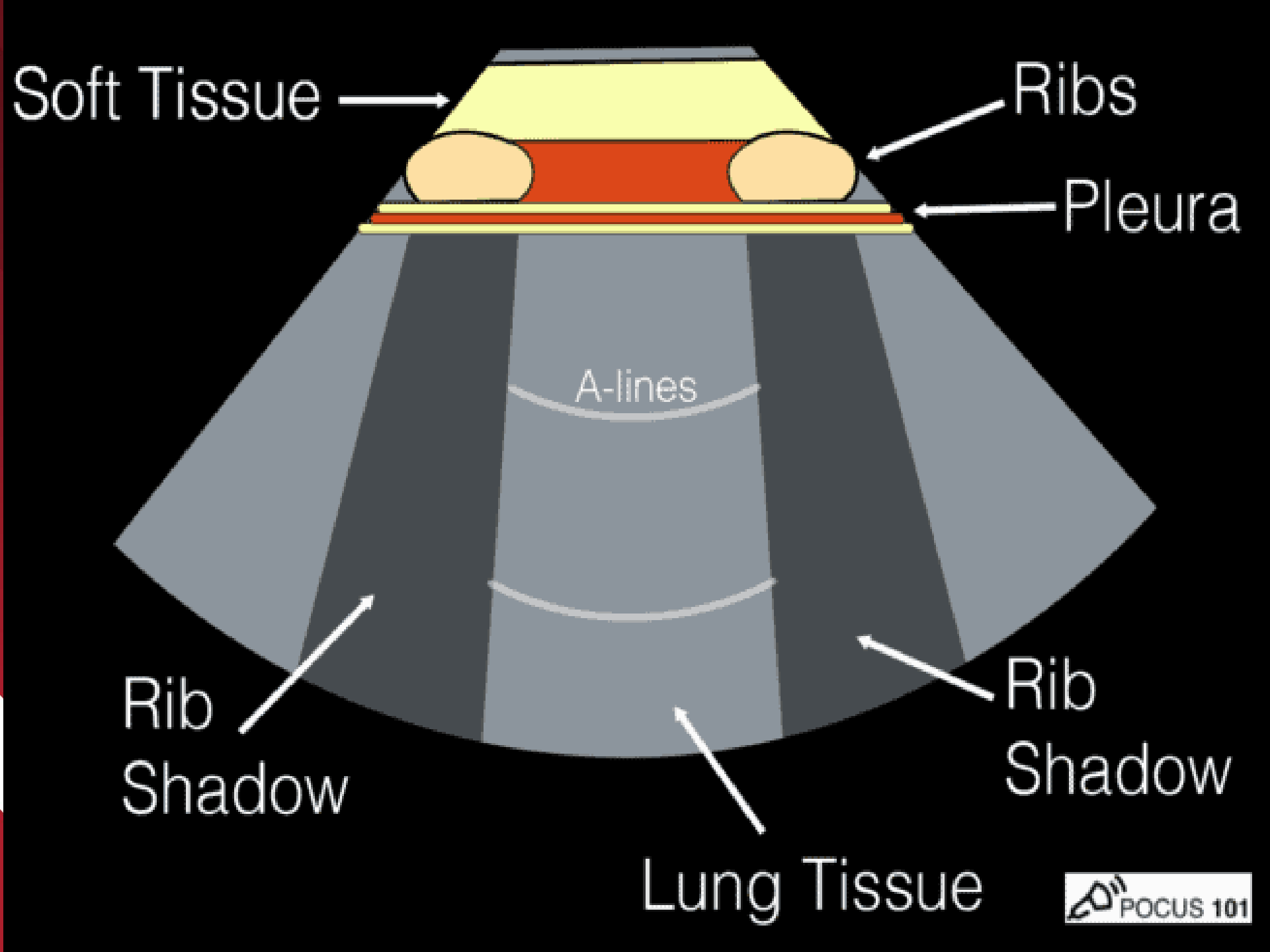
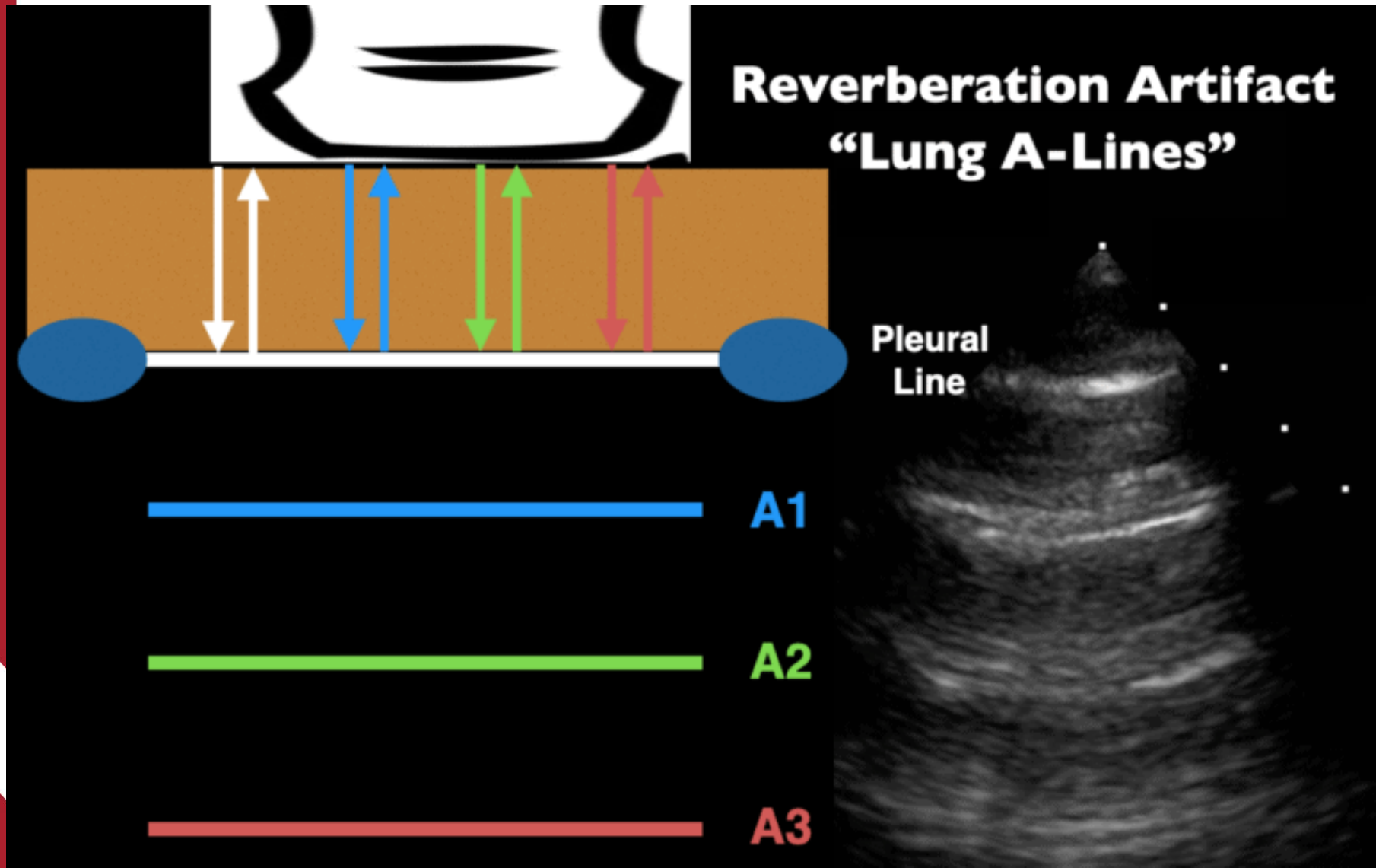
Internal Jugular (may be flat at first)

Internal Carotid (pulsatile)

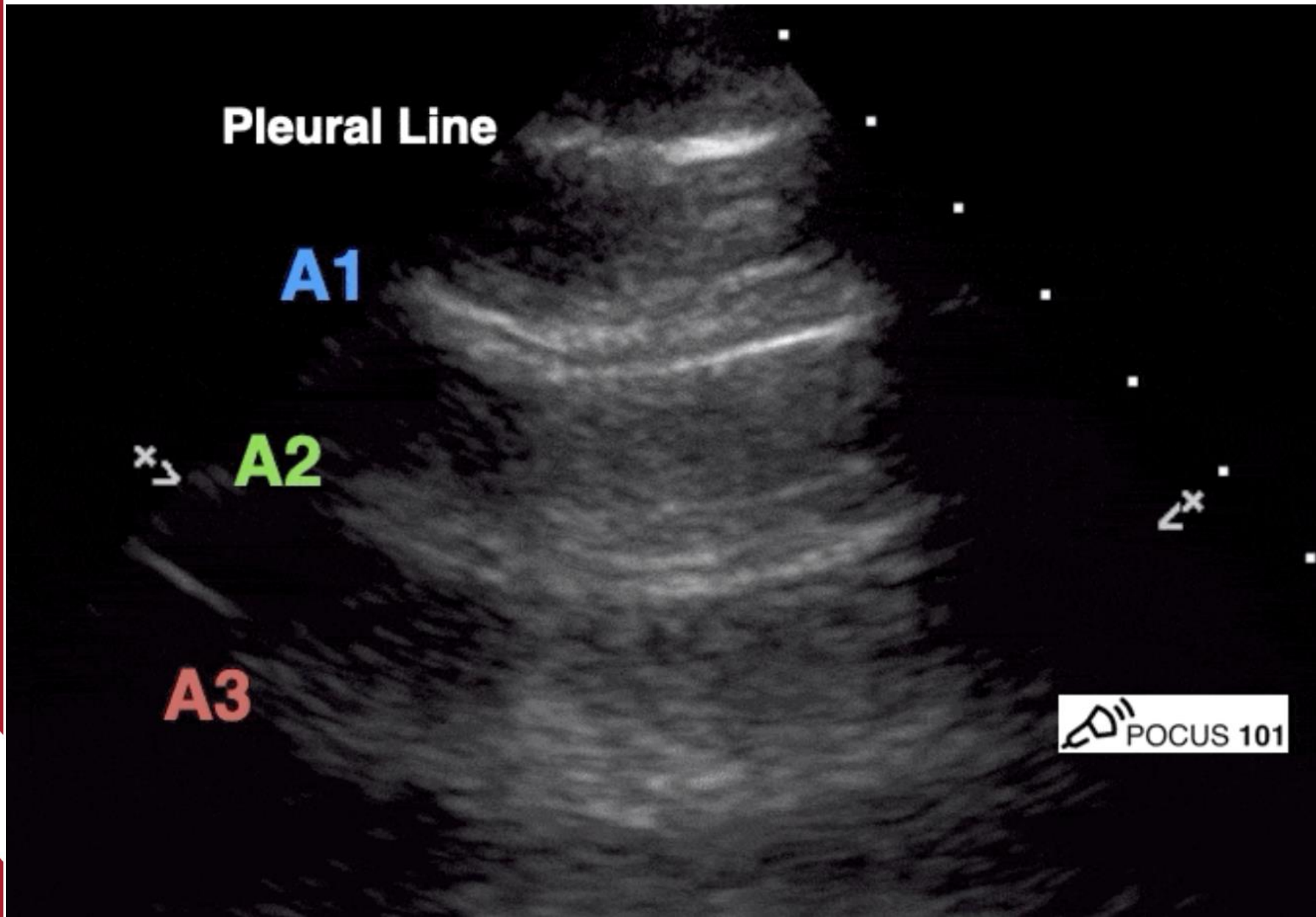



Soft Tissue
Ribs
Pleura
A-lines
Rib
Shadow
Rib
Shadow
Lung Tissue
POCUS 101

“A-Lines” are because of air in the lungs (normal)



A-Lines (air, artifact, reverberations)

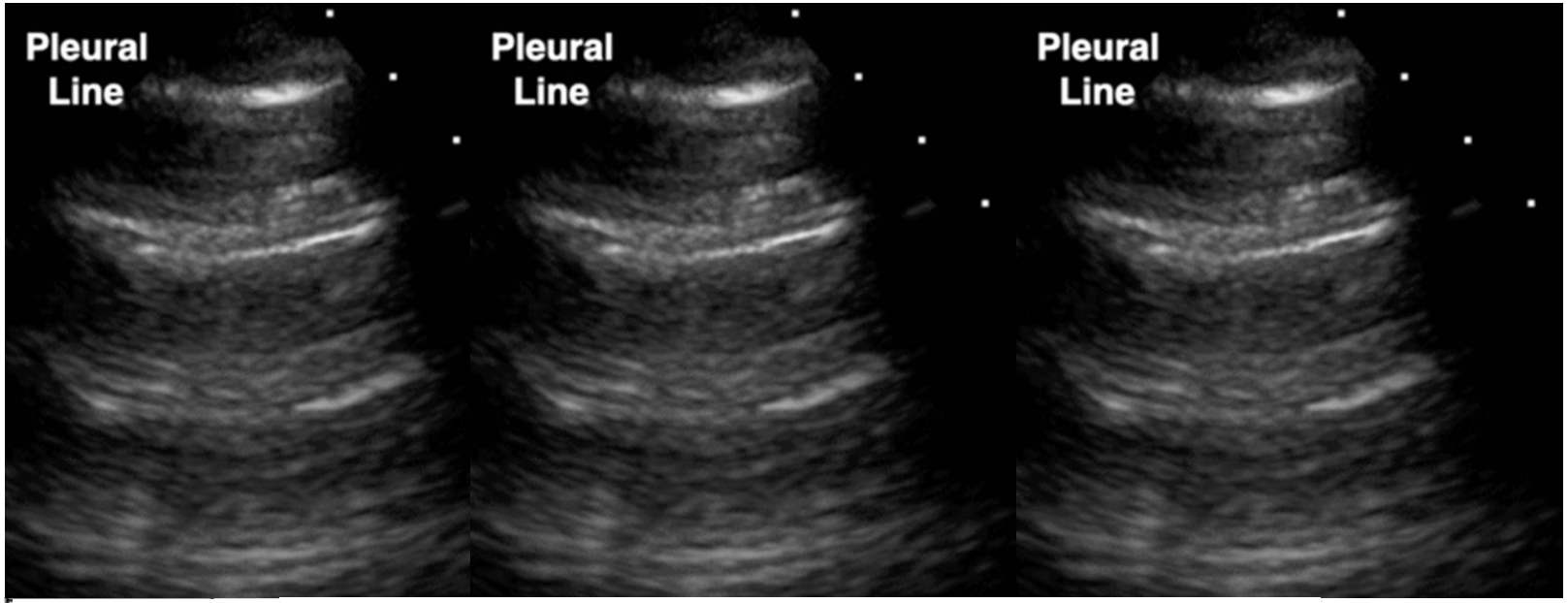


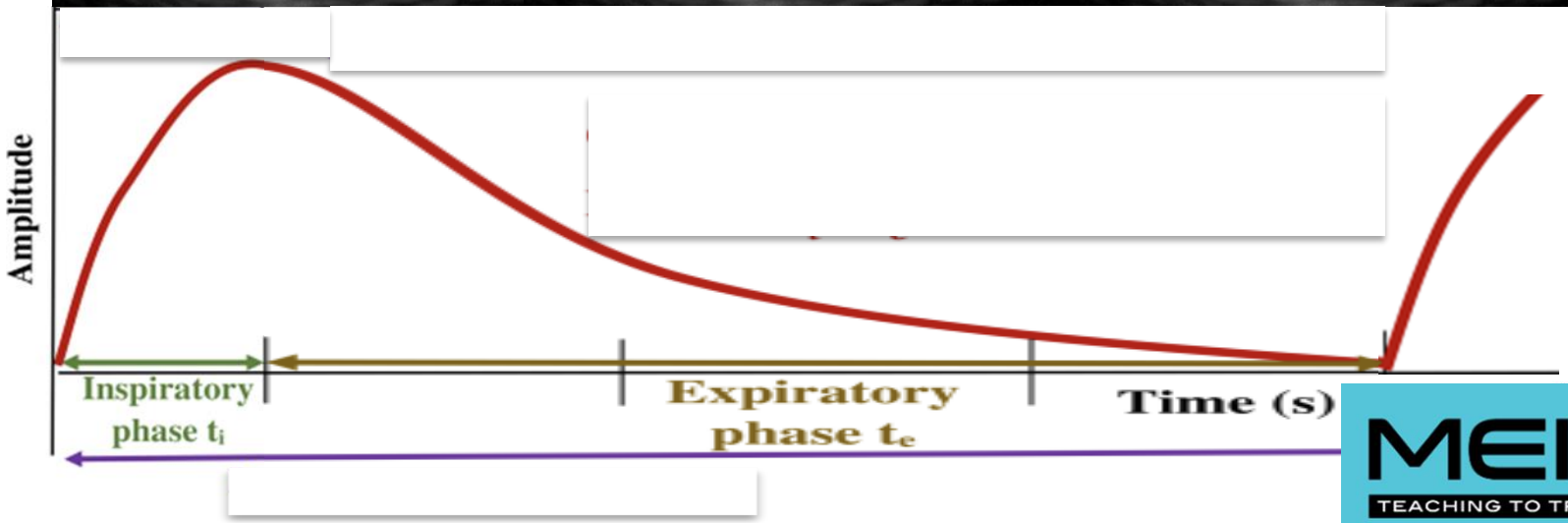

Batwing Sign
Rib
Rib
Rib Shadow
Rib Shadow
POCUS 101

B-Lines "beams"

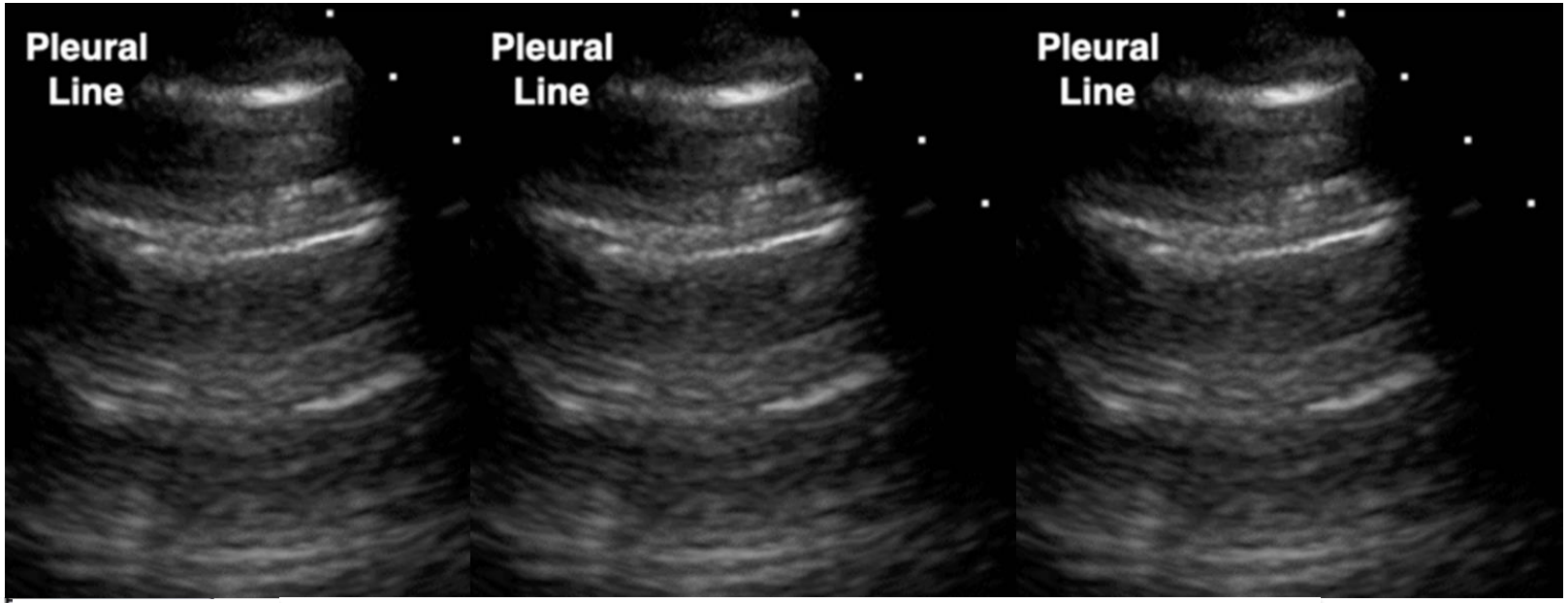
- Must extend the full length of screen
- ≥2-3 per rib space
- B-Lines in one rib space is normal (often seen near diaphragm)
- Must be 2 or more rib spaces to be abnormal

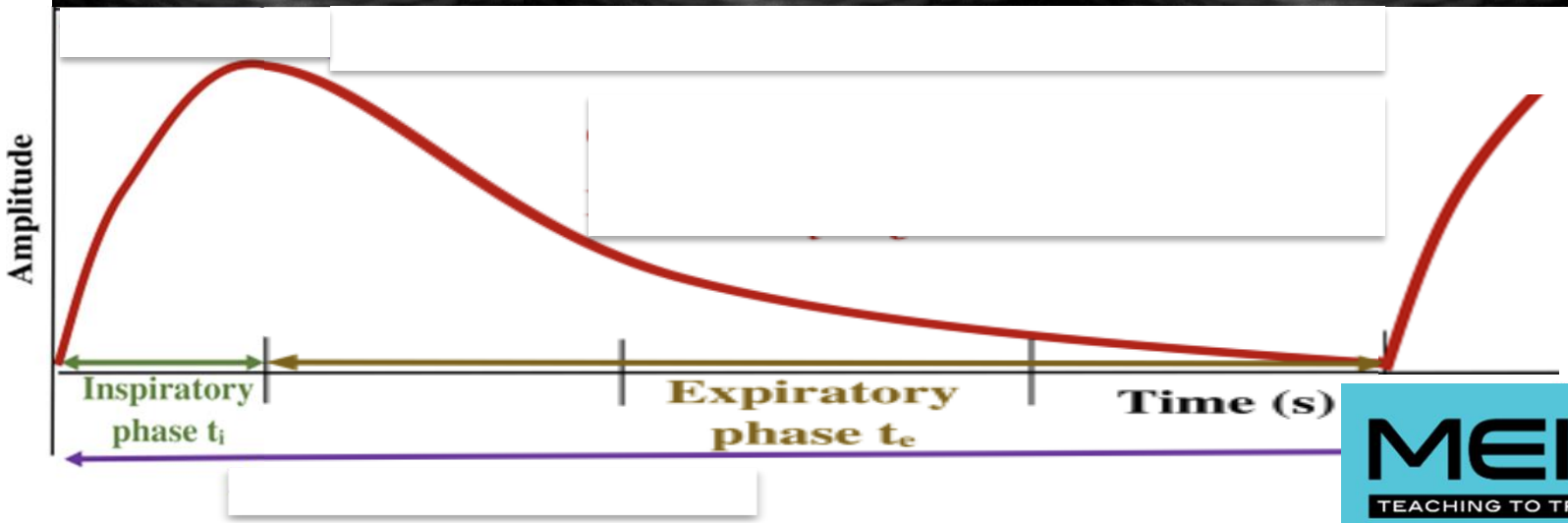
A-Lines with prolonged expiration (looking between many rib spaces)



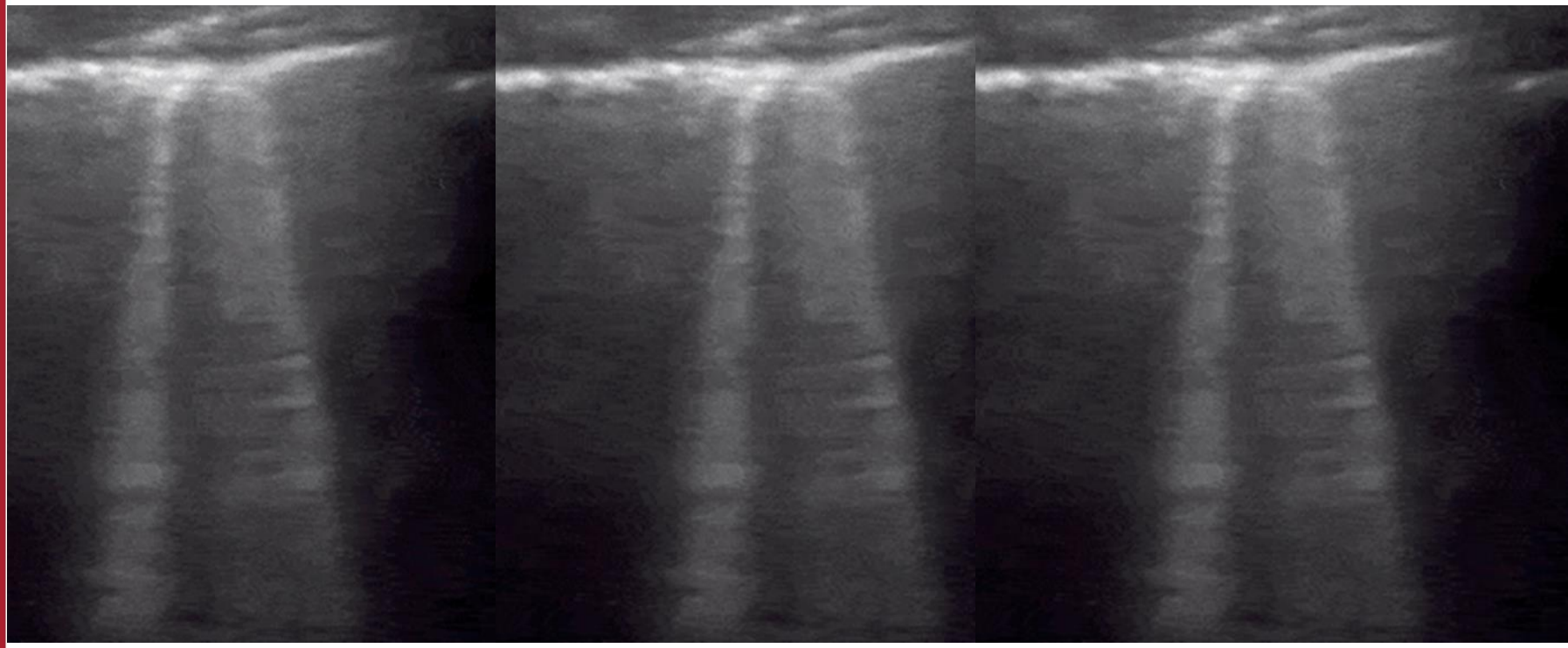


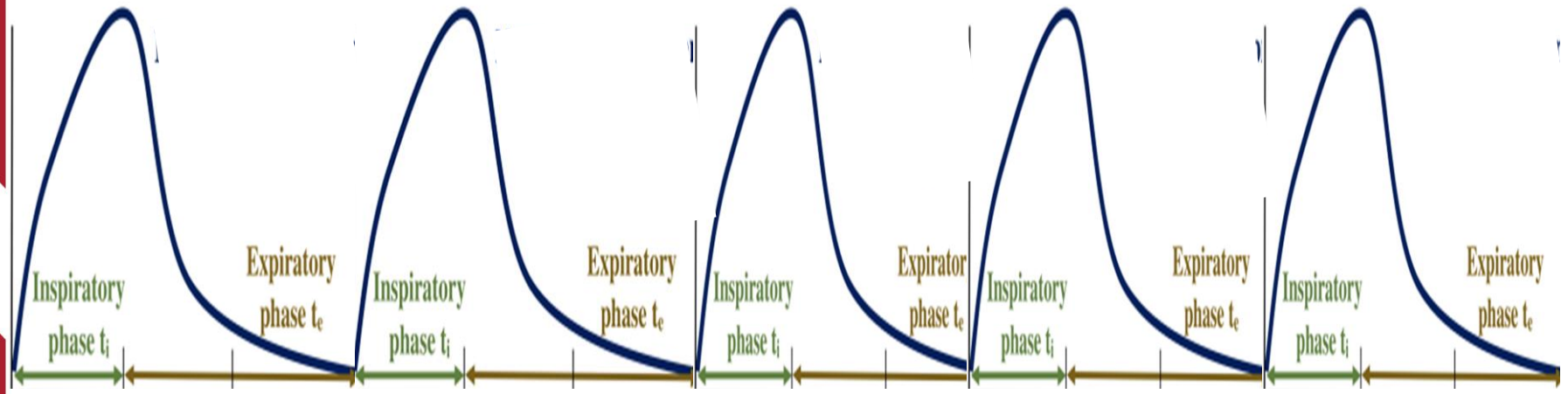
This is a COPD exacerbation; expiratory wheezing; +/- insp. wheeze



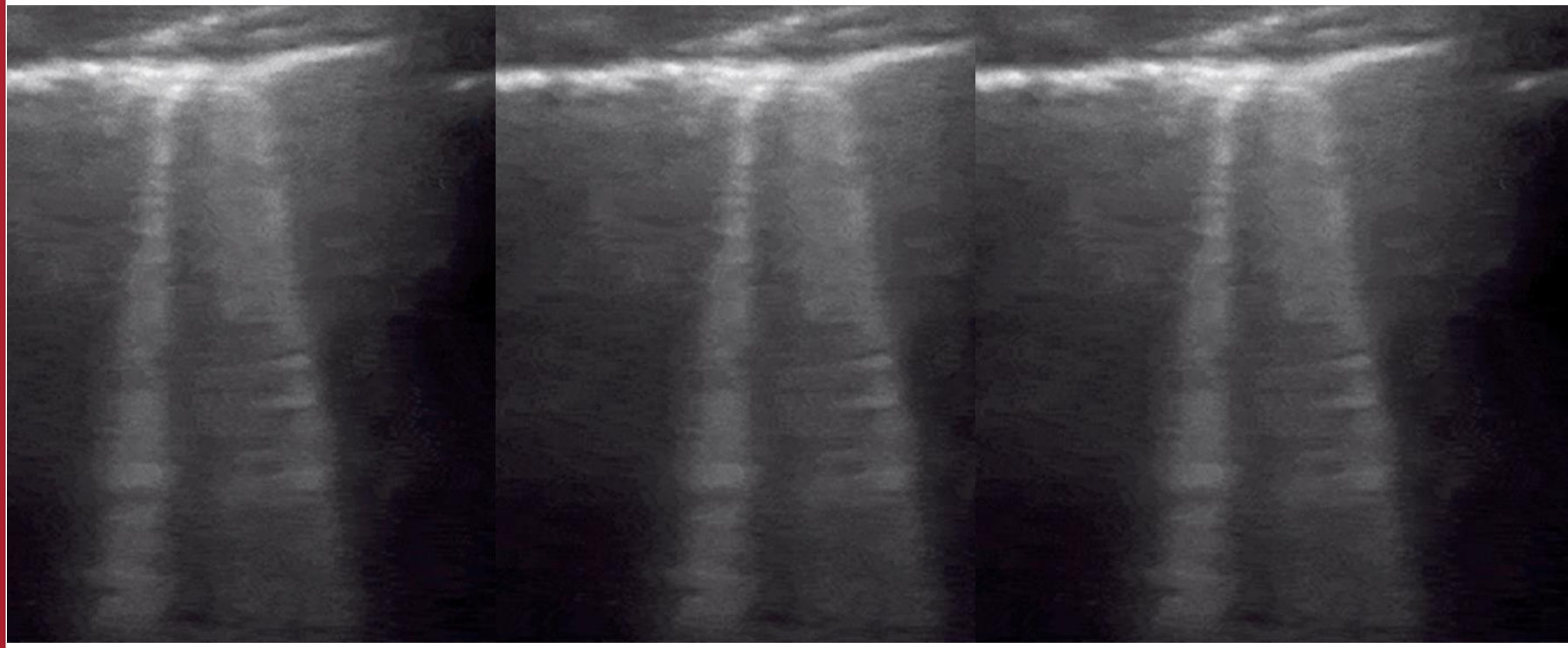


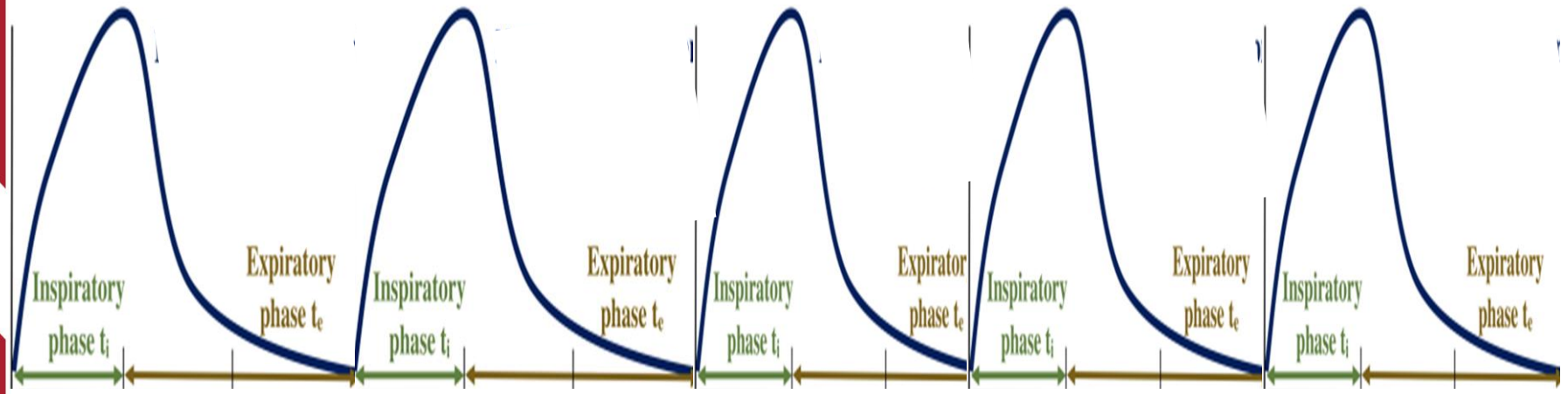
Hypoxic, History of “COPD” with prominent expiratory wheezing



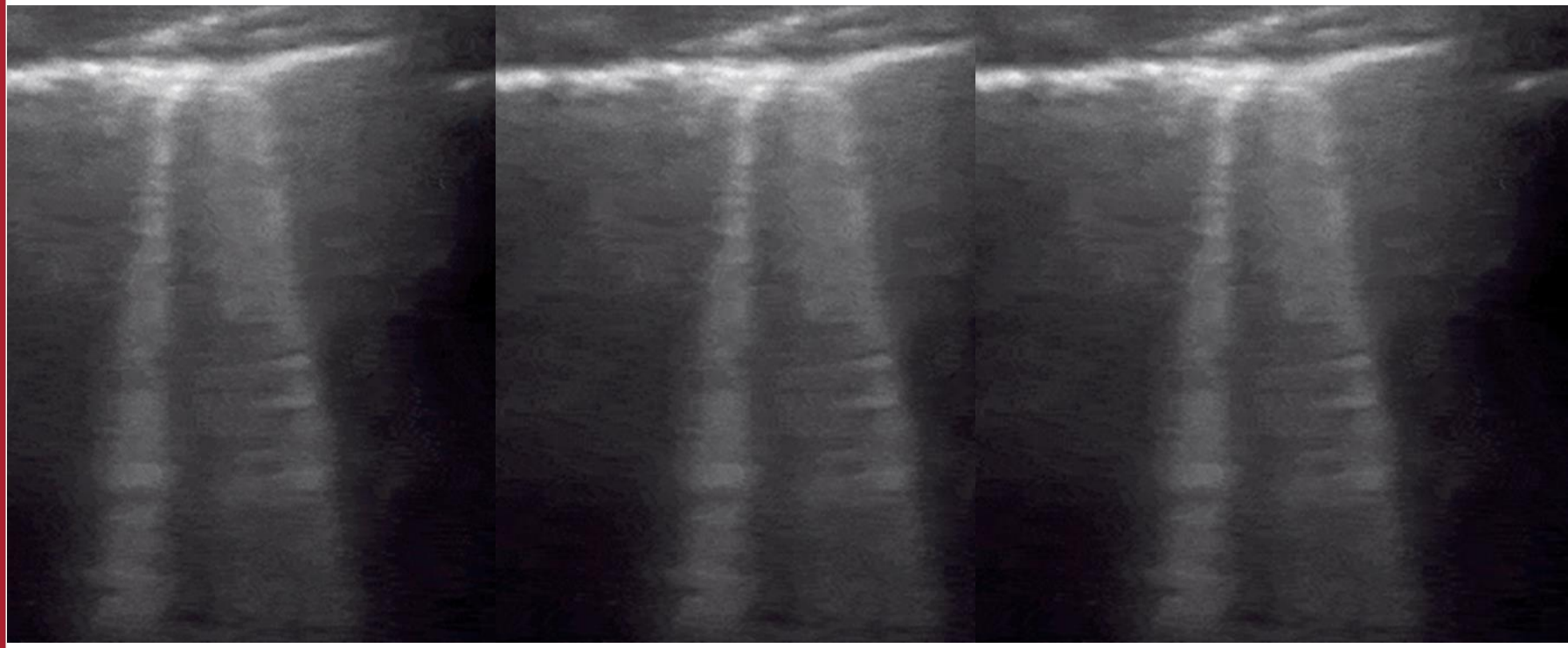


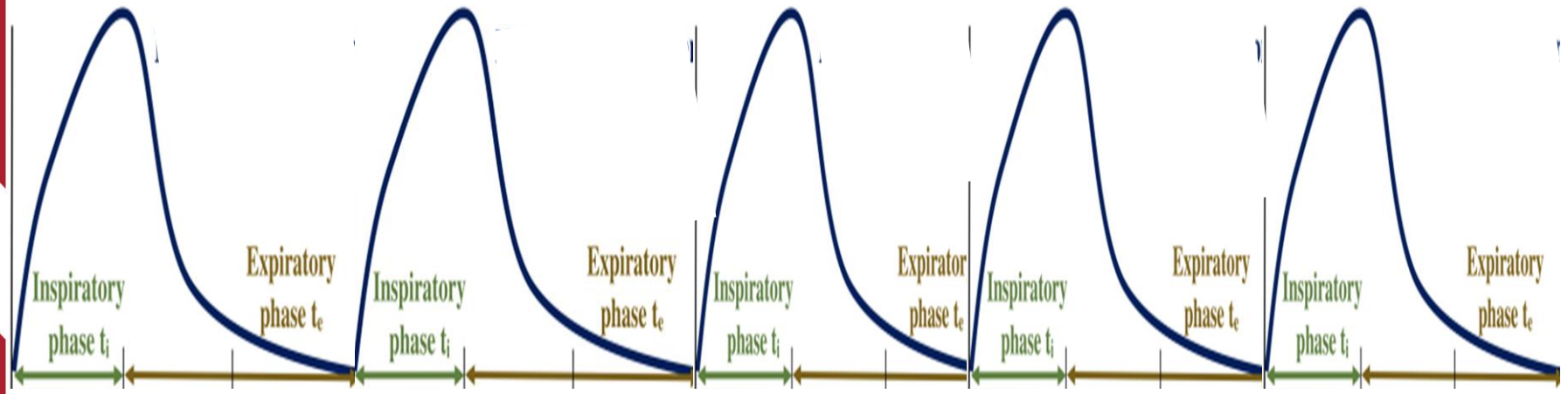
Tachypnea & B-Lines; inspiratory to expiratory ratios about equal





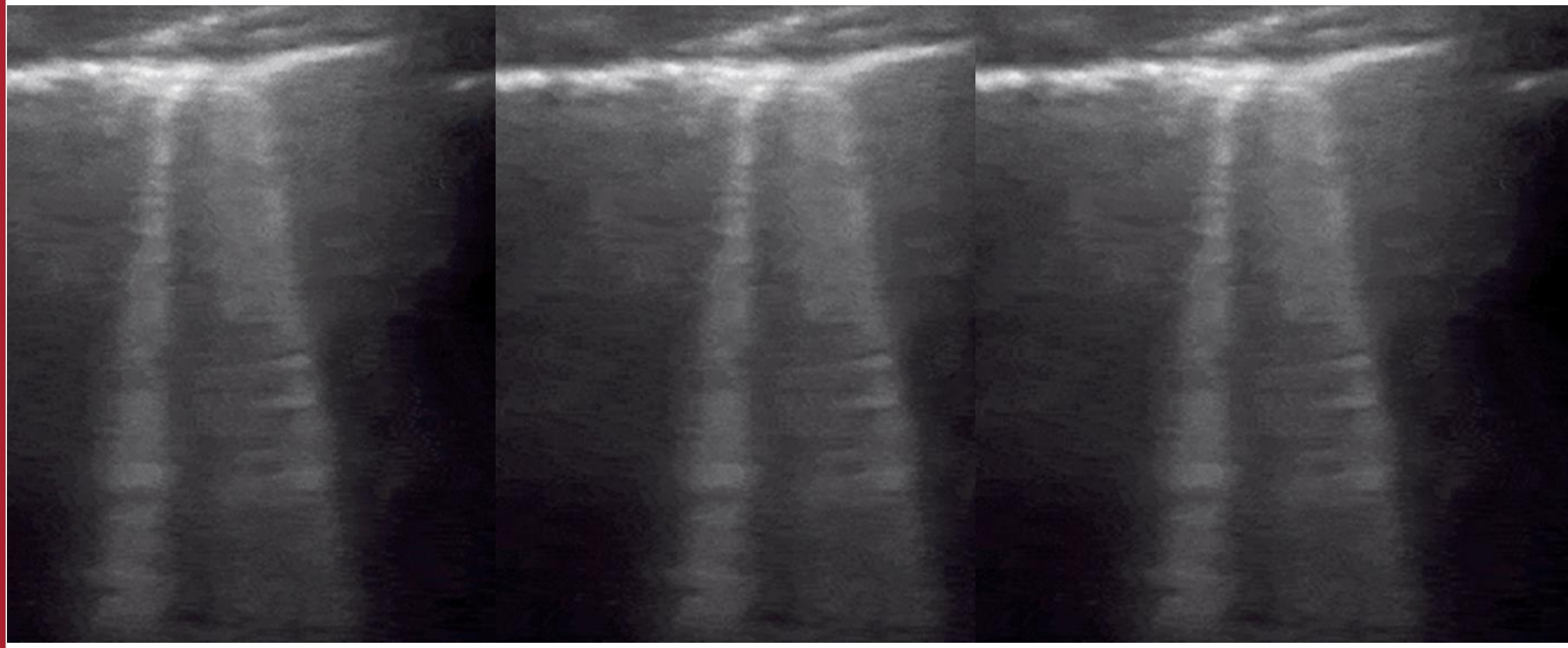
What is your diagnosis?

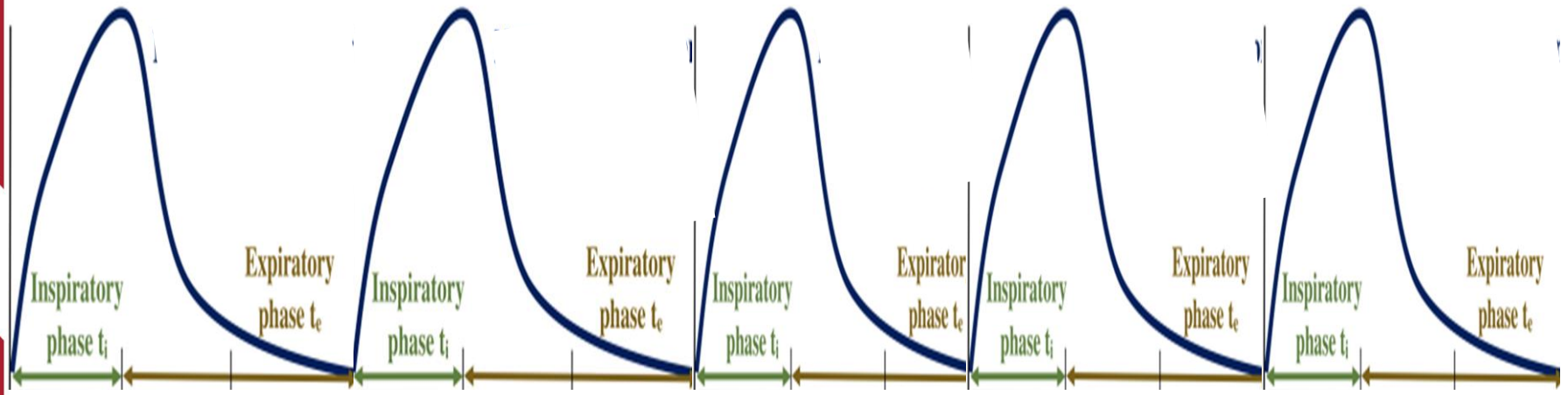




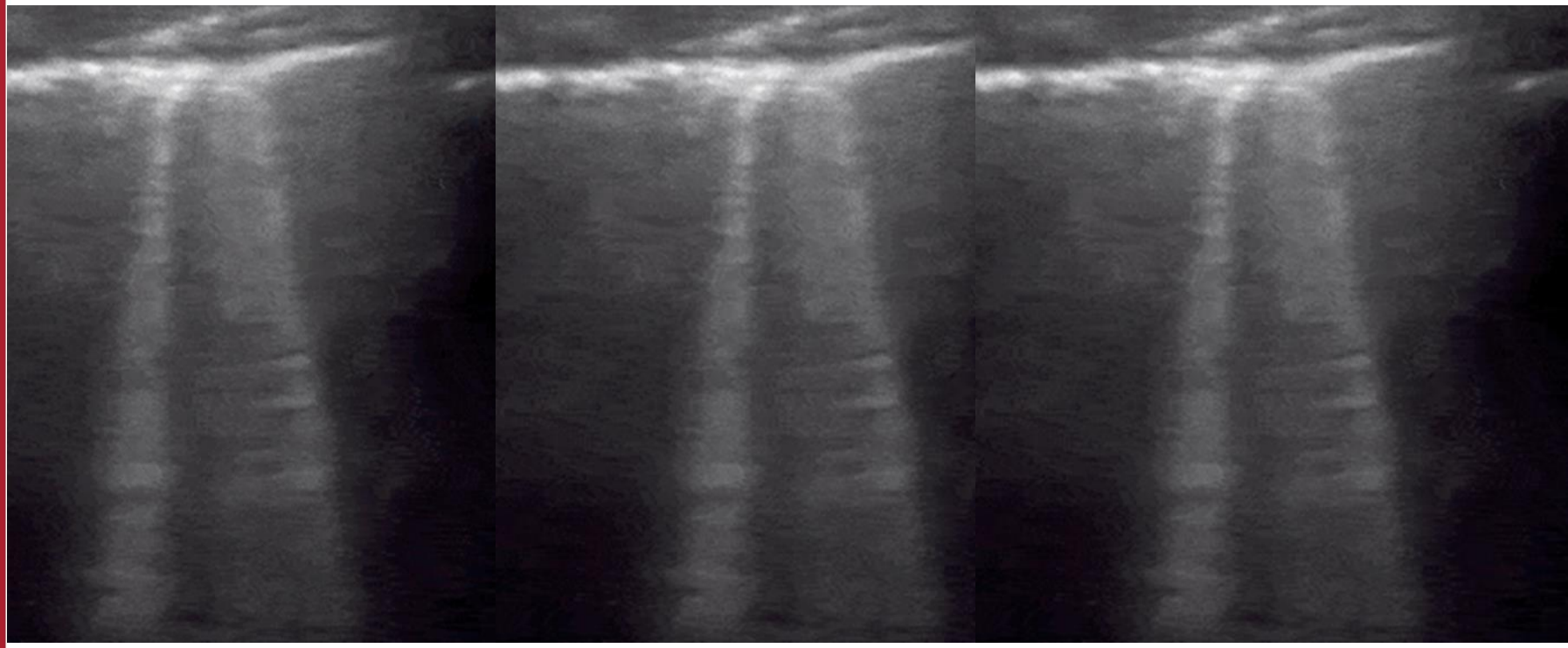
Heart Failure

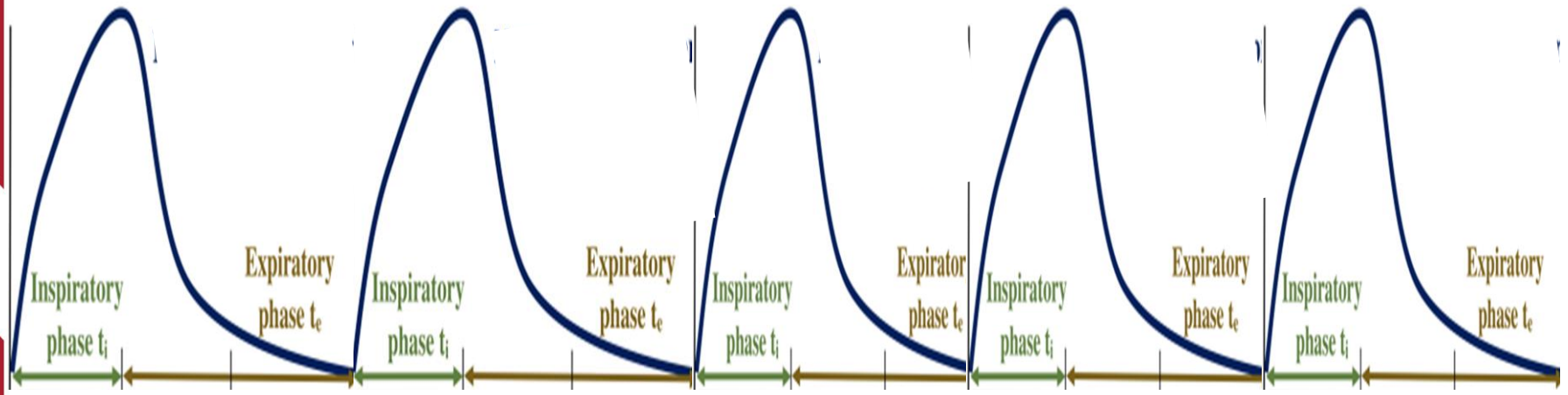
This could wheeze, crackle/rales or be silent





Always correlate to clinical scenario, as sepsis & COVID could also look like this





Jugular Venous Pressure (or HJR)	A-Lines (air-artifact)	B-Lines (beam fluid)
Normal	Asthma COPD	Sepsis (ARDS)
Elevated	Pulmonary Embolism (⬆ JVP only)	Heart Failure (JVP or HJR)

BACK-UP SLIDES

Collect the data before making a diagnosis

- First: SICK or NOT SICK?

- Obtain the VITAL SIGNS
  - Alert or confused?
  - Tachycardic?
  - Fever/No Fever? (or hypothermia?)
  - Blood Pressure adequate for perfusion?
  - Pulse oximeter? (any chance incorrect?)

  - Any risk for Carbon Dioxide Retention?

The Problem:

- All that wheezes is not Asthma (or COPD)

- All Asthma does not wheeze

- Acute hypoxia has many different causes
  - Pulmonary (primary or secondary)
    - Infectious (primary or secondary)
    - Neoplastic (thromboembolic, effusion, etc
  - Cardiac (left and right sided failure)
- OR
  - Blockage of airflow to the alveoli
    - upper or lower airway
  - Alveolar compromise
    - Water
    - Inflammatory soup
    - Consolidation (infection)
  - Space occupying the lung (large effusion)
  - Not enough blood flow (pulmonary embolism)

What are the “normal presumptions” for good oxygenation?

Airway

- Easy air exchange with normal oxygen concentration
- No obstructions or constrictions in the air flow
- Alveoli do not contain anything but air

Alveoli

- Fluid, pus or air filled?

Gas Exchange (pH, basement membrane)

Blood flow/supply

- Decreased “flow” from obstruction or low pressure

Volume of alveoli (compression or destruction)

- Pleural fluid or pulmonary mass vs Emphysema

Asthma-RAD is PRIMARILY an INFLAMMATORY Disease

- Early Phase: Bronchospasm
  - β_2 agonists

- Secondary/late phase: Inflammatory soup
  - Oral steroids stabilize & repair
  - Inhaled steroids: mainstay to reduce inflammation
  - leukotriene inhibitors (weak anti-inflammation)
  - biologics (severe eosinophilic inflammation)

- **Must control the inflammation**
- **β_2 agonists: NO ROLE in inflammation**

Medication Classes (main)

- ❑ Beta-2 Agonists
  SABA/LABA (Short/long)
  - Relaxes smooth muscle
- ❑ Leukotriene inhibitors
  - Controls inflammation (weak)
- ❑ Inhaled corticosteroids
  ICS
  - Controls inflammation (does so very well)
- ❑ Oral steroids
  - Systemic controller
    - "5 days" is standard
    - May take 2-3 weeks for severe inflammation
- ❑ Anti-cholinergics "Muscarinics"
  SAMA/LAMA (Short/long)
  - A type of smooth muscle relaxation
    - COPD Cornerstone
    - Asthma adjunct

Histopathology of the asthmatic airway

Normal airway (left), compared with a
Cross section of a **severe asthmatic airway (right)**

Asthma involves **mucosal inflammation** that most frequently consists of activated eosinophils, mast cells and T lymphocytes…

…within the context of a remodeled airway with mucous metaplasia, an increase in smooth muscle (Sm), fibrosis and angiogenesis. Bm, basement membrane; Bv, blood vessel; Ep, epithelium.

Albuterol Use in Terms of Asthma Guidelines* :

- One canister contains 200 puffs
  - Or, one canister contains 100 treatments
- Mild-intermittent ≤2 treatments/week
  - (52 weeks)(2 treatments)(2puffs)=208
- Therefore “Mild Intermittent Asthma” should really only require one inhaler per year
- Three dispenses of albuterol in any form (inhaler, nebulized-liquid, etc.) IMPLIES uncontrolled asthma
- *AAAI 86(2);190-5….**30% severe and 60% moderate asthmatics consider themselves “well controlled” and “without need” of further controller therapy**

3 Albuterol Canisters/Year…

= 600 puffs/year

= 300 treatments/year/365 days

= Nearly daily albuterol

= ***Moderate persistent asthma***

*Only 27% of clinicians are able to identify patients using albuterol excessively**

So, the first thing to do is to call the pharmacy for a history of asthma medication use (past 18-24 months or so)

**Journal of Pediatrics 136(4) April 2000*

Asthma-RAD is PRIMARILY an INFLAMMATORY Disease

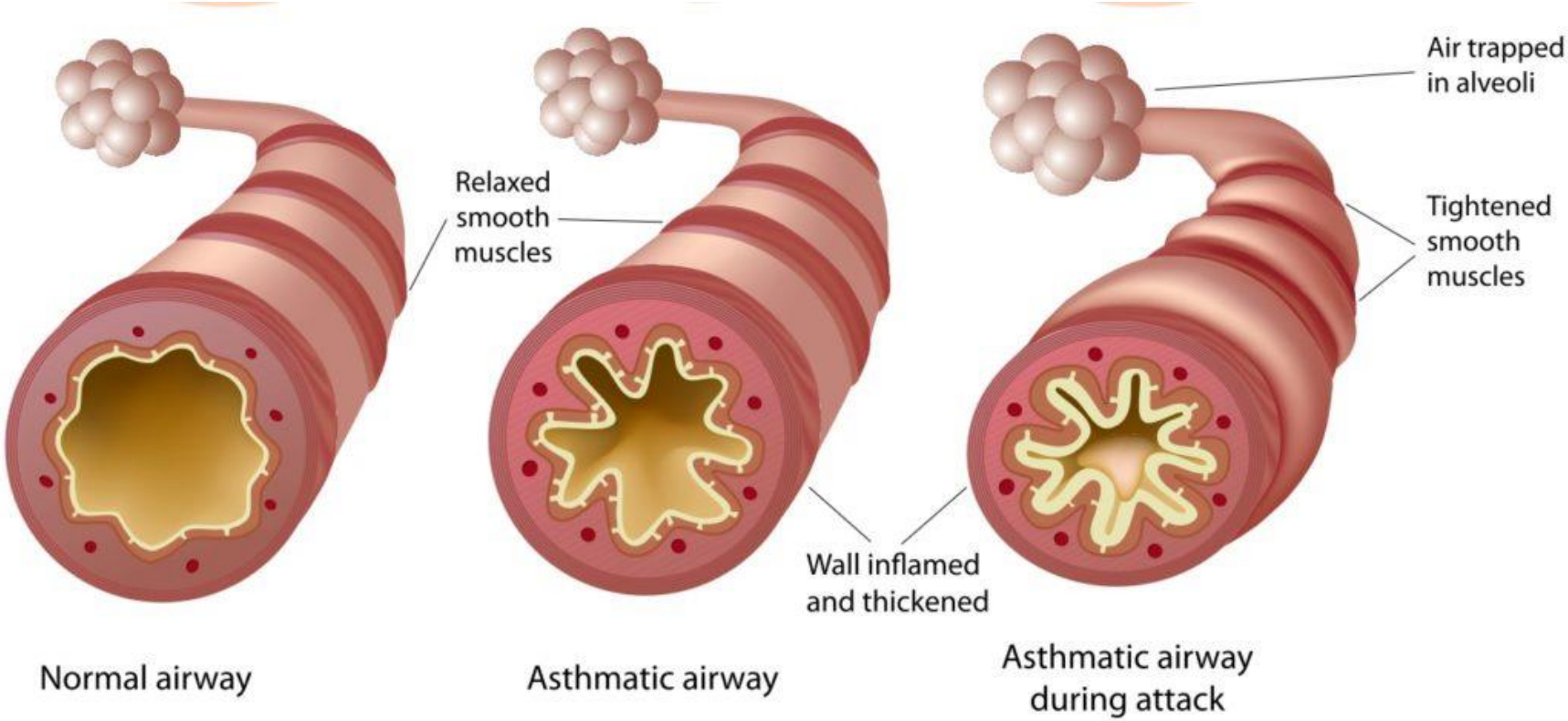
- **Early Phase: Bronchospasm-relaxes smooth muscle**
  - **β_2 agonists** (salbutamol, duo-neb, fomoterol)
  - **β_2 agonists: NO ROLE in inflammation**
  - **Must control the inflammation**
- **Secondary/late phase: Inflammatory soup**
  - **Oral/IV steroids stabilize & repair**
- **Asthma is about CONTROL-prevention**
  - Inhaled steroids: mainstay to reduce inflammation
  - Leukotriene inhibitors (weak anti-inflammation)
  - Biologics (severe eosinophilic inflammation)

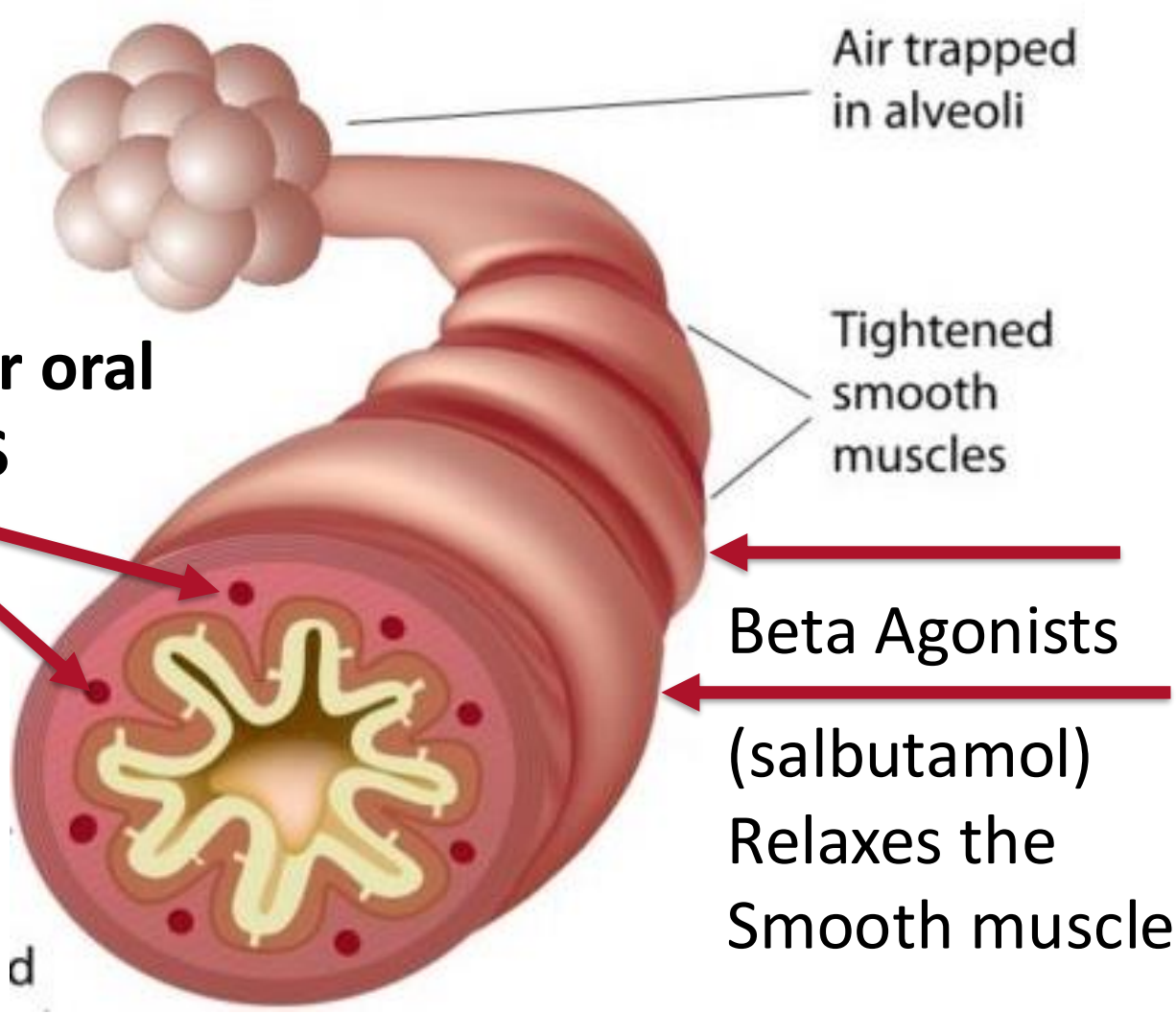
Clinical Issue	Key Clinical Activities and Action Steps
➡ ASTHMA DIAGNOSIS	

	Establish asthma diagnosis.
	▪ Determine that symptoms of recurrent airway obstruction are present, based on history and exam.
	  • History of cough, recurrent wheezing, recurrent difficulty breathing, recurrent chest tightness
	  • Symptoms occur or worsen at night or with exercise, viral infection, exposure to allergens and irritants, changes in weather, hard laughing or crying, stress, or other factors
	▪ In all patients ≥5 years of age, use spirometry to determine that airway obstruction is at least partially reversible.
	▪ Consider other causes of obstruction.

➡ LONG-TERM ASTHMA MANAGEMENT	
GOAL: **Asthma Control**	**Reduce Impairment** ▪ Prevent chronic symptoms. ▪ Require infrequent use of short-acting $beta_2$-agonist (SABA). ▪ Maintain (near) normal lung function and normal activity levels. **Reduce Risk** ▪ Prevent exacerbations. ▪ Minimize need for emergency care, hospitalization. ▪ Prevent loss of lung function (or, for children, prevent reduced lung growth). ▪ Minimize adverse effects of therapy.

Asthma that is not optimally controlled





Inhaled or oral STEROIDS

Beta Agonists

(salbutamol)
Relaxes the
Smooth muscles

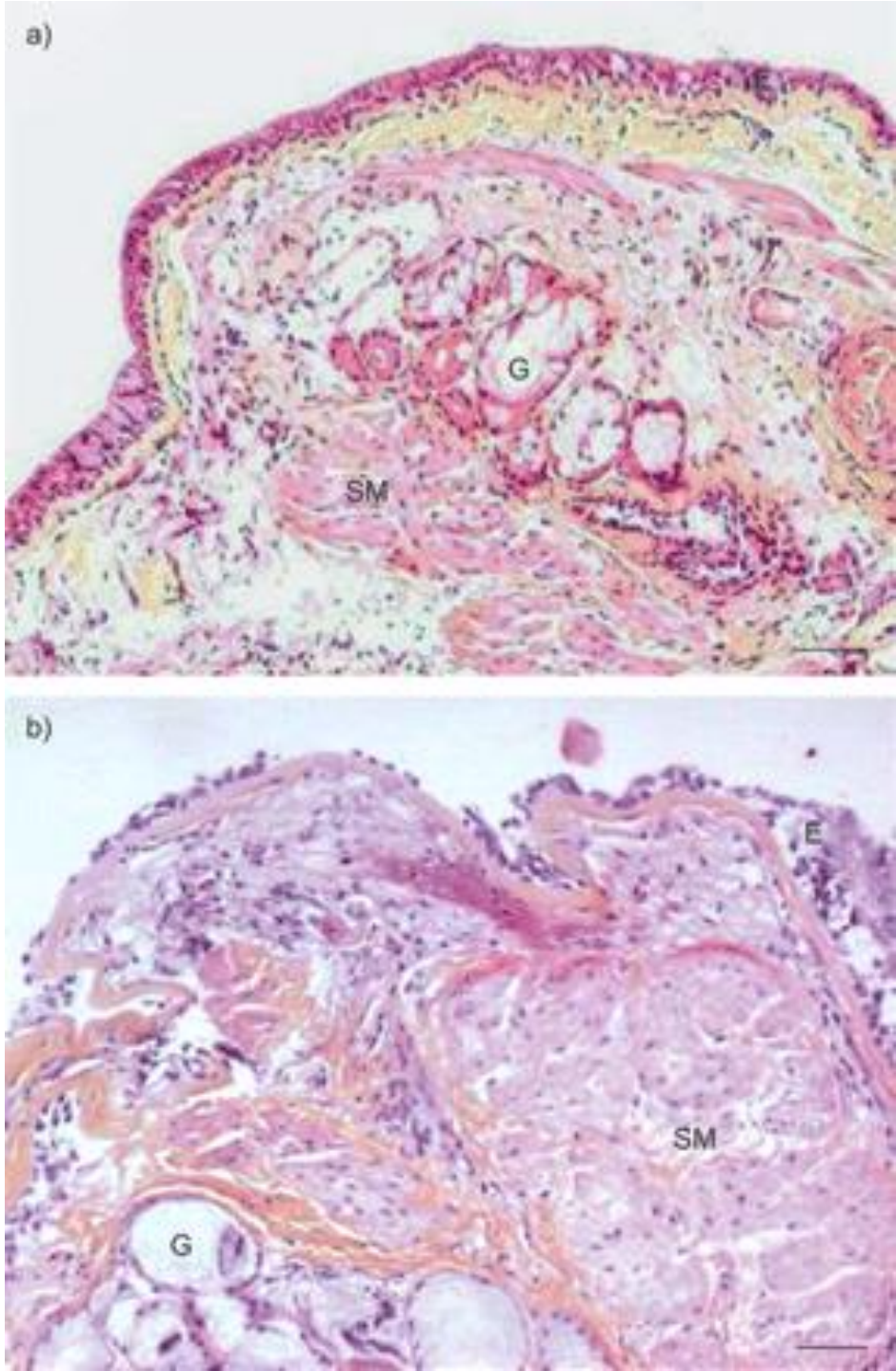
Normal Epithelium

β-agonists & LAMAs

NO EFFECT on inflammation

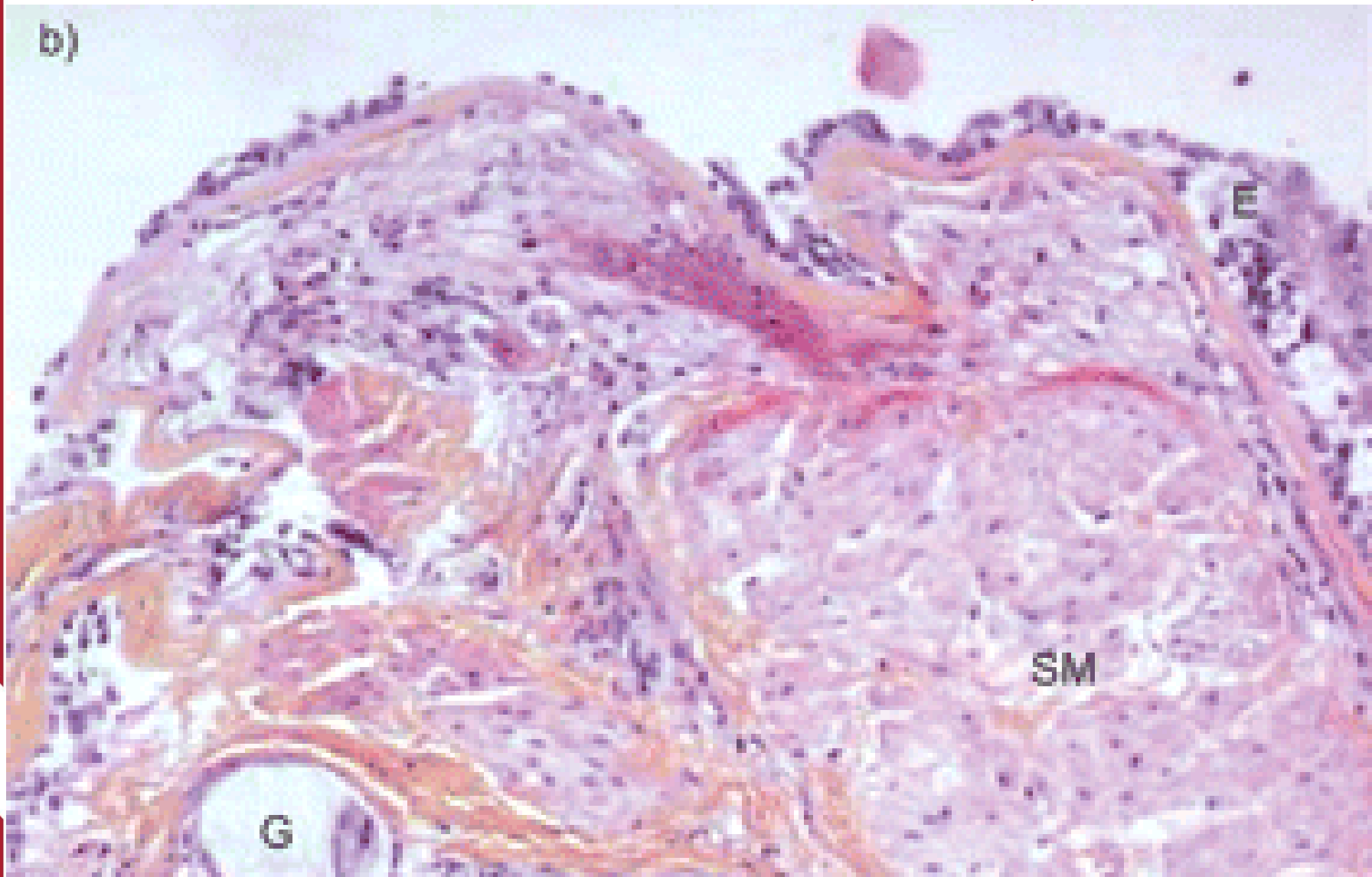
-Need steroids, oral or ICS to restore to normal epithelium

-possible mild effect w/montelukasts

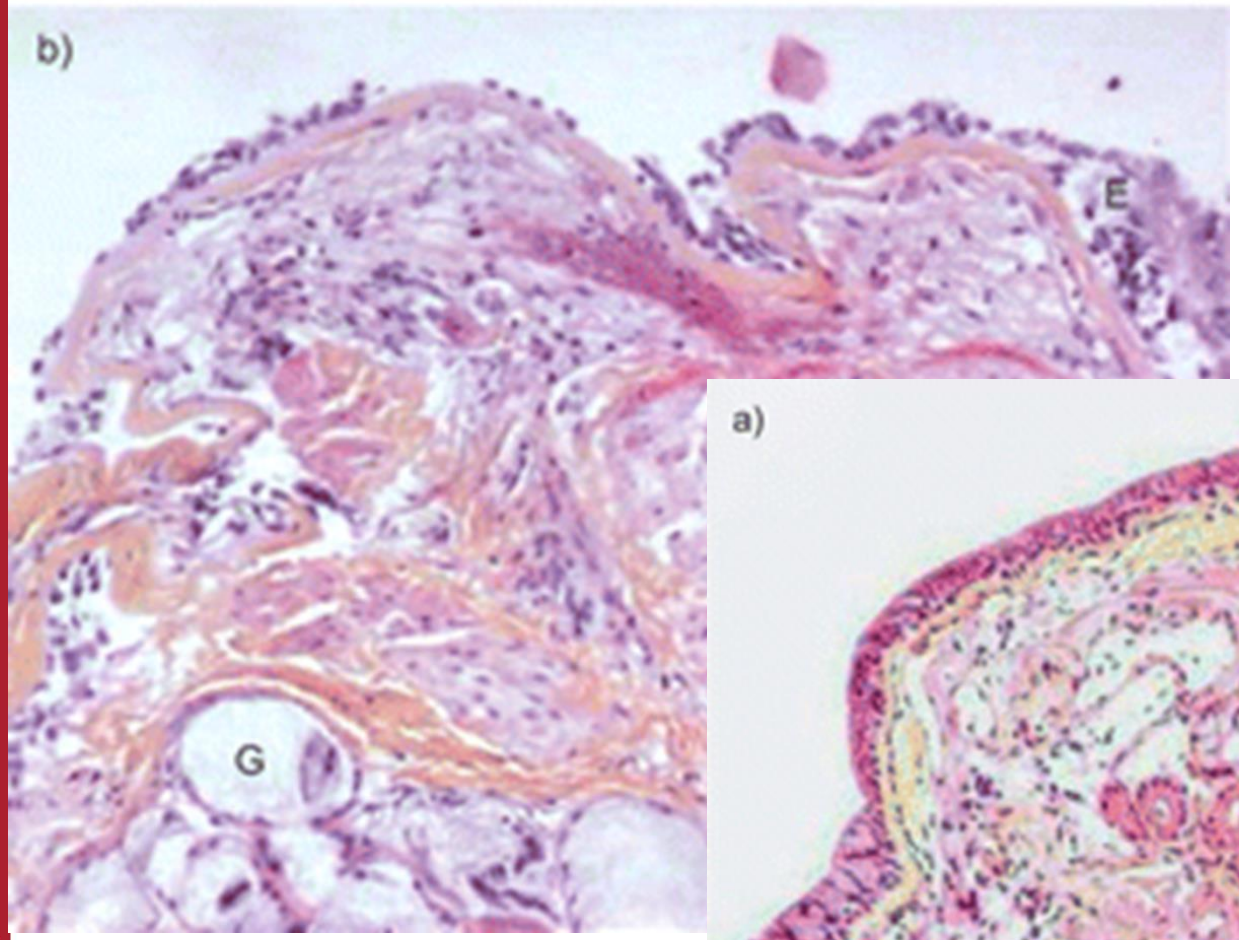


Severe Inflammation:

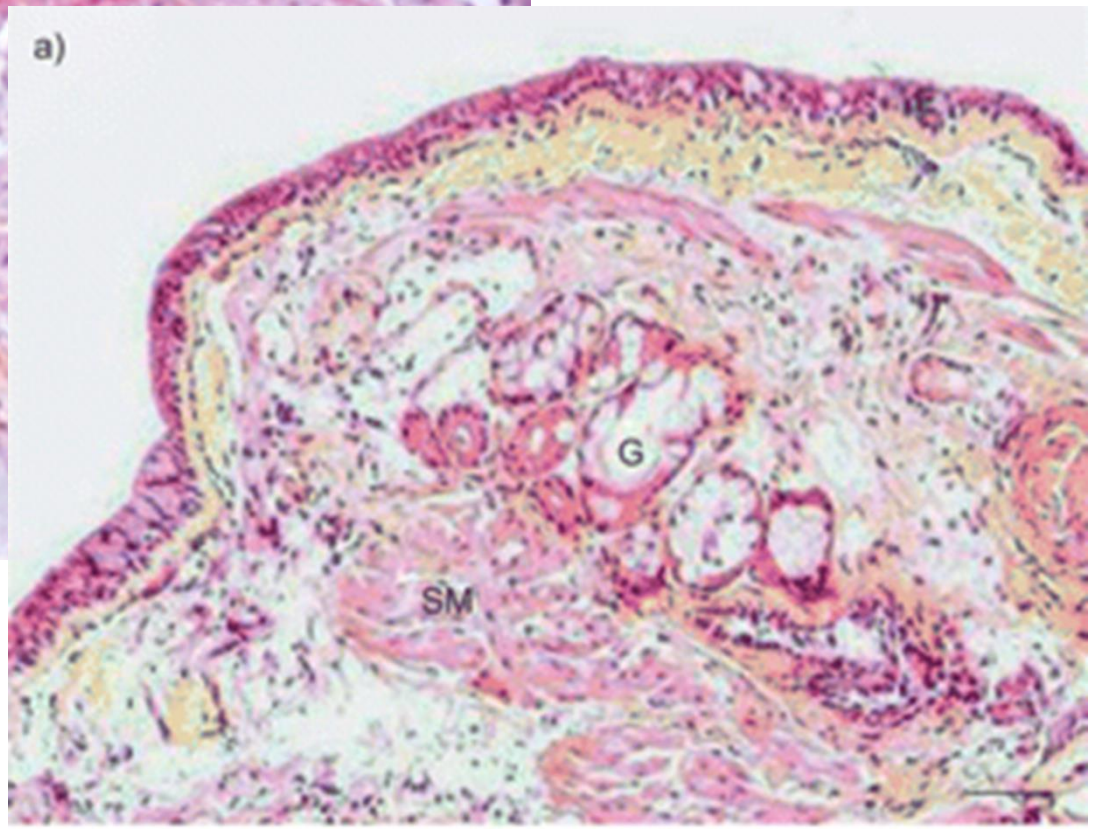
β_2 agonists & muscarinics ("duo-nebs") will not decrease the inflammation—need steroids; ICS or oral



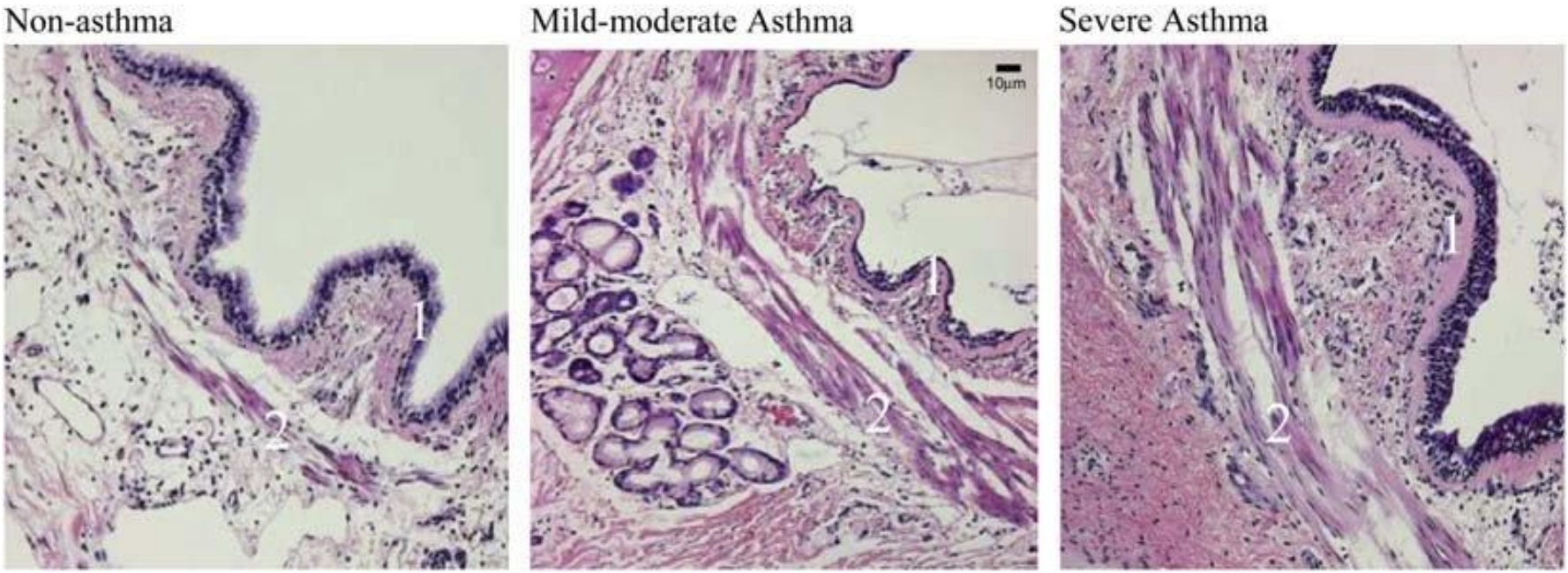
Steroids restore the cilia & epithelial layer - Scarring occurs when ICS are delayed



Peak expiratory flows decrease by 5-10% each year of delaying inhaled steroids



Normal Airway compared to: UNCONTROLLED Mild to Mod RAD & Severe RAD



Uncontrolled inflammation over the years leads to smooth-muscle hyperplasia & Mixed RAD-COPD

Asthma Rescue to Controller Ratio

- Add up all of the beta agonist medications
- Add up all of the inhaled corticosteroid meds
- Combined ICS/LABA counts one for each

- More Beta Agonist than ICS is of concern
- 2:1 β agonist:ICS => RISK for hospitalization

Guideline Pitfalls & Pearls

- Asthma NHLBI Guidelines are “by committee”
- “Steps” assume good patient follow-up
- VERY EASY to not identify uncontrolled asthma, because the Pt says “it is fine”
- Inhaled corticosteroids are expensive & often take convincing of the need for them
- NO Guidelines for mixed asthma-COPD

- **MUST IDENTIFY: FINE vs NOT-FINE**
  - 12-24 months prescription history
  - Controller to rescue ratio (or rescue to controller)
  - A quick peak flow (should be >300 L/min)
  - Point of care spirometry

The Guidelines are cumbersome & do not address do not highlight the critical assessments

- Controlled or not-controlled?
- GAIN THE CONFIDENCE of Pt once the Dx is made
  - Give enough controller to control quickly
  - I err on the side of pouncing to control (& 1/3 of the time I underestimated the steroid need)
  - Many only come in when feeling ill
  - Steroids, with a peak-flow meter, tracking each day, shows the Pt how their lungs are improving
- Give enough controller so that albuterol/rescue is an infrequent event
- ***Track the β-agonist to ≤1 β_2-inhaler needed/year***
- ***Spirometry is your friend (and refill history)***

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Making Spirometry Accessible

- Hand-held portable spirometers range from ~$500 to $5000 and higher (decent quality $2-2.5k)
- Another $5-$20 per session for β agonist & delivery (either spacer or nebulizer treatment)
- GINA Guidelines INCLUDE use of a hand-held Peak-Flow Meter in resource constrained situations
  - 20% reversibility In Peak Exp Flow
  - vs 12% FEV1 for usual PFTs

Different examples of spirometers available online…

Why use a spacer?
Probably 30-80% more efficient

- ❑ You need to know how to use your inhaler correctly for the medicine to get to your lungs and work effectively.
- ❑ In general, using the inhaler without a spacer **requires more coordination** in order to ensure that medicine reaches your lungs.
- ❑ Metered-dose inhalers can spray medicine as fast as **60 miles per hour**, causing the medicine to hit the back of your throat or roof of your mouth.
- ❑ So, when possible, it's best to use a spacer.

https://www.mountsinai.org/health-library/selfcare-instructions/how-to-use-an-inhaler-no-spacer

https://www.nationalasthma.org.au/living-with-asthma/resources/patients-carers/factsheets/spacer-use-and-care

Commercial versus home-made spacers in delivering bronchodilator therapy for acute therapy in children

Cochrane Database of Systematic Reviews - Intervention
Carlos E Rodriguez-Martinez, Monica Sossa, Juan Manuel Lozano
16 April 2008; https://doi.org/10.1002/14651858.CD005536.pub2

all analyzed **outcomes were not significantly different** in delivering bronchodilator therapy

home-made spacers were compared with commercial devices

Sample Home-made Devices

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**Journal of Pediatrics 136(4) April 2000*

Understanding the Beta Agonists & Finding Affordable Medications

Bronchodilator	Mean onset (mins)	Duration of action (hrs)
Formoterol	7.2	12
Salmeterol	14.1	12
Vilanterol	5	24

Abbreviations: mins = minutes, hrs = hours.

Types	**Agonist activity**	**Partition coefficient (Log *P*)**	**Duration of action (hours)**
Short acting			
Salbutamol[5–7,11]	Partial	0.34–0.6	4–6
Terbutaline[7,11]	Partial	0.44–0.55	4–8
Fenoterol[5,7,8,11]	Full	1.36–1.47	6–8
Long acting			
Salmeterol[5–7,11]	Partial	3.61–3.82	12
Formoterol[5–7,11]	Full	1.06–1.91	12
Ultra-long acting			
Indacaterol[5,7,9–11]	Full	3.26–3.31	24

INHALED CORTICOSTEROID Inhaler Strengths

Dosing for Asthma in patients >12 years old

Drug		Daily Dose (mcg)		
Generic	Brand	Low	Medium	High
Beclomethasone	Qvar	100-200	>200-400	>400
Budesonide	Pulmicort	200-400	>400-800	>800
Ciclesonide	Alvesco	80-160	>160-320	>320
Fluticasone furoate	Arnuity Ellipta	100	N/A	200
Fluticasone dipropionate	Flovent	100-250	>250-500	>500
Mometasone fuorate	Asmanex	110-220	>220-440	>440

Global Initiative for Asthma 2018 Report

ICS THERAPY IS THE MAINSTAY IN ASTHMA MANAGEMENT

Amazon Rx & GoodRx

Albuterol (Proventil/ProAir)

Results

90mcg albuterol (1 hfa inhaler (8.5g))

Prescription Required

Albuterol Sulfate Hfa (proair) (200 Actuat

Inhaler · 90mcg · 16-day supply +more

With insurance

est. $10.00

Estimated insurance price. Final price varies with your insurance.

Without insurance

$16.65 ~~$60.61~~

Prime member price, 16-day supply.

amazon pharmacy FREE delivery

Prescription Required

Ipratropium - Albuterol

Inhalation Solution · 0.5mg-3mg/3ml · 30-day supply

With insurance

est. $9.00

Estimated insurance price. Final price varies with your insurance.

Without insurance

$36.50 ~~$144.00~~

Prime member price, 30-day supply.

amazon pharmacy FREE delivery

Prescription Required

Albuterol Sulfate Hfa (proventil) (200 Act

Inhaler · 90mcg · 17-day supply +more

With insurance

est. $10.00

Estimated insurance price. Final price varies with your insurance.

Without insurance

$13.23 ~~$63.78~~

Prime member price, 17-day supply.

amazon pharmacy FREE delivery

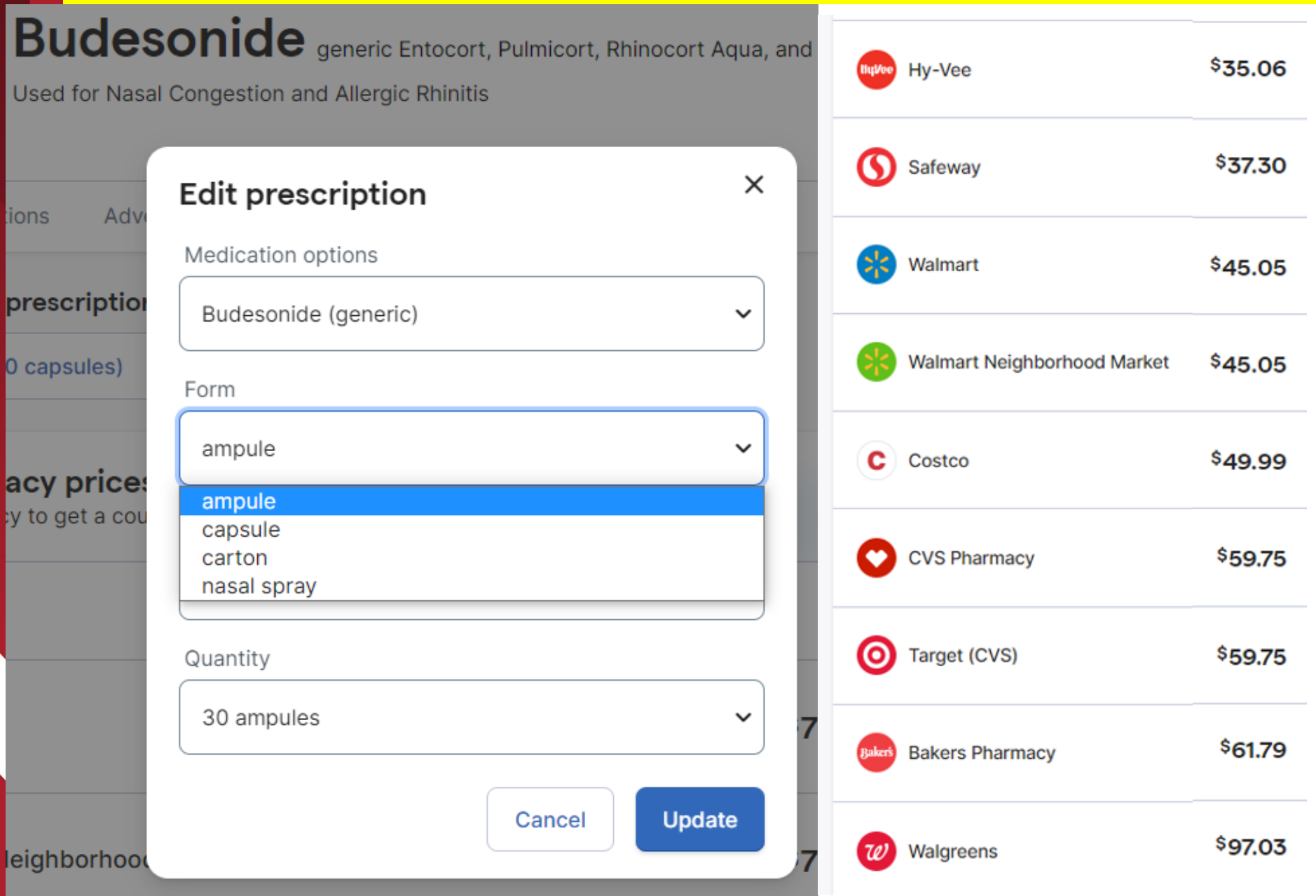
Local pharmacy prices

Choose a pharmacy to get a coupon

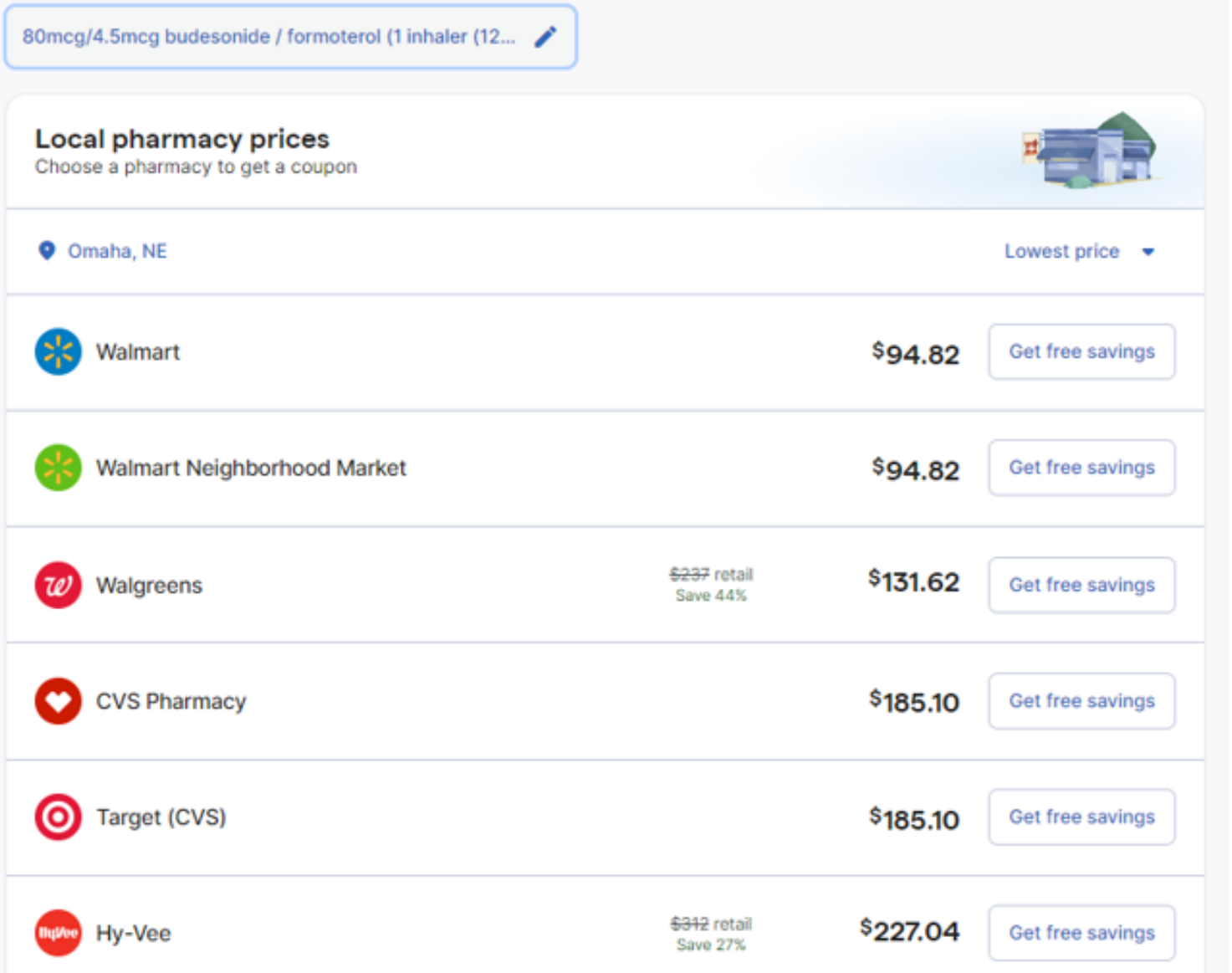
Omaha, NE

Bakers Pharmacy	~~$85~~ retail Save 84%	$13.42
Walmart		$23.00
Walmart Neighborhood Market		$23.00
Hy-Vee	~~$65~~ retail Save 63%	$23.92
Target (CVS)		$24.37
CVS Pharmacy		$24.37
Walgreens	~~$45~~ retail Save 44%	$25.07
Costco		$31.99

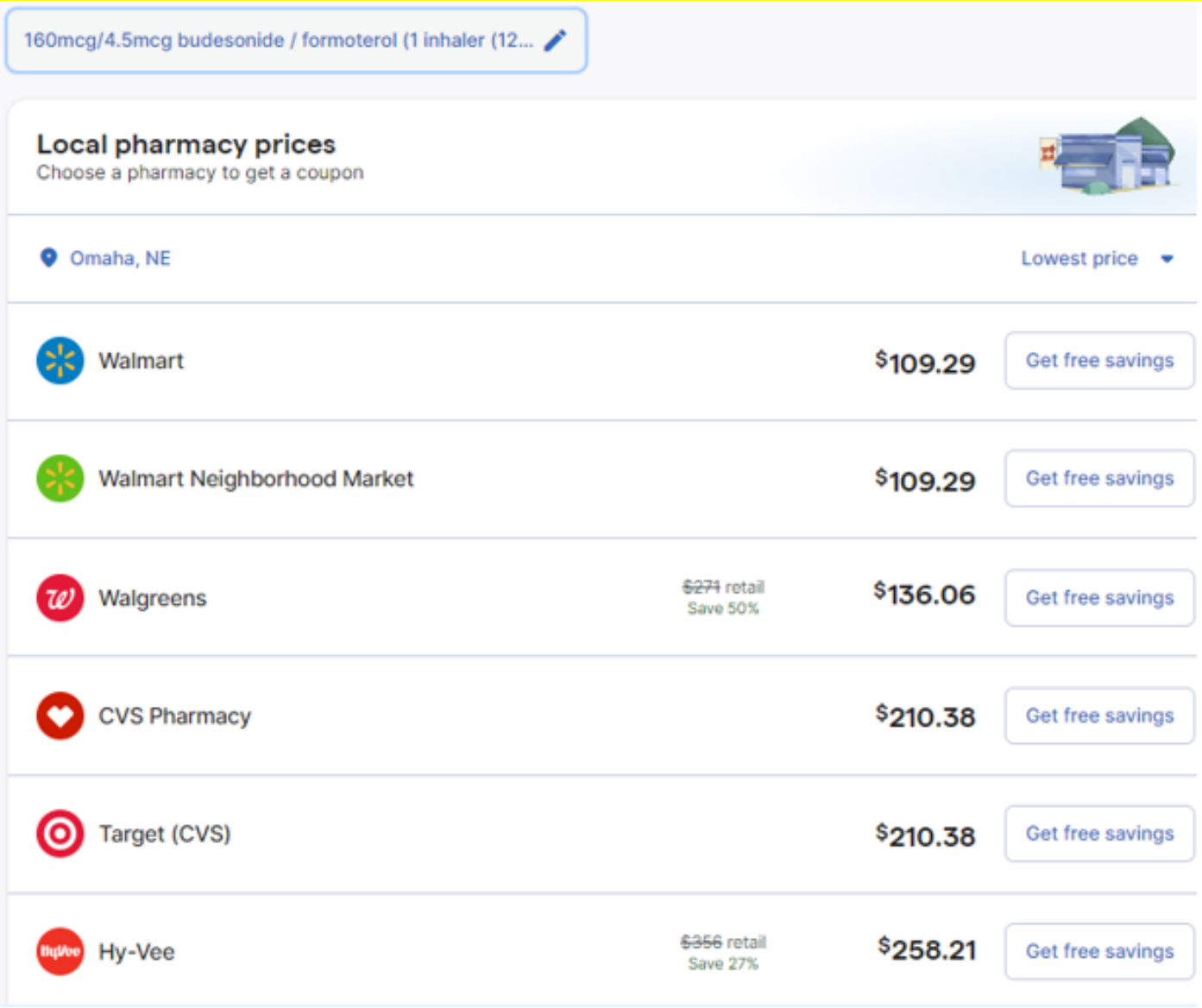
GoodRx.com


Budesonide generic Entocort, Pulmicort, Rhinocort Aqua, and
Used for Nasal Congestion and Allergic Rhinitis
Edit prescription
Medication options
Budesonide (generic)
Form
ampule
ampule
capsule
carton
nasal spray
Quantity
30 ampules
Cancel
Update
Hy-Vee $35.06
Safeway $37.30
Walmart $45.05
Walmart Neighborhood Market $45.05
Costco $49.99
CVS Pharmacy $59.75
Target (CVS) $59.75
Bakers Pharmacy $61.79
Walgreens $97.03

GoodRx: Budesonide/Formoterol Generic (80 mcg/4.5 mcg)



GoodRx: Budesonide/Formoterol Generic (160 mcg/4.5 mcg)



Amazon Rx & GoodRx

Budesonide-Inhalers and Ampules

Prescription Required

Budesonide (Generic for Pulmicort Respules)
Inhalation Solution · 0.5mg/2ml · 30-day supply +more

With insurance
est. $10.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$132.50 ~~$381.60~~
Prime member price, 30-day supply.
amazon pharmacy FREE delivery

Prescription Required

Budesonide - Formoterol (120 Actuations) (Generic for Symbicort)
Inhaler · 160mcg-4.5mcg · 30-day supply +more

With insurance
est. $7.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$254.38 ~~$363.22~~
Prime member price, 30-day supply.
amazon pharmacy FREE delivery

Prescription Required

Symbicort (120 Actuations) (Brand for Budesonide - Formoterol)
Inhaler · 80mcg-4.5mcg · 30-day supply +more

With insurance
est. $40.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$290.49 ~~$368.93~~
Prime member price, 30-day supply.
amazon pharmacy FREE delivery

Hy-Vee	$35.06
Safeway	$37.30
Walmart	$45.05
Walmart Neighborhood Market	$45.05
Costco	$49.99
CVS Pharmacy	$59.75
Target (CVS)	$59.75
Bakers Pharmacy	$61.79
Walgreens	$97.03

Amazon Rx & GoodRx

Generic Fluticasone-Salmeterol 100mcg-50mcg

Results

Prescription Required

Fluticasone - Salmeterol (60 Actuations) (Generic for Advair Diskus
Inhalant Powder · 100mcg-50mcg · 30-day supply +more

With insurance
est. $15.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$88.10 ~~$255.80~~
Prime member price. 30-day supply.
amazon pharmacy FREE delivery

Prescription Required

Wixela Inhub (60 Actuations) (Generic for Advair Diskus (60 Actuati
Inhalant Powder · 100mcg-50mcg · 30-day supply +more

With insurance
est. $40.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$88.10 ~~$256.80~~
Prime member price. 30-day supply.
amazon pharmacy FREE delivery

Prescription Required

Advair Diskus (60 Actuations) (Brand for Fluticasone - Salmeterol (6
Inhalant Powder · 100mcg-50mcg · 30-day supply +more

With insurance
est. $10.00
Estimated insurance price. Final price varies with your insurance.

Without insurance
$323.90 ~~$342.60~~
Prime member price. 30-day supply.
amazon pharmacy FREE delivery

100mcg/50mcg fluticasone / salmeterol (1 diskus inhal...

Local pharmacy prices
Choose a pharmacy to get a coupon

Omaha, NE — Lowest price

Bakers Pharmacy	$61.43	Get free savings
Hy-Vee	$85.20	Get free savings
Walmart	$90.72	Get free savings
Walmart Neighborhood Market	$90.72	Get free savings
CVS Pharmacy	$96.91	Get free savings
Target (CVS)	$96.91	Get free savings
Costco	$99.99	Get free savings
Walgreens	$104.94	Get free savings

Amazon Rx & GoodRx

Fluticasone-Vilanterol 100mcg-25mcg

Prescription Required

Breo Ellipta (30 Actuations)

Inhaler · 100mcg-25mcg · 30-day supply +more

With insurance

est. $25.00

Estimated insurance price varies with your insurance

Without insurance

$364.10 ~~$426.00~~

Prime member price, 30-

amazon pharmacy FREE d

Rite Aid	~~$416~~ retail Save 70%	$122.78	Get free savings
Walgreens	~~$407~~ retail Save 60%	$160.97	Get free savings
Walmart		$250.50	Get free savings
Walmart Neighborhood Market		$250.50	Get free savings
Hy-Vee	~~$416~~ retail Save 38%	$257.65	Get free savings
Safeway	~~$420~~ retail Save 33%	$281.71	Get free savings
CVS Pharmacy		$315.81	Get free savings
Target (CVS)		$315.81	Get free savings
Bakers Pharmacy	~~$416~~ retail Save 8%	$382.32	Get free savings

Conclusions

- Anytime you see more than two albuterol inhalers/year (under age 40) should give concern for uncontrolled asthma
- Titrate “controller” medications to effect
- ***I NEVER give more than 2 albuterol inhalers per Rx***
- Recurrent pneumonias (without a clear CXR pneumonia) should give concern for RAD
- **MOST “exercise induced asthma”** is really just uncontrolled asthma that becomes symptomatic with exercise
- Delaying ICS for RAD leads to RAD-COPD
- Only 27% of clinicians recognize sub-optimally controlled RAD in children
- Nearly everyone says they are “fine”—trust, but verify

Conclusions

- Pulmonary Function Testing (PFT) has a <35% compliance nationally for COPD diagnosis, an NCQA HEDIS measure.
- A large managed care organization demonstrated that 10% of asymptomatic asthma patients with a normal asthma symptom questionnaire were in need of therapeutic adjustment only identified by spirometry testing.
- Designing an affordable, practical, point-of-care clinic work-flow is a win-win quality improvement enhancement we have experienced in our residency clinic.
- It has improved patient compliance for PFT confirmation of COPD, augmented recognition of under-treated asthma, enhanced residency education, boosted clinic revenue and positively impacted clinical therapeutic decision making
- Our clinic had greatly under-estimated the prevalence of the asthma-COPD overlap syndrome, leading to more appropriate ICS/LABA usage

INHALED CORTICOSTEROID Inhaler Strengths

Dosing for Asthma in patients >12 years old

Drug		Daily Dose (mcg)		
Generic	Brand	Low	Medium	High
Beclomethasone	Qvar	100-200	>200-400	>400
Budesonide	Pulmicort	200-400	>400-800	>800
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Mometasone fuorate	Asmanex	110-220	>220-440	>440

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ICS THERAPY IS THE MAINSTAY IN ASTHMA MANAGEMENT

11 yo male c/o not being able to run as much

- Father concerned for exercise induced asthma
- What do you do in your office?

11 yo c/o SOB playing soccer

Gender	Male	Height	62.5 in
Ethnicity	African	Weight	110 lb

FVC (ex only)

Your FEV1

Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/H
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NH

Parameter	Pred	LLN	Pre Best	Trial 4	Trial 5	Trial 2	%Pred
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115
FEV1 [L]	2.51	1.85	2.67	2.67	2.63	2.43	106
FEV1/FVC	0.872	0.768	0.797	0.797	0.821	0.758*	91
FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95
FET [s]	-	-	5.7	5.7	4.5	3.8	-

Why we get a post; +13% in FEV1 2.67L→3.02L post β agonist; +350 ml

Your FEV1 / Predicted: 106%

GOLD(2008)/Hardie — Value Selection — Best Value

Hankinson (NHANES III), 1999 — BTPS (IN/EX) — 1.09/1.02

	%Pred	Post Best	Trial 3	Trial 4	Trial 1	%Pred	%Chg
	115	3.46	3.46	3.40	3.28	118	3
	106	3.02	3.02	2.98	2.73	120	13*
	91	0.871	0.871	0.876	0.834	100	9
	89	3.32	3.32	3.42	2.76	117	32
	95	5.02	5.02	4.87	4.68	88	-8

59 yo Male with “COPD”

Gender	Male	Height	72 in		
Ethnicity	Caucasian	Weight	205 lb	BMI	27.8

FVC (ex only)

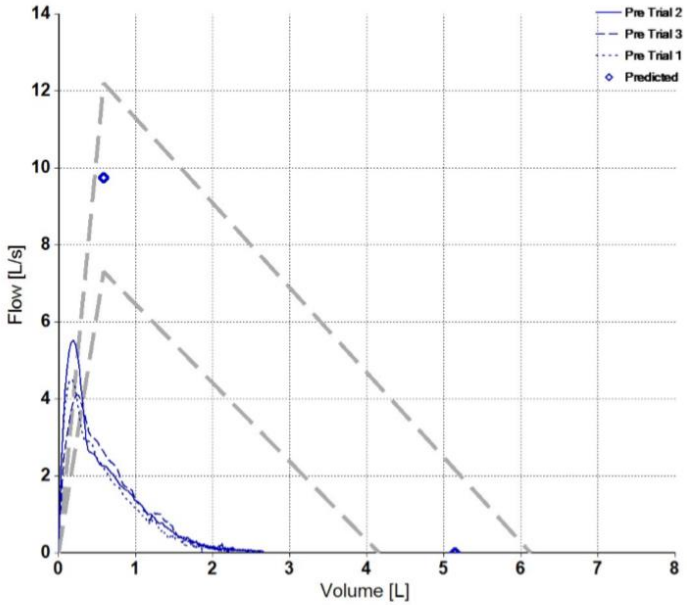
Your FEV1 / Predicted: 40%

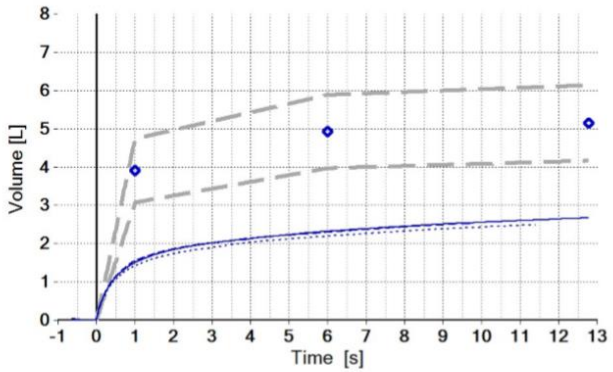
Test Date	3/18/2019 11:38:31 AM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time		Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.11/1.02

			Pre				
Parameter	Pred	LLN	Best	Trial 2	Trial 3	Trial 1	%Pred
FVC [L]	5.14	4.16	2.66*	2.66*	2.52*	2.48*	52
FEV1 [L]	3.90	3.07	1.54*	1.50*	1.54*	1.41*	40
FEV1/FVC	0.758	0.661	0.580*	0.563*	0.613*	0.570*	77
FEF25-75 [L/s]	3.21	1.52	0.49*	0.49*	0.63*	0.49*	15
PEF [L/s]	9.75	7.30	5.53*	5.53*	4.09*	4.50*	57
FET [s]	-	-	12.8	12.8	9.7	11.4	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (2.8%); FVC Var=0.14L (5.4%))
System Interpretation	Pre	Severe Obstruction





Clearly Demonstrates FEV1/FEVC <70%

			Pre				
Parameter	Pred	LLN	Best	Trial 2	Trial 3	Trial 1	%Pred
FVC [L]	5.14	4.16	2.66*	2.66*	2.52*	2.48*	52
FEV1 [L]	3.90	3.07	1.54*	1.50*	1.54*	1.41*	40
FEV1/FVC	0.758	0.661	0.580*	0.563*	0.613*	0.570*	77
FEF25-75 [L/s]	3.21	1.52	0.49*	0.49*	0.63*	0.49*	15
PEF [L/s]	9.75	7.30	5.53*	5.53*	4.09*	4.50*	57
FET [s]	-	-	12.8	12.8	9.7	11.4	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (2.8%); FVC Var=0.14L (5.4%))
System Interpretation	Pre	Severe Obstruction

67 yo Female with “COPD”

Gender	Female	Height	66 in		
Ethnicity	Caucasian	Weight	202 lb	BMI	32.6

FVC (ex only)

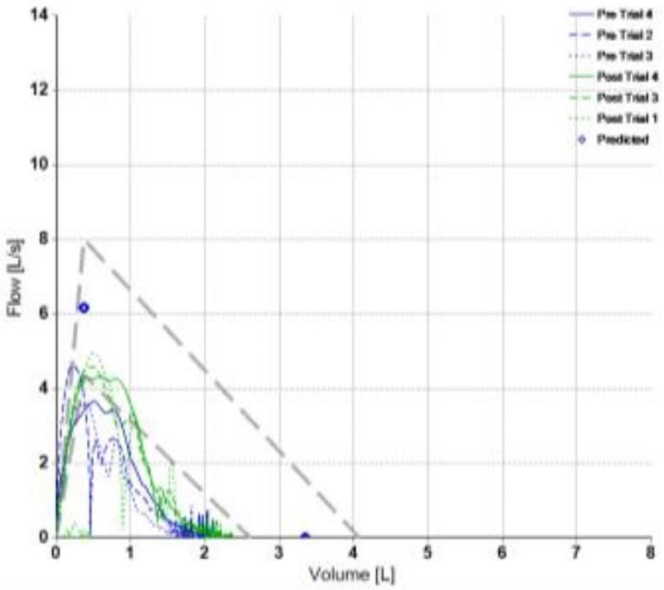
Your FEV1 / Predicted: 62%

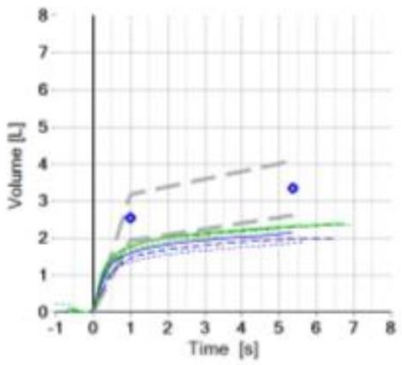
Test Date	3/13/2019 11:15:36 AM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	3/13/2019 11:43:27 AM	Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

			Pre					Post					
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best	Trial 4	Trial 3	~~Trial 1~~	%Pred	%Chg
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*	2.38*	2.37*	2.22*	71	12
FEV1 [L]	2.55	1.93	1.59*	1.59*	1.45*	1.35*	62	1.77*	1.77*	1.76*	1.68*	69	11
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742	0.742	0.743	0.760	97	0
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30	1.30	1.30	1.36	60	7
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59	4.34*	4.59	4.96	74	-1
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8	6.8	6.9	4.9	-	26

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended





“Obstruction” NOT Identified

			Pre					Post
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*
FEV1 [L]	2.55	1.93	1.59*	1.59*	1.45*	1.35*	62	1.77*
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

“Obstruction” NOT Identified

			Pre					Post
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*
FEV1 [L]	2.55	1.93	1.58*	1.59*	1.45*	1.35*	62	1.77*
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8

* Indicates value outside normal range or significant post change.

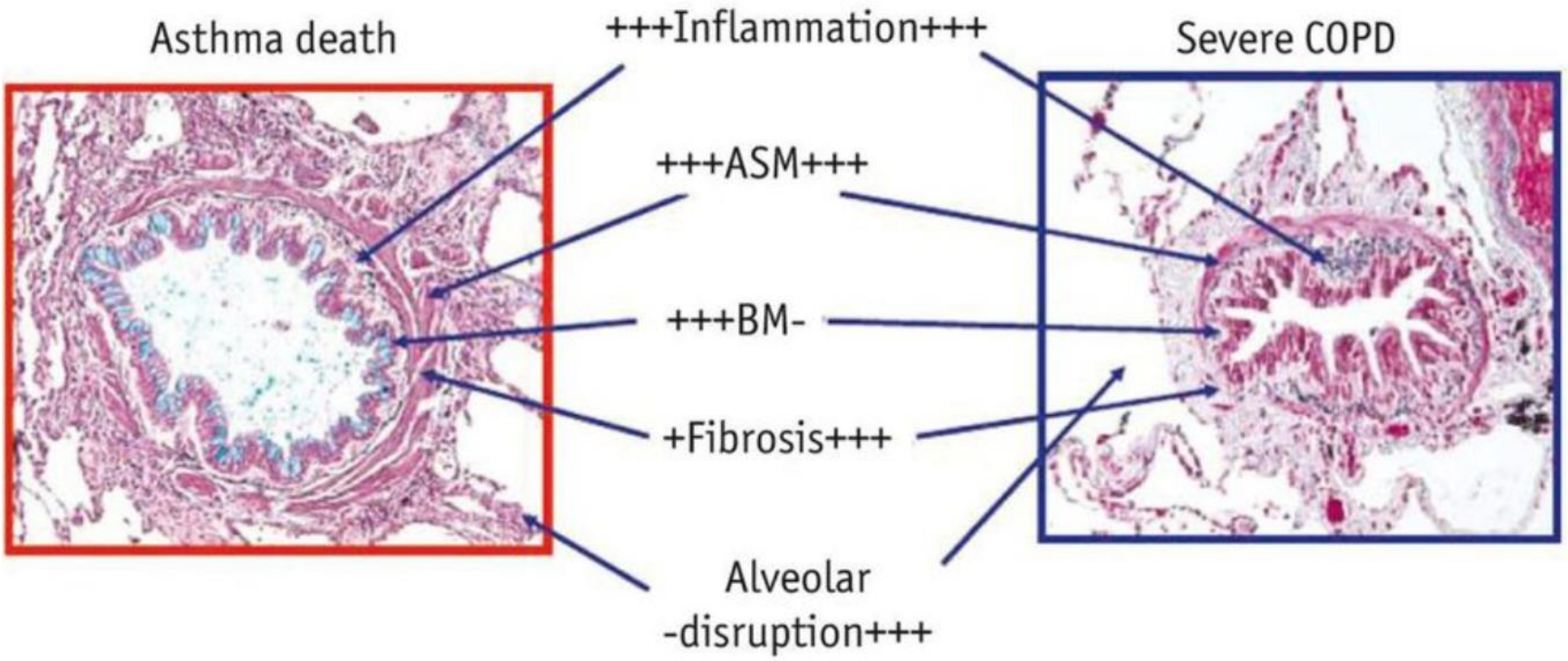
Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

Reversibility & Restriction
Further Examination Recommended

Pre					Post					
Best	Trial 4	Trial 2	Trial 3	%Pred	Best	Trial 4	Trial 3	~~Trial 1~~	%Pred	%Chg
2.14*	2.14*	2.00*	1.89*	64	2.38*	2.38*	2.37*	2.22*	71	12
1.59*	1.59*	1.45*	1.35*	62	1.77*	1.77*	1.76*	1.68*	69	11
0.745	0.745	0.726	0.711	97	0.742	0.742	0.743	0.760	97	0
1.21	1.21	1.15	0.84*	56	1.30	1.30	1.30	1.36	60	7
4.62	3.66*	4.62	3.59*	75	4.59	4.34*	4.59	4.96	74	-1
5.4	5.4	6.5	5.7	-	6.8	6.8	6.9	4.9	-	26

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

Histopathology Contrasts: RAD & COPD



Histopathology of the asthmatic airway

Normal airway (left), compared with a
Cross section of a **severe asthmatic airway (right)**

Asthma involves **mucosal inflammation** that most frequently consists of activated eosinophils, mast cells and T lymphocytes…

…within the context of a remodeled airway with mucous metaplasia, an increase in smooth muscle (Sm), fibrosis and angiogenesis. Bm, basement membrane; Bv, blood vessel; Ep, epithelium.

Airway inflammation is a prominent feature of asthma

T2-type inflammation occurs in >80% of children and in the majority of adults with asthma in association with sensitization to environmental allergens, such as those from dust mites, fungi, pets and pollens

This sensitization is often associated with other clinical manifestations of atopy such as atopic dermatitis (eczema), allergic rhinoconjunctivitis and food allergy.

The inflammatory infiltrate that accompanies T helper 2 (TH2) lymphocyte responses is mainly composed of eosinophils but also includes mast cells, basophils, neutrophils, monocytes and macrophages.

Cellular activation and release of inflammatory mediators in asthma is evidenced by mast cell degranulation and eosinophil vacuolation.

The majority of mucosal mast cells in mild-to-moderate allergic-type asthma are of the TH2 cell-dependant tryptase-expressing type (MCT)28.

In the more intractable forms of asthma, mast cells containing both tryptase and chymase (MCTC) predominate, which are more dependent on stem cell factor (also known as KIT ligand) for their survival than are MCT cells29,30

Pathophysiology of severe asthma: We've only just started--GREGORYG. KING,1,2,3ALANJAMES,1,4,5LOUISEHARKNESS1,3AND PETERA.B. WARK1--Respirology(2018)23, 262–271doi: 10.1111/resp.13251

Inhaled Combined Budesonide–Formoterol as Needed in Mild Asthma

Paul M. O'Byrne, M.B., J. Mark FitzGerald, M.D., Eric D. Bateman, M.D., Peter J. Barnes, M.D., Nanshan Zhong, Ph.D., Christina Keen, M.D., Carin Jorup, M.D., Rosa Lamarca, Ph.D., Stefan Ivanov, M.D., Ph.D., and Helen K. Reddel, M.B., B.S., Ph.D. May 17, 2018; N Engl J Med 2018; 378:1865-1876

DOI: 10.1056/NEJMoa1715274

A DIAGNOSIS

Establish asthma diagnosis.

- Determine that symptoms of recurrent airway obstruction are present, and exam.
  - History of cough, recurrent wheezing, recurrent difficulty breathing chest tightness
  - Symptoms occur or worsen at night or with exercise, viral infection, and irritants, changes in weather, hard laughing or crying, stress, or
- In all patients ≥5 years of age, use spirometry to determine that airway least partially reversible.
- Consider other causes of obstruction.

TERM ASTHMA MANAGEMENT

ontrol

Reduce Impairment

- Prevent chronic symptoms.
- Require infrequent use of short-acting beta$_2$-agonist (SABA).
- Maintain (near) normal lung function and normal activity levels.

Reduce Risk

Clinical Issue	Key Clinical Activities and Action Steps
➡ ASTHMA DIAGNOSIS	

	Establish asthma diagnosis.
	▪ Determine that symptoms of recurrent airway obstruction are present, based on history and exam.
	  • History of cough, recurrent wheezing, recurrent difficulty breathing, recurrent chest tightness
	  • Symptoms occur or worsen at night or with exercise, viral infection, exposure to allergens and irritants, changes in weather, hard laughing or crying, stress, or other factors
	▪ In all patients ≥5 years of age, use spirometry to determine that airway obstruction is at least partially reversible.
	▪ Consider other causes of obstruction.

➡ LONG-TERM ASTHMA MANAGEMENT	
GOAL: **Asthma Control**	**Reduce Impairment** ▪ Prevent chronic symptoms. ▪ Require infrequent use of short-acting $beta_2$-agonist (SABA). ▪ Maintain (near) normal lung function and normal activity levels. **Reduce Risk** ▪ Prevent exacerbations. ▪ Minimize need for emergency care, hospitalization. ▪ Prevent loss of lung function (or, for children, prevent reduced lung growth). ▪ Minimize adverse effects of therapy.

KEY POINTS: OVERVIEW OF MEASURES OF ASTHMA ASSESSMENT AND MONITORING

- The functions of assessment and monitoring are closely linked to the concepts of severity, control, and responsiveness to treatment:
  - Severity: the intrinsic intensity of the disease process. Severity is measured most easily and directly in a patient not receiving long-term-control therapy.
  - Control: the degree to which the manifestations of asthma (symptoms, functional impairments, and risks of untoward events) are minimized and the goals of therapy are met.
  - Responsiveness: the ease with which asthma control is achieved by therapy.
- Both severity and control include the domains of current impairment and future risk:
  - Impairment: frequency and intensity of symptoms and functional limitations the patient is experiencing or has recently experienced
  - Risk: the likelihood of either asthma exacerbations, progressive decline in lung function (or, for children, reduced lung growth), or risk of adverse effects from medication

KEY POINTS: DIAGNOSIS OF ASTHMA

- To establish a diagnosis of asthma, the clinician should determine that (EPR—2 1997):
  - — Episodic symptoms of airflow obstruction or airway hyperresponsiveness are present.
  - — Airflow obstruction is at least partially reversible.
  - — Alternative diagnoses are excluded.
- Recommended methods to establish the diagnosis are (EPR—2 1997):
  - — Detailed medical history.
  - — Physical exam focusing on the upper respiratory tract, chest, and skin.
  - — Spirometry to demonstrate obstruction and assess reversibility, including in children 5 years of age or older. Reversibility is determined either by an increase in FEV_1 of ≥12 percent from baseline or by an increase ≥10 percent of predicted FEV_1 after inhalation of a short-acting bronchodilator.
  - — Additional studies as necessary to exclude alternate diagnoses.

Layout Selection

Gender	Male	Height	62.5 in
Ethnicity	African	Weight	110 lb

FVC (ex only)

Your FEV1

Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/H
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NH

			Pre				
Parameter	Pred	LLN	Best	Trial 4	Trial 5	Trial 2	%Pred
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115
FEV1 [L]	2.51	1.85	2.67	2.67	2.63	2.43	106
FEV1/FVC	0.872	0.768	0.797	0.797	0.821	0.758*	91
FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95
FET [s]	-	-	5.7	5.7	4.5	3.8	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (1.4%); FVC Var=0.14L (4.2%))
	Post	A (FEV1 Var=0.03L (1.2%); FVC Var=0.06L (1.8%))
System Interpretation	Pre	Normal Spirometry
	Post	Normal Spirometry

What do you do with this information?

Layout Selection

Gender	Male	Height	62.5 in
Ethnicity	African	Weight	110 lb

FVC (ex only)

Your FEV1

Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/H
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NH

			Pre				
Parameter	Pred	LLN	Best	Trial 4	Trial 5	Trial 2	%Pred
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115
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FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95
FET [s]	-	-	5.7	5.7	4.5	3.8	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (1.4%); FVC Var=0.14L (4.2%))
	Post	A (FEV1 Var=0.03L (1.2%); FVC Var=0.06L (1.8%))
System Interpretation	Pre	Normal Spirometry
	Post	Normal Spirometry

I added a post-albuterol

Gender	Male	Height	62.5 in		
Ethnicity	African	Weight	110 lb	BMI	19.8

FVC (ex only)

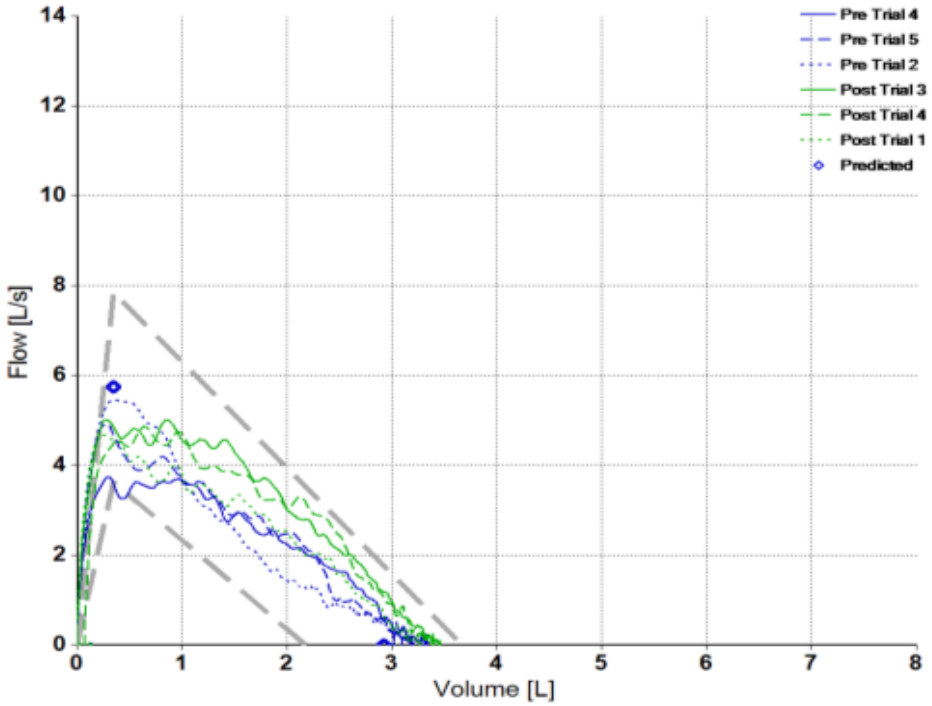
Your FEV1 / Predicted: 106%

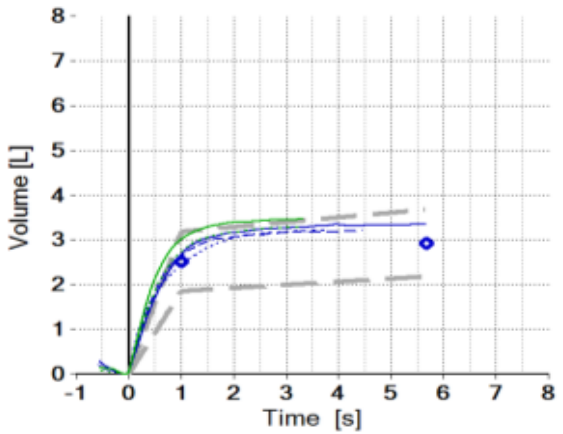
Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

			Pre					Post					
Parameter	Pred	LLN	Best	Trial 4	Trial 5	Trial 2	%Pred	Best	Trial 3	Trial 4	Trial 1	%Pred	%Chg
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115	3.46	3.46	3.40	3.28	118	3
FEV1 [L]	2.51	1.85	2.67	2.67	2.63	2.43	106	3.02	3.02	2.98	2.73	120	13*
FEV1/FVC	0.872	0.768	0.797	0.797	0.821	0.758*	91	0.871	0.871	0.876	0.834	100	9
FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89	3.32	3.32	3.42	2.76	117	32
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95	5.02	5.02	4.87	4.68	88	-8
FET [s]	-	-	5.7	5.7	4.5	3.8	-	3.3	3.3	2.7	3.2	-	-41

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (1.4%); FVC Var=0.14L (4.2%))
	Post	A (FEV1 Var=0.03L (1.2%); FVC Var=0.06L (1.8%))
System Interpretation	Pre	Normal Spirometry
	Post	Normal Spirometry





Your FEV1 / Predicted: 106%

GOLD(2008)/Hardie	Value Selection	Best Value
Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

		Post					
al 2	%Pred	Best	Trial 3	Trial 4	Trial 1	%Pred	%Chg
3.21	115	3.46	3.46	3.40	3.28	118	3
.43	106	3.02	3.02	2.98	2.73	120	13*
58*	91	0.871	0.871	0.876	0.834	100	9
.96	89	3.32	3.32	3.42	2.76	117	32
.46	95	5.02	5.02	4.87	4.68	88	-8
3.8	-	3.3	3.3	2.7	3.2	-	-41

ar=0.14L (4.2%))

ar=0.06L (1.8%))

What do you do now?

Ethnicity	Asian	Weight	103 lb	BMI	19.8

FVC (ex only)

Your FEV1 / Predicted: 60%

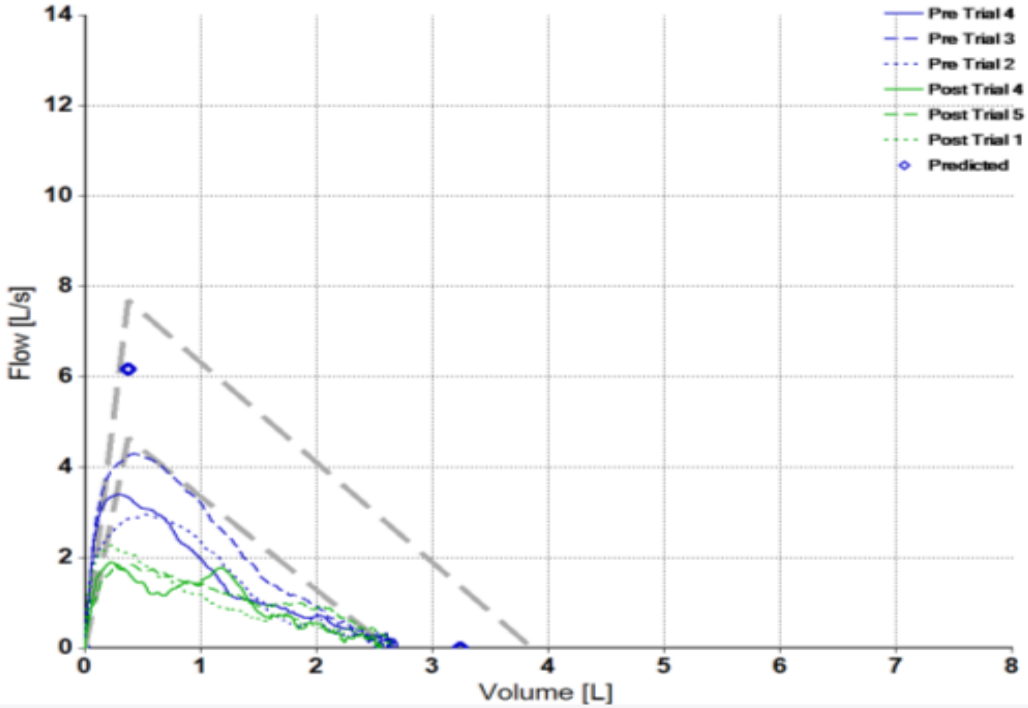
Test Date	6/14/2018 9:26:09 AM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	6/14/2018 9:40:22 AM	Predicted	Hankinson (NHANES III), 1999 * 1.00	BTPS (IN/EX)	1.09/1.02

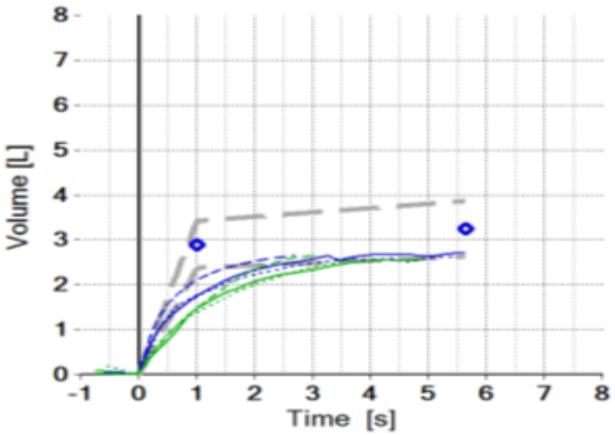
			Pre					Post					
Parameter	Pred	LLN	Best	Trial 4	~~Trial 3~~	~~Trial 2~~	%Pred	Best	Trial 4	~~Trial 5~~	~~Trial 1~~	%Pred	%Chg
FVC [L]	3.24	2.62	2.70	2.70	2.64	2.61*	83	2.56*	2.56*	2.64	2.54*	79	-5
FEV1 [L]	2.89	2.37	1.74*	1.74*	2.10*	1.75*	60	1.46*	1.46*	1.47*	1.38*	51	-16
FEV1/FVC	0.874	0.776	0.645*	0.645*	0.793	0.669*	74	0.573*	0.573*	0.557*	0.542*	66	-11
FEF25-75 [L/s]	3.60	2.49	1.14*	1.14*	1.87*	1.11*	32	0.97*	0.97*	1.13*	0.84*	27	-14
PEF [L/s]	6.17	4.64	3.40*	3.40*	4.29*	2.95*	55	1.90*	1.90*	1.85*	2.27*	31	-44
FET [s]	-	-	5.6	5.6	2.7	5.5	-	4.9	4.9	3.1	3.7	-	-13

Caution: Poor session quality. Interpret with care

* Indicates value outside normal range or significant post change.

Session Quality	Pre	D - Only one acceptable trial
	Post	D - Only one acceptable trial
System Interpretation	Pre	No interpretation, not enough acceptable maneuvers
	Post	No interpretation, not enough acceptable maneuvers





59 yo Male w/cough x 1 month

59 yo Male w/cough x 1 month

Gender	Male	Height	64 in		
Ethnicity	Caucasian	Weight	180 lb	BMI	30.9

FVC (ex only)

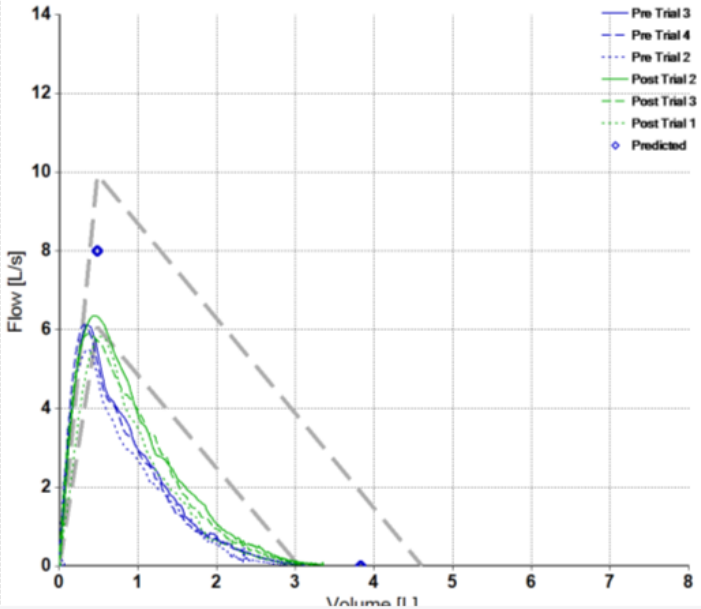
Your FEV1 / Predicted: 70%

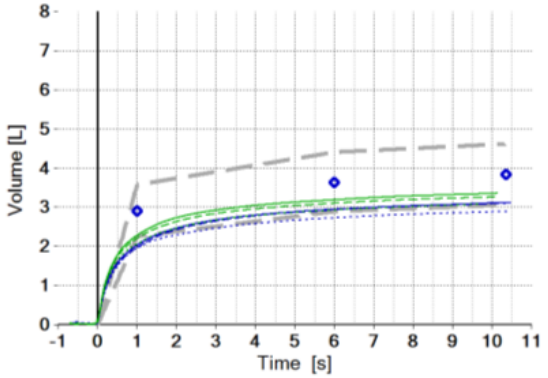
Test Date	4/3/2019 4:49:37 PM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	4/3/2019 5:09:22 PM	Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

			Pre					Post					
Parameter	Pred	LLN	Best	Trial 3	Trial 4	Trial 2	%Pred	Best	Trial 2	Trial 3	Trial 1	%Pred	%Chg
FVC [L]	3.83	3.06	3.11	3.11	3.11	2.89*	81	3.36	3.36	3.26	3.08	88	8
FEV1 [L]	2.91	2.25	2.04*	2.04*	1.97*	1.96*	70	2.28	2.28	2.21*	2.06*	78	12
FEV1/FVC	0.758	0.661	0.654*	0.654*	0.634*	0.676	86	0.679	0.679	0.677	0.669	90	4
FEF25-75 [L/s]	2.49	1.15	1.07*	1.07*	1.00*	1.10*	43	1.31	1.31	1.25	1.14*	53	22
PEF [L/s]	8.00	6.06	6.14	6.12	6.14	5.51*	77	6.36	6.36	5.88*	5.83*	79	4
FET [s]	-	-	10.4	10.4	10.5	10.4	-	10.1	10.1	10.1	9.8	-	-2

* Indicates value outside normal range or significant post change.

Session Quality	Pre	A (FEV1 Var=0.07L (3.3%); FVC Var=0.01L (0.3%))
	Post	A (FEV1 Var=0.07L (3.2%); FVC Var=0.10L (2.8%))
System Interpretation	Pre	Moderate Obstruction
	Post	Moderate Obstruction





Lovelace Disease Management:

More Rescue Than Controller:

{Short Beta-2's > Inhaled Steroids}

(R>C)

Equals "Uncontrolled" Asthma

Lovelace Targets for Education those with ***R>C***

Personal Observation:

Those admitted for an asthma exacerbation often had double the

Rescue to **Controller**

dispensed the year prior or…

$$R:C \geq 2$$

Therefore…

…could a one year medication history of "Rescue" to "Controllers"

(R:C)

***dispensed* identify a population at greater risk for hospitalization?**

Rescue:	ALBUTEROL	**11**
08 Apr 99	ALB--INH 90MCG/INH INH	1
13 May 99	ALB--INH 90MCG/INH INH	1
27 Jun 99	ALB--INH 90MCG/INH INH	1
01 Aug 99	ALB--INH 90MCG/INH INH	1
31 Aug 99	ALB--INH 90MCG/INH INH	1
26 Sep 99	ALB--INH 90MCG/INH INH	1
16 Oct 99	ALB--INH 90MCG/INH INH	2
17 Nov 99	ALB--INH 90MCG/INH INH	1
17 Jan 00	ALB--INH 90MCG/INH INH	1
16 Feb 00	ALB--INH 90MCG/INH INH	1

R:C

11:4

=

Controller:	AZMACORT	**4**
08 Apr 99	AZMACORT--INH 200MCG	1
29 Aug 99	AZMACORT--INH 200MCG	1
22 Oct 99	AZMACORT--INH 200MCG	1
17 Jan 00	AZMACORT--INH 200MCG	1

3.75

Results:

120 patients with 15 admissions

49 were controlled = **(R:C) ≤ 1 or R≤C**

1 admitted (2%)

mean ratio ***0.58*** *95% CI:* ***0.49-0.67***

71 were uncontrolled = **(R:C) > 1 or R >C**

14 *admitted* ***(20%)***

Mean ratio ***3.6*** *95% CI:* ***1.7-5.5***

P=0.004

Further Analysis of the R>C

54 of 71 uncontrolled were “high risk”

R:C≥2 (mean ratio 4.8)

14 of the 15 admits were “high risk”

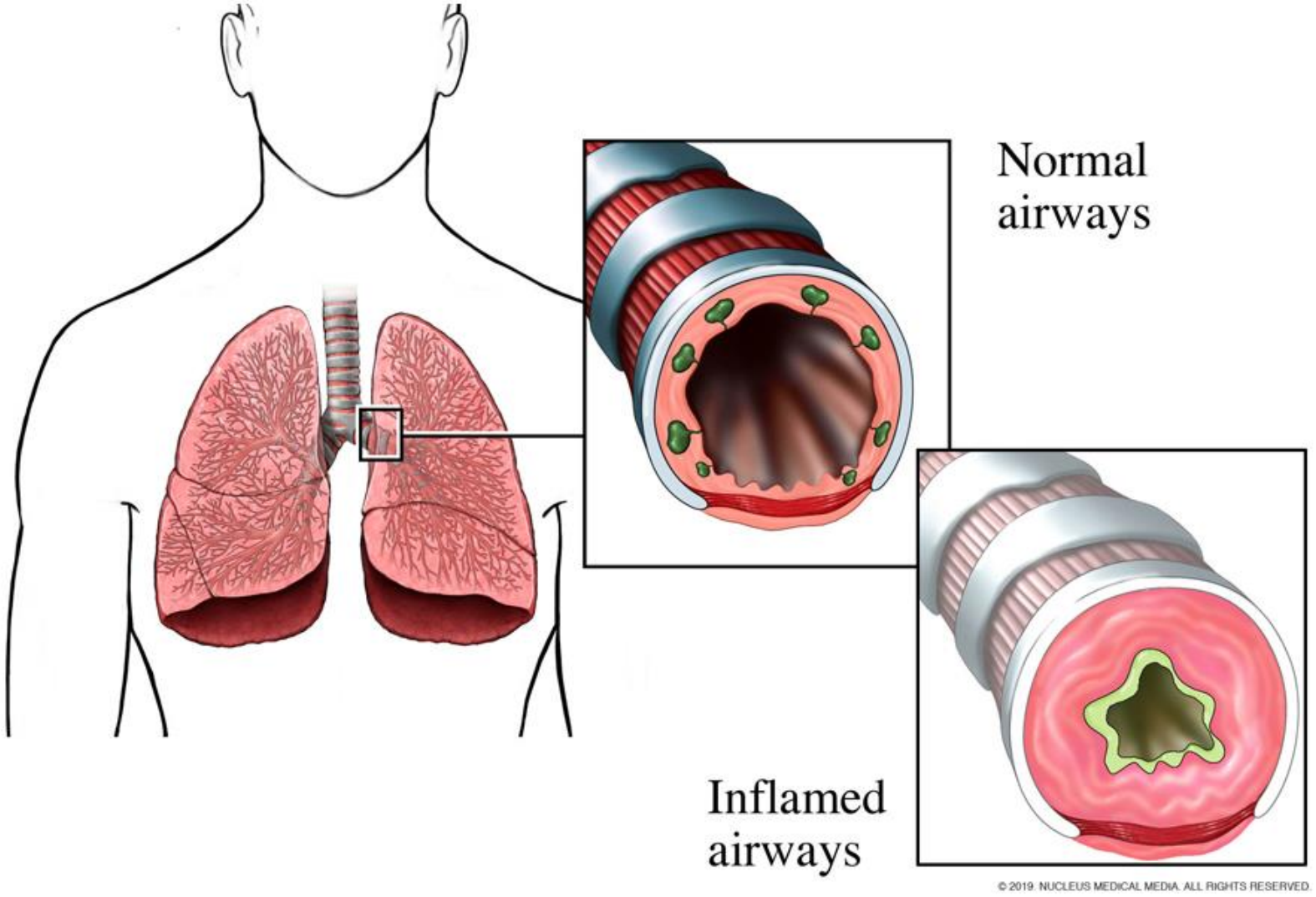
one controlled admit…… R:C = 8:8 = 1

14 other admissions (mean) R:C = 13:4 = 3.1

(range 6:3 to 15:1 and 45:10)

14 of 54 “high risk” Patients admitted (26%)

P=0.001



Airway narrowing from an asthma attack. *The image on the left shows the location of the lungs in the body. The middle image is a close-up of a normal airway, and the image on the right shows a narrowed, inflamed airway typical of an asthma attack.* *Medical Illustration Copyright © 2022 Nucleus Medical Media. All rights reserved.external link*

https://www.nhlbi.nih.gov/health/asthma/attacks

Asthma-RAD is PRIMARILY an INFLAMMATORY Disease

- Early Phase: — Treatment
  - Bronchospasm — - β agonist

- Secondary/late phase:
  - Inflammation (inflammatory soup) — - **inhaled-oral steroids**
    - leukotriene inhibitors
    - biologics

- **Must control the inflammation**
- **β agonists: NO ROLE in inflammation**
- **More than 1 albuterol cannister per/year strongly implies NOT mild intermittent**

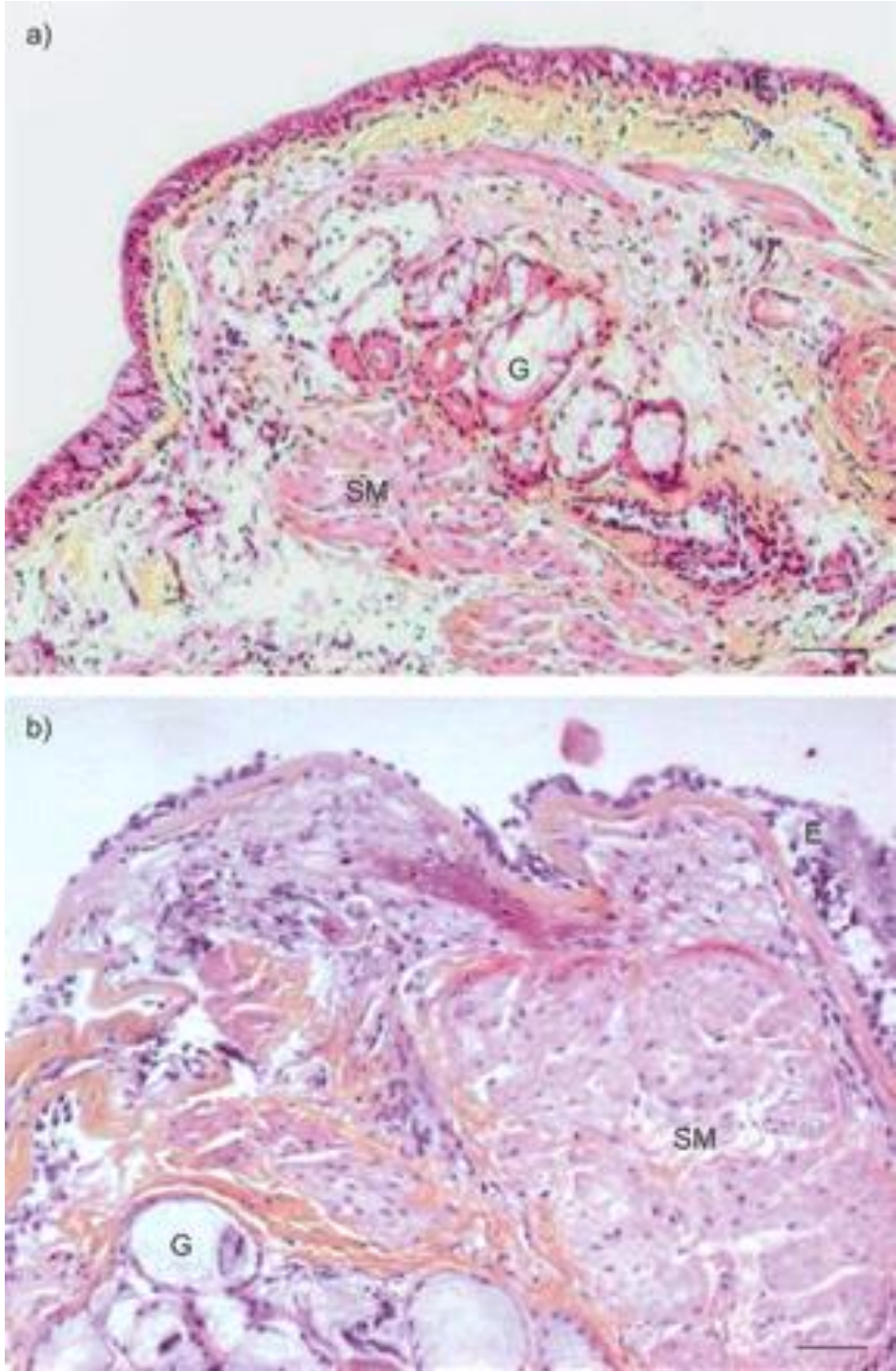
Normal Epithelium

β-agonists & LAMAs

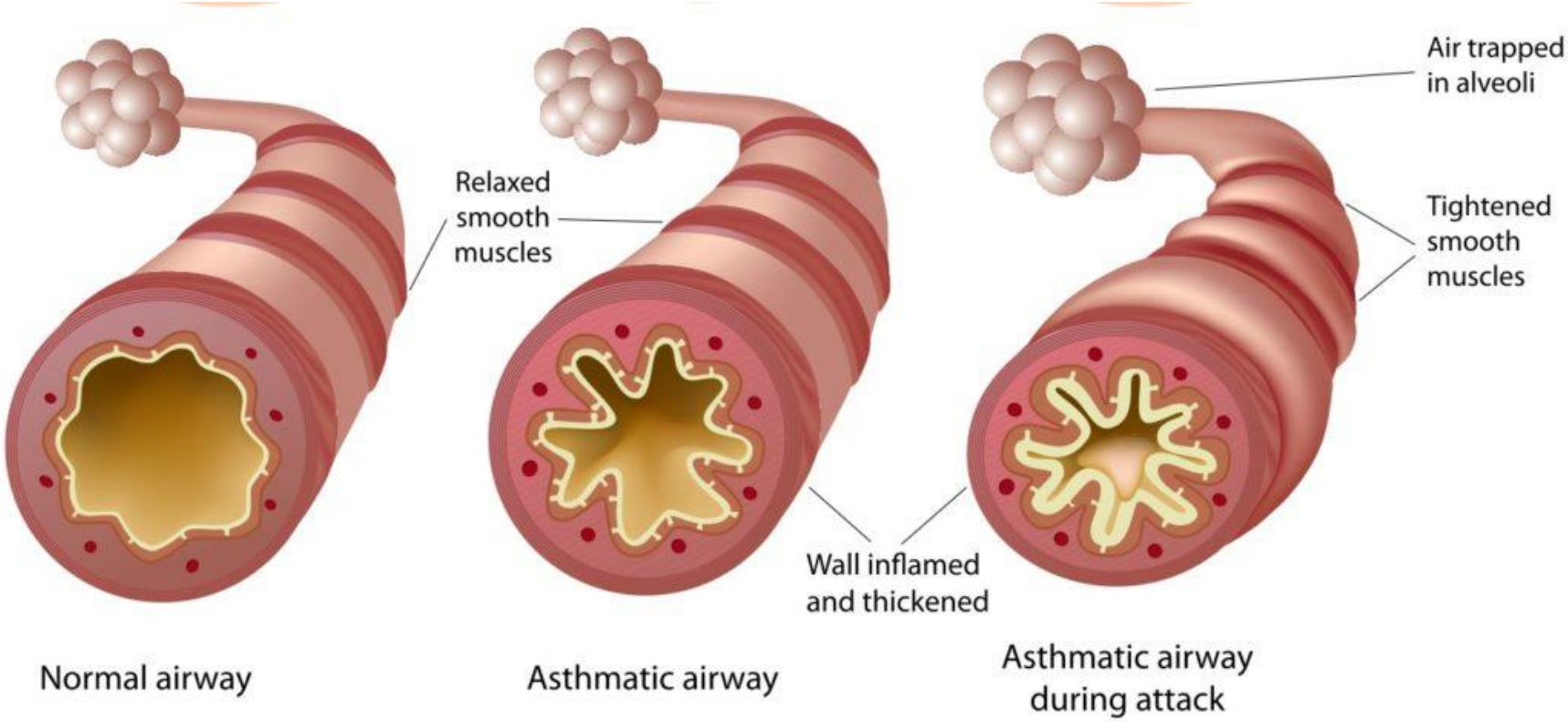
NO EFFECT on inflammation

-Need steroids, oral or ICS to restore to normal epithelium

-possible mild effect w/montelukasts



Asthma that is not optimally controlled



Overview

- What we use
- Why?
- Benefits
  - Resident Education
  - Improved HEDIS scores
  - Improved Medical Decision Making
  - Low-overhead to implement
  - Utilizing spirometer in community outreach
- Requirements
- Our Lessons Learned
- Example PFTs


EasyOne Air
Flow [L/s]
Volume [L]
Volume [L]
Time [s]
Param Best %Pred
FVC[L] 4.64 84
FEV1[L] *3.80 79
FEV1/FVC[%] 81.79 94
FEF2575[L/s] 3.89 74
PEF[L/s] 10.55 107
BEV[L] — —
FET[s] 6.36 —
FEV1var: 444ml FVCvar: 508ml. Session Quality D(1)
Normal spirometry.
< Back
Print
new diagnostic design

Practicalities

- Spirometer's "fine print" states it's accuracy is within 5% of formal PFTs ***(excellent "wind/weather-vane")***
- Any question of interpretation? **=>formal PFTs**
- We have not seen a decrease in formal PFTs
  - Finding ++restrictive dz, Mis-Dx'ed COPD, CHF
  - Office PFTs motivate Pt to see Pulm Medicine
- Formal PFTs ~$2,000
  - Office PFT: 94060 bills ~$160-238
  - If PFTs uninterpretable (effort), we defer billing
  - Could perform an "educational" PFT
- Historically, no req's for privileges to perform/bill
- Since formal PFTs have such poor compliance, an office PFT for "education" is VERY helpful for Pts

Why We Implemented Office Point of Care Spirometry

- ~80% of our Pts referred for PFTs didn't get them
- Over 50% of Pts Dx'ed w/COPD have NEVER had a PFT to confirm the diagnosis
- PFT's have a <35% compliance nationally for COPD diagnosis, an NCQA HEDIS measure.
- 34-55% have an incorrect diagnosis of COPD
- ~15% of Pts with COPD have mixed RAD
- Asthma Pt's recommended to have annual PFTs
- Many residents need help in PFT interpretation
- Pt's perceptions of airflow obstruction is highly variable and spirometry is useful to reveal an obstruction much more significant that history or physical would have suggested (NHLBI 2007)

How Many Patients with Diagnosed COPD Truly Have It?

Sator L et al. & Vanfleteren LEGW et al. ***Chest Aug 2019***

- **62%** of Pts w/COPD diagnoses considered to have **false-positive COPD** (FEV_1/FVC <LLN)
- IF one uses the GOLD Dx: FEV_1/FVC <0.7, the **false-positive rate was 55%**
- Even when patients w/Hx of RAD excluded, **34% of Pts w/false-positive COPD** were using inhaled medications.
- Performing spirometry **Pre/Post β-agonist** is **essential before making a diagnosis**.

How Common Is Asthma in Patients with COPD? (15%**)

Cosio BG et al. ***Chest January 2016***

- 2015, an international panel defined **asthma–COPD overlap syndrome = ACOS**
- Our knowledge about ACOS is limited, because ***clinical trials typically exclude patients with features of both diseases***
- **15%** of COPD Pts found to have ACOS
  - ACOS w/15% reversibility & ≥400ml
  - **Thereby, a stricter RAD diagnosis than 12% & ≥200ml (***maybe 20-30%?***)

How Good Are Sx's to Predict Control?

J Allergy Clin Immunol Pract Sept/Oct 2019

Original Article

Association Between Pulmonary Function and Asthma Symptoms

Patrick W. Sullivan, PhD[a], Vahram H. Ghushchyan, PhD[b,c], Jessica Marvel, MPH[d], Yu Chen Barr

What is already known about this topic? Asthma guidelines state that pulmonary function may be weakly correlated with asthma symptoms, and evidence in the literature is inconsistent with regard to the magnitude of association reported, ranging from weak to strong correlation.

What does this article add to our knowledge? In a longitudinal study of a managed-care population with persistent asthma, a weak correlation between FEV_1 as a percentage of predicted and 5-item Asthma Control Questionnaire/6-item Asthma Control Questionnaire scores was observed in unadjusted models; however, the correlation became significant after adjusting for covariates.

How does this study impact current management guidelines? Clinical assessments of asthma control should not rely on single measures such as FEV_1 as a percentage of predicted or 5-item Asthma Control Questionnaire/6-item Asthma Control Questionnaire scores, because elements of control may be missed if assessments of both lung function and symptoms are not used.

Association Between Pulmonary Function and Asthma Symptoms

- FEV1 as a percentage of predicted (FEV1% pred) is commonly measured in asthma clinical studies
- Reports vary on its association with asthma control instruments evaluating symptoms.
- Study looked at FEV1 & 5/6 Question Asthma Control Questionnaire
- **Conclusion: weak correlation**
- **Bottom Line: OBJECTIVE information needed to assess asthma control**
- Supports Kaiser Permente's internal study/practice
- Relying on symptoms only will miss the one in 10 that say they are "fine"…but really not

Clinic Implementation

- Scheduling
  - Split Nursing/Provider appointments
  - Provider-only appointment
- Time Constraints
  - 30 mins – Experienced patient
  - 40 mins – Novice patient
- Best if a support staff can “add-on” during the appointment (continuing to work w/manager)

Lessons Learned

- SAME-DAY is best for compliance
- Challenges to workflow continue to happen
- Need 2 faculty & 2 support staff champions
- Reimburses quickly
- Working to get a dedicated RN/LPN to assist "Johnny on the Spot" so as to perform more "same day" PFTs
- Resident/staff performing spirometry on themselves is a great way to improve comfort
- Improves resident willingness to "add" to an appointment

Next Steps

- ❑ Better refine ability to perform during the same appointment
- ❑ Encourage pre/post Peak Flows in the acute setting (for objective data; this is used for pediatric patients in resource limited areas)
- ❑ We have made it mandatory for resident to complete 5 PFTs as part of their requirements
- ❑ Continue PFT interpretation during lectures
- ❑ Continue hands-on with the spirometer (resident performs on each other)

Conclusions

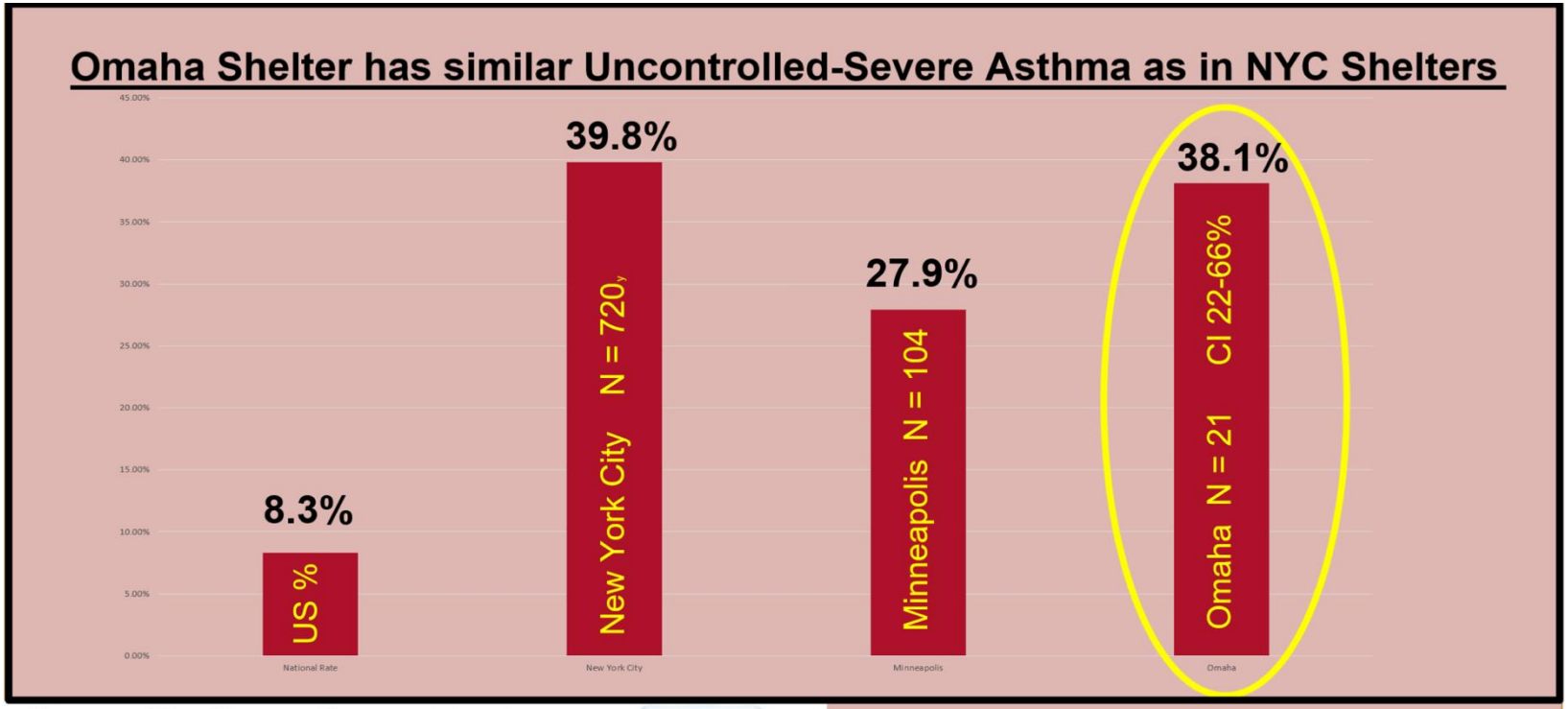
- Pulmonary Function Testing (PFT) has a <35% compliance nationally for COPD diagnosis, an NCQA HEDIS measure.
- A large managed care organization demonstrated that 10% of asymptomatic asthma patients with a normal asthma symptom questionnaire were in need of therapeutic adjustment only identified by spirometry testing.
- Designing an affordable, practical, point-of-care clinic work-flow is a win-win quality improvement enhancement we have experienced in our residency clinic.
- It has improved patient compliance for PFT confirmation of COPD, augmented recognition of under-treated asthma, enhanced residency education, boosted clinic revenue and positively impacted clinical therapeutic decision making
- Our clinic had greatly under-estimated the prevalence of the asthma-COPD overlap syndrome, leading to more appropriate ICS/LABA usage

QUESTIONS?
BACK-UP SLIDES

Nebraska Medicine

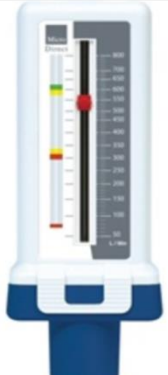
SERIOUS MEDICINE. EXTRAORDINARY CARE.®

CLINIC PFT Initiative: Asthma Outreach at a Local Family Homeless Shelter




Nebraska Medicine
HEALTH QUESTIONNAIRE FOR BREATHING DIFFICULTIES


Nebraska Medicine



BARRIERS IDENTIFIED

- Appointments are difficult to coordinate
- "Walk-ins" work best at the Lydia House
- Saturday AM screening is not an optimal time
- Difficult to coordinate delivery of medications
- Kids often move from mother to grandmother
- Finding a home-job predominated concerns

Combined Spirometry & Peak-flow (PF) Assessments in the Asthma Outreach, as Age Appropriate

(20% for PF Dx per GINA)

Open Door Mission - Lydia House

- Emergency shelter & rehabilitative programs for men, women, & families

- The Lydia House provides housing for women & families at the Open Door Mission

Peak Flow Assessments for RAD			
Pre-β	Post-β	Change %	RAD
250	350	40	**Yes**
270	360	33	**Yes**
100	130	30	**Yes**
80	160	100	**Yes**
300	275	0	No
275	300	9	No
150	200	33	**Yes**
200	200	0	No

59 yo Male with “COPD”

Gender	Male	Height	72 in		
Ethnicity	Caucasian	Weight	205 lb	BMI	27.8

FVC (ex only)

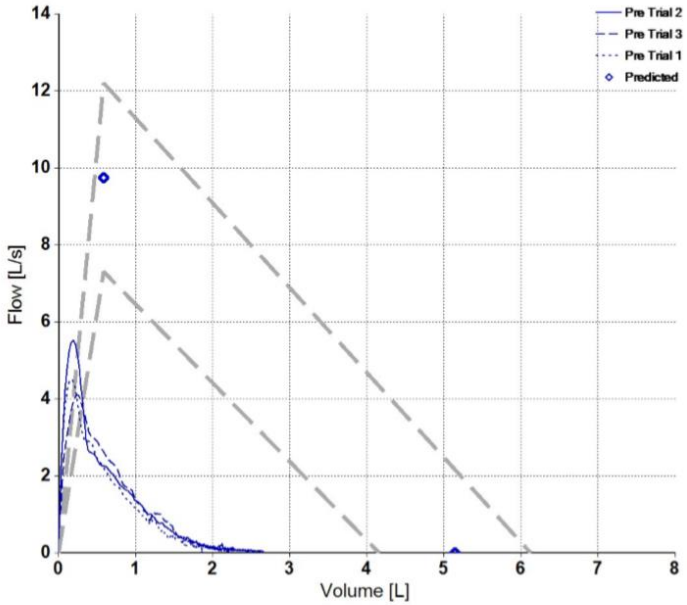
Your FEV1 / Predicted: 40%

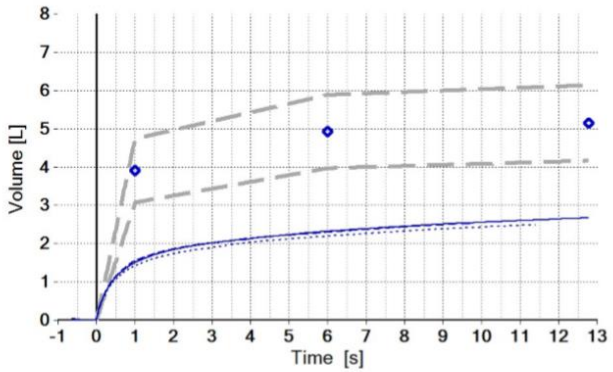
Test Date	3/18/2019 11:38:31 AM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time		Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.11/1.02

			Pre				
Parameter	Pred	LLN	Best	Trial 2	Trial 3	Trial 1	%Pred
FVC [L]	5.14	4.16	2.66*	2.66*	2.52*	2.48*	52
FEV1 [L]	3.90	3.07	1.54*	1.50*	1.54*	1.41*	40
FEV1/FVC	0.758	0.661	0.580*	0.563*	0.613*	0.570*	77
FEF25-75 [L/s]	3.21	1.52	0.49*	0.49*	0.63*	0.49*	15
PEF [L/s]	9.75	7.30	5.53*	5.53*	4.09*	4.50*	57
FET [s]	-	-	12.8	12.8	9.7	11.4	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (2.8%); FVC Var=0.14L (5.4%))
System Interpretation	Pre	Severe Obstruction





Clearly Demonstrates FEV1/FEVC <70%

			Pre				
Parameter	Pred	LLN	Best	Trial 2	Trial 3	Trial 1	%Pred
FVC [L]	5.14	4.16	2.66*	2.66*	2.52*	2.48*	52
FEV1 [L]	3.90	3.07	1.54*	1.50*	1.54*	1.41*	40
FEV1/FVC	0.758	0.661	0.580*	0.563*	0.613*	0.570*	77
FEF25-75 [L/s]	3.21	1.52	0.49*	0.49*	0.63*	0.49*	15
PEF [L/s]	9.75	7.30	5.53*	5.53*	4.09*	4.50*	57
FET [s]	-	-	12.8	12.8	9.7	11.4	-

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (2.8%); FVC Var=0.14L (5.4%))
System Interpretation	Pre	Severe Obstruction

67 yo Female with “COPD”

Gender	Female	Height	66 in		
Ethnicity	Caucasian	Weight	202 lb	BMI	32.6

FVC (ex only)

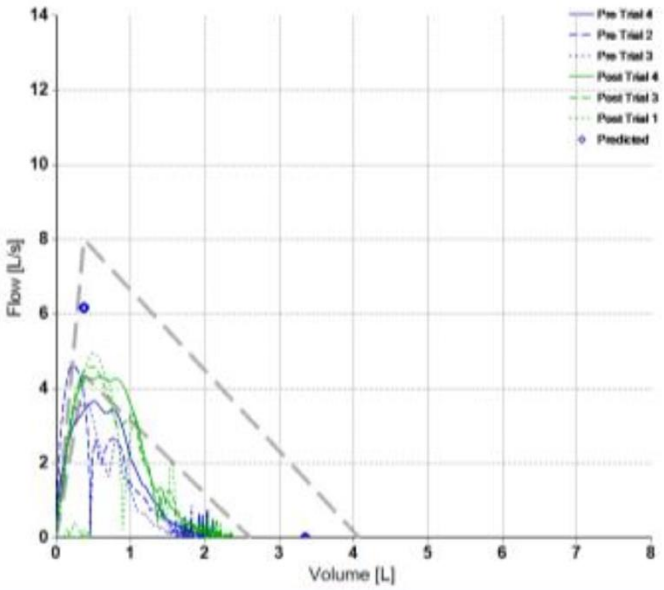
Your FEV1 / Predicted: 62%

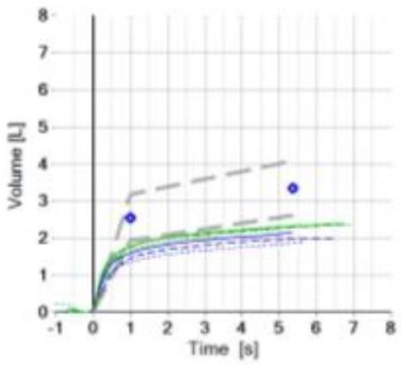
Test Date	3/13/2019 11:15:36 AM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	3/13/2019 11:43:27 AM	Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

			Pre					Post					
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best	Trial 4	Trial 3	~~Trial 1~~	%Pred	%Chg
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*	2.38*	2.37*	2.22*	71	12
FEV1 [L]	2.55	1.93	1.59*	1.59*	1.45*	1.35*	62	1.77*	1.77*	1.76*	1.68*	69	11
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742	0.742	0.743	0.760	97	0
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30	1.30	1.30	1.36	60	7
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59	4.34*	4.59	4.96	74	-1
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8	6.8	6.9	4.9	-	26

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended





“Obstruction” NOT Identified

			Pre					Post
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*
FEV1 [L]	2.55	1.93	1.59*	1.59*	1.45*	1.35*	62	1.77*
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

“Obstruction” NOT Identified

			Pre					Post
Parameter	Pred	LLN	Best	Trial 4	Trial 2	Trial 3	%Pred	Best
FVC [L]	3.35	2.61	2.14*	2.14*	2.00*	1.89*	64	2.38*
FEV1 [L]	2.55	1.93	1.58*	1.59*	1.45*	1.35*	62	1.77*
FEV1/FVC	0.765	0.667	0.745	0.745	0.726	0.711	97	0.742
FEF25-75 [L/s]	2.16	0.84	1.21	1.21	1.15	0.84*	56	1.30
PEF [L/s]	6.17	4.35	4.62	3.66*	4.62	3.59*	75	4.59
FET [s]	-	-	5.4	5.4	6.5	5.7	-	6.8

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

Reversibility & Restriction
Further Examination Recommended

Pre					Post					
Best	Trial 4	Trial 2	Trial 3	%Pred	Best	Trial 4	Trial 3	~~Trial 1~~	%Pred	%Chg
2.14*	2.14*	2.00*	1.89*	64	2.38*	2.38*	2.37*	2.22*	71	12
1.59*	1.59*	1.45*	1.35*	62	1.77*	1.77*	1.76*	1.68*	69	11
0.745	0.745	0.726	0.711	97	0.742	0.742	0.743	0.760	97	0
1.21	1.21	1.15	0.84*	56	1.30	1.30	1.30	1.36	60	7
4.62	3.66*	4.62	3.59*	75	4.59	4.34*	4.59	4.96	74	-1
5.4	5.4	6.5	5.7	-	6.8	6.8	6.9	4.9	-	26

Session Quality	Pre	B (FEV1 Var=0.14L (8.9%); FVC Var=0.14L (6.6%))
	Post	C (FEV1 Var=0.01L (0.6%); FVC Var=0.02L (0.8%))
System Interpretation	Pre	Restriction probable; further examination recommended
	Post	Restriction probable; further examination recommended

11 yo c/o SOB playing soccer

Gender	Male	Height	62.5 in
Ethnicity	African	Weight	110 lb

FVC (ex only)

Your FEV1

Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/H
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NH

Parameter	Pred	LLN	Pre Best	Trial 4	Trial 5	Trial 2	%Pred
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115
FEV1 [L]	2.51	1.85	2.67	2.67	2.63	2.43	106
FEV1/FVC	0.872	0.768	0.797	0.797	0.821	0.758*	91
FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95
FET [s]	-	-	5.7	5.7	4.5	3.8	-

Why we get a post; +13% in FEV1 2.67L→3.02L post β agonist; +350 ml

Your FEV1 / Predicted: 106%

GOLD(2008)/Hardie — Value Selection — Best Value

Hankinson (NHANES III), 1999 — BTPS (IN/EX) — 1.09/1.02

	%Pred	Post Best	Trial 3	Trial 4	Trial 1	%Pred	%Chg
	115	3.46	3.46	3.40	3.28	118	3
	106	3.02	3.02	2.98	2.73	120	13*
	91	0.871	0.871	0.876	0.834	100	9
	89	3.32	3.32	3.42	2.76	117	32
	95	5.02	5.02	4.87	4.68	88	-8

Gender	Male	Height	62.5 in		
Ethnicity	African	Weight	110 lb	BMI	19.8

FVC (ex only)

Your FEV1 / Predicted: 106%

Test Date	7/17/2019 4:23:10 PM	Interpretation	GOLD(2008)/Hardie	Value Selection	Best Value
Post Time	7/17/2019 4:41:19 PM	Predicted	Hankinson (NHANES III), 1999	BTPS (IN/EX)	1.09/1.02

			Pre					Post					
Parameter	Pred	LLN	Best	Trial 4	Trial 5	Trial 2	%Pred	Best	Trial 3	Trial 4	Trial 1	%Pred	%Chg
FVC [L]	2.92	2.17	3.35	3.35	3.21	3.21	115	3.46	3.46	3.40	3.28	118	3
FEV1 [L]	2.51	1.85	2.67	2.67	2.63	2.43	106	3.02	3.02	2.98	2.73	120	13*
FEV1/FVC	0.872	0.768	0.797	0.797	0.821	0.758*	91	0.871	0.871	0.876	0.834	100	9
FEF25-75 [L/s]	2.83	1.41	2.52	2.52	2.72	1.96	89	3.32	3.32	3.42	2.76	117	32
PEF [L/s]	5.74	3.62	5.46	3.74	4.92	5.46	95	5.02	5.02	4.87	4.68	88	-8
FET [s]	-	-	5.7	5.7	4.5	3.8	-	3.3	3.3	2.7	3.2	-	-41

* Indicates value outside normal range or significant post change.

Session Quality	Pre	B (FEV1 Var=0.04L (1.4%); FVC Var=0.14L (4.2%))
	Post	A (FEV1 Var=0.03L (1.2%); FVC Var=0.06L (1.8%))
System Interpretation	Pre	Normal Spirometry
	Post	Normal Spirometry

How Good Are Symptoms in Predicting Control?

J Allergy Clin Immunol Pract Sept/Oct 2019

Original Article

Association Between Pulmonary Function and Asthma Symptoms

Patrick W. Sullivan, PhD[a], Vahram H. Ghushchyan, PhD[b,c], Jessica Marvel, MPH[d], Yu Chen Barrett, MD[d], and Anne L. Fuhlbrigge, MD[e] *Denver and Aurora, Colo; Yerevan, Armenia; and East Hanover, NJ*

What is already known about this topic? Asthma guidelines state that pulmonary function may be weakly correlated with asthma symptoms, and evidence in the literature is inconsistent with regard to the magnitude of association reported, ranging from weak to strong correlation.

What does this article add to our knowledge? In a longitudinal study of a managed-care population with persistent asthma, a weak correlation between FEV_1 as a percentage of predicted and 5-item Asthma Control Questionnaire/6-item Asthma Control Questionnaire scores was observed in unadjusted models; however, the correlation became significant after adjusting for covariates.

How does this study impact current management guidelines? Clinical assessments of asthma control should not rely on single measures such as FEV_1 as a percentage of predicted or 5-item Asthma Control Questionnaire/6-item Asthma Control Questionnaire scores, because elements of control may be missed if assessments of both lung function and symptoms are not used.