

# PFTS FOR THE PCP

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NEW MEXICO ACADEMY OF  
FAMILY PHYSICIANS  
**STRONG MEDICINE FOR NEW MEXICO**



# OUTLINE

- 1) Indications for PFTs
- 2) Quality Control/Normal Values
- 3) Spirometry
- 4) Bronchodilator Response
- 5) Lung Volumes
- 6) Diffusion Capacity
- 7) FeNO
- 8) Methacholine Challenge
- 9) Flow Volume Loops





## Evaluation of symptoms

- 1) Dyspnea
- 2) Chronic cough
- 3) Wheezing
- 4) Exercise limitation

## Pre-operative assessment

Lung resection

Prior to BMT

Evaluation of effects of exposure  
to dusts or chemicals at work

Occupations qualification  
(firefighting)

VA disability payments

Response to  
therapy

Monitoring disease  
progression

# INDICATIONS FOR PFTS





2022

EUROPEAN RESPIRATORY JOURNAL  
ERS OFFICIAL DOCUMENTS  
S. STANOJEVIC ET AL.

## SETTING THE STANDARDS

### ERS/ATS technical standard on interpretive strategies for routine lung function tests

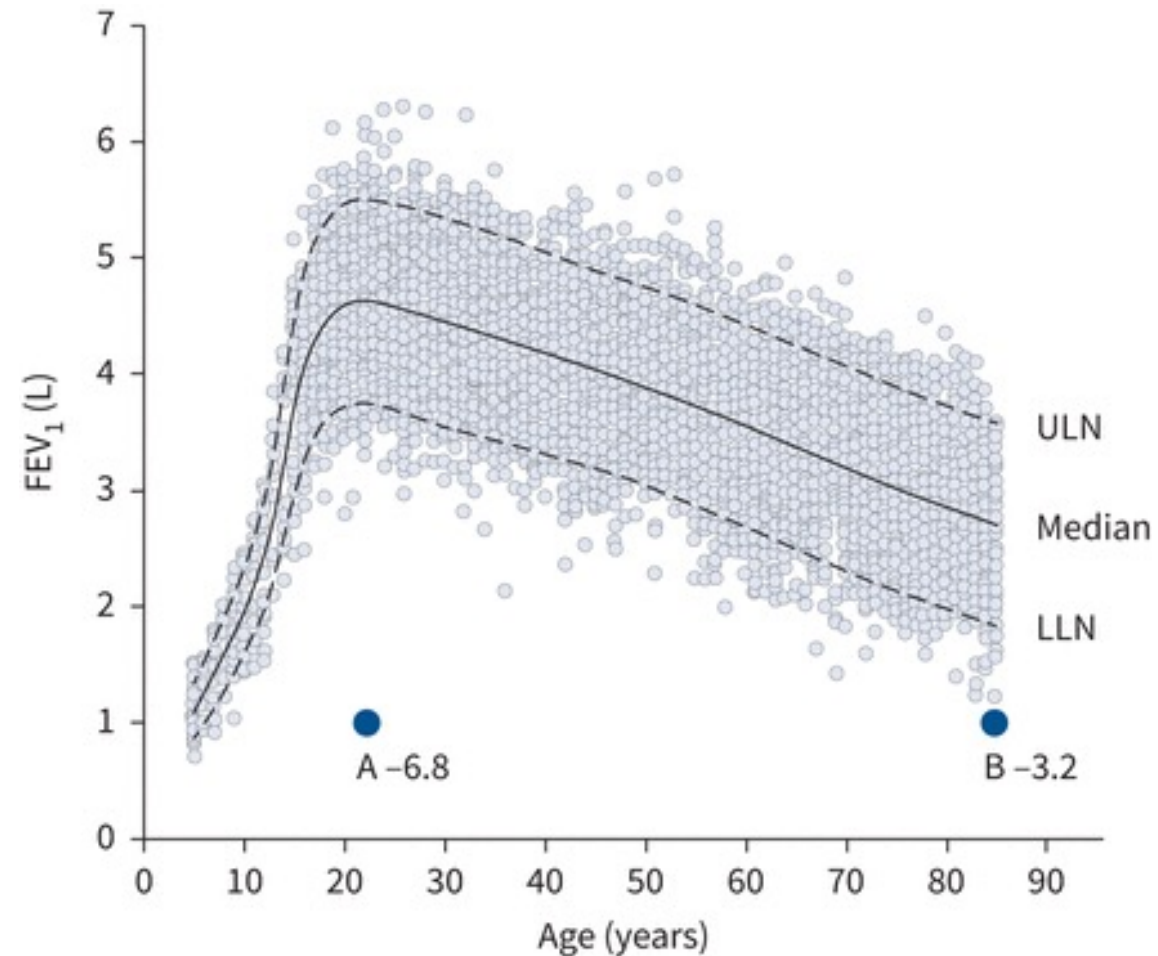
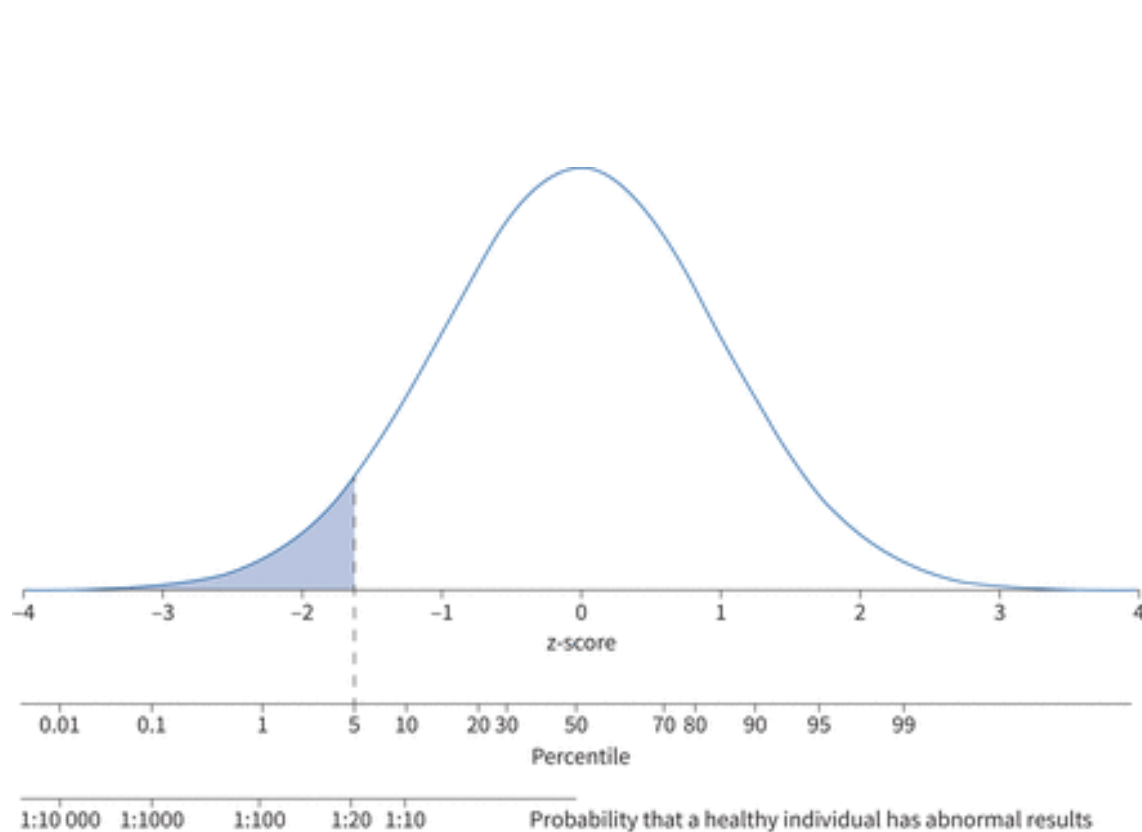
Sanja Stanojevic<sup>1</sup>, David A. Kaminsky<sup>2</sup>, Martin R. Miller<sup>3</sup>, Bruce Thompson<sup>4</sup>, Andrea Aliverti<sup>5</sup>,  
Igor Barjaktarevic<sup>6</sup>, Brendan G. Cooper<sup>7</sup>, Bruce Culver<sup>8</sup>, Eric Derom<sup>9</sup>, Graham L. Hall<sup>10</sup>, Teal S. Hallstrand<sup>8</sup>,  
Joerg D. Leuppi<sup>11,12</sup>, Neil MacIntyre<sup>13</sup>, Meredith McCormack<sup>14</sup>, Margaret Rosenfeld<sup>15</sup> and  
Erik R. Swenson<sup>8,16</sup>



Yearly

## REFERENCE VALUES

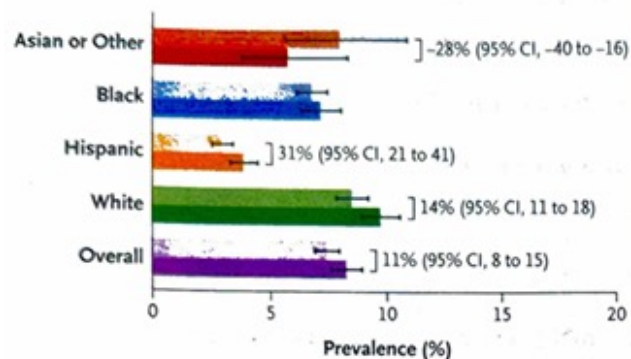




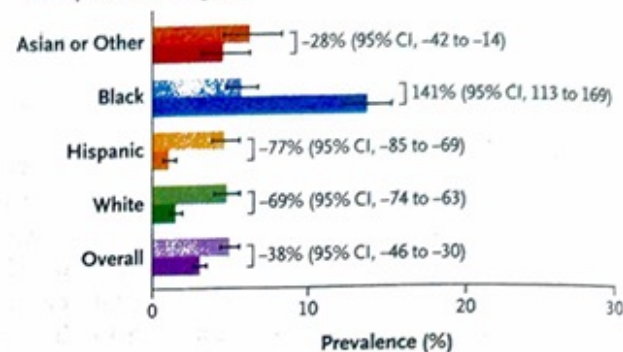
*The 5th and 95th percentile limits ( $-1.645$  and  $+1.645$  z-score) of the healthy population can be used to identify individuals with unusually low or high results.*

Reference Equation  
 ■ GLI-2012 (race-based)  
 ■ GLI-Global (race-neutral)

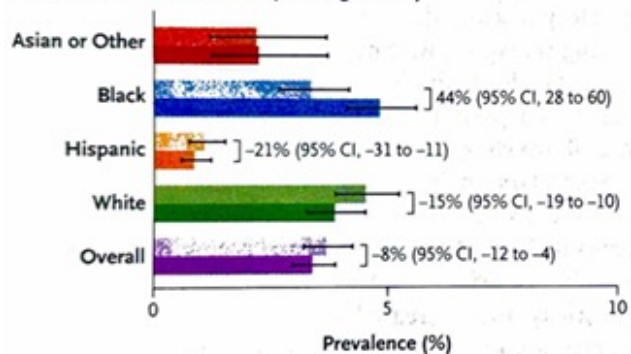
A Obstructive Ventilatory Impairment (low FEV<sub>1</sub>:FVC)



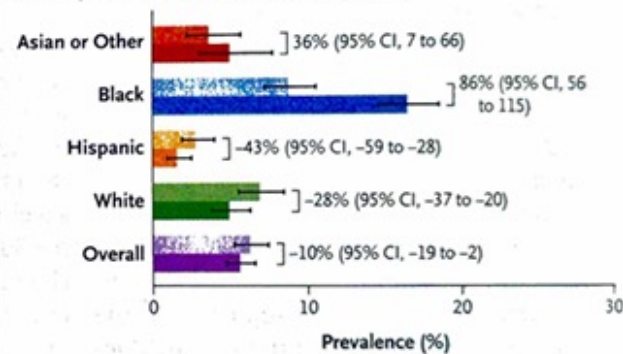
B Nonobstructive Ventilatory Impairment (low FEV<sub>1</sub> or FVC with preserved FEV<sub>1</sub>:FVC)



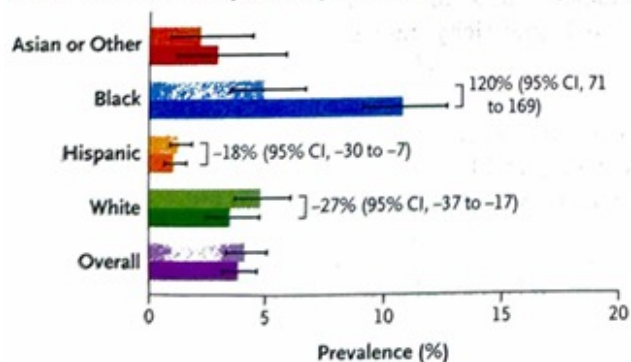
C Moderate-to-Severe COPD (GOLD grade ≥2)



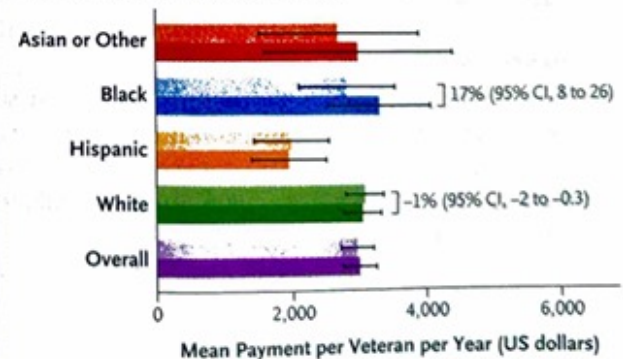
D Occupational Disqualification (firefighting)



E Moderate-to-Severe Impairment (AMA class ≥2)



F Veterans Affairs Disability Payments



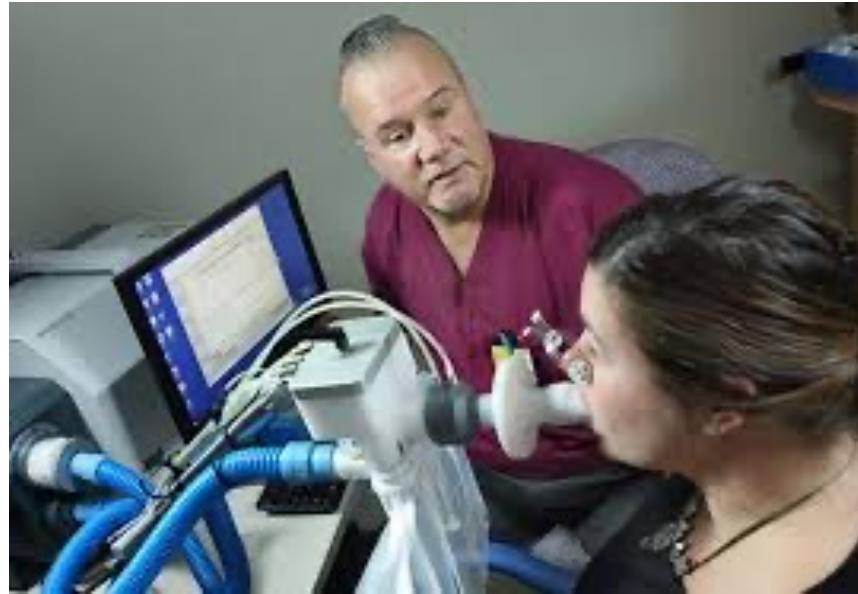
# IMPLICATIONS OF RACE ADJUSTMENT IN LUNG-FUNCTION EQUATIONS

The New England Journal of Medicine

June 13, 2024

J.A. Diaz et al.

## QUALITY CONTROL



- Review age, gender, smoking status, BMI, indication, flow-volume curves
- Quality control
  - Three acceptable maneuvers with repeatable values: Two highest values of FVC and FEV<sub>1</sub> should be within 150mL (100mL if FVC ≤ 1L)
  - Good start (back extrapolation < 5% of FVC or 150 mL)
  - No cough or artifact in initial expiratory loop
  - Post-expiratory flow should be ≥ 6 seconds or 1 second plateau



# SPIROMETRY AND BRONCHODILATOR RESPONSE



FEV<sub>1</sub>/FVC >5th  
percentile?

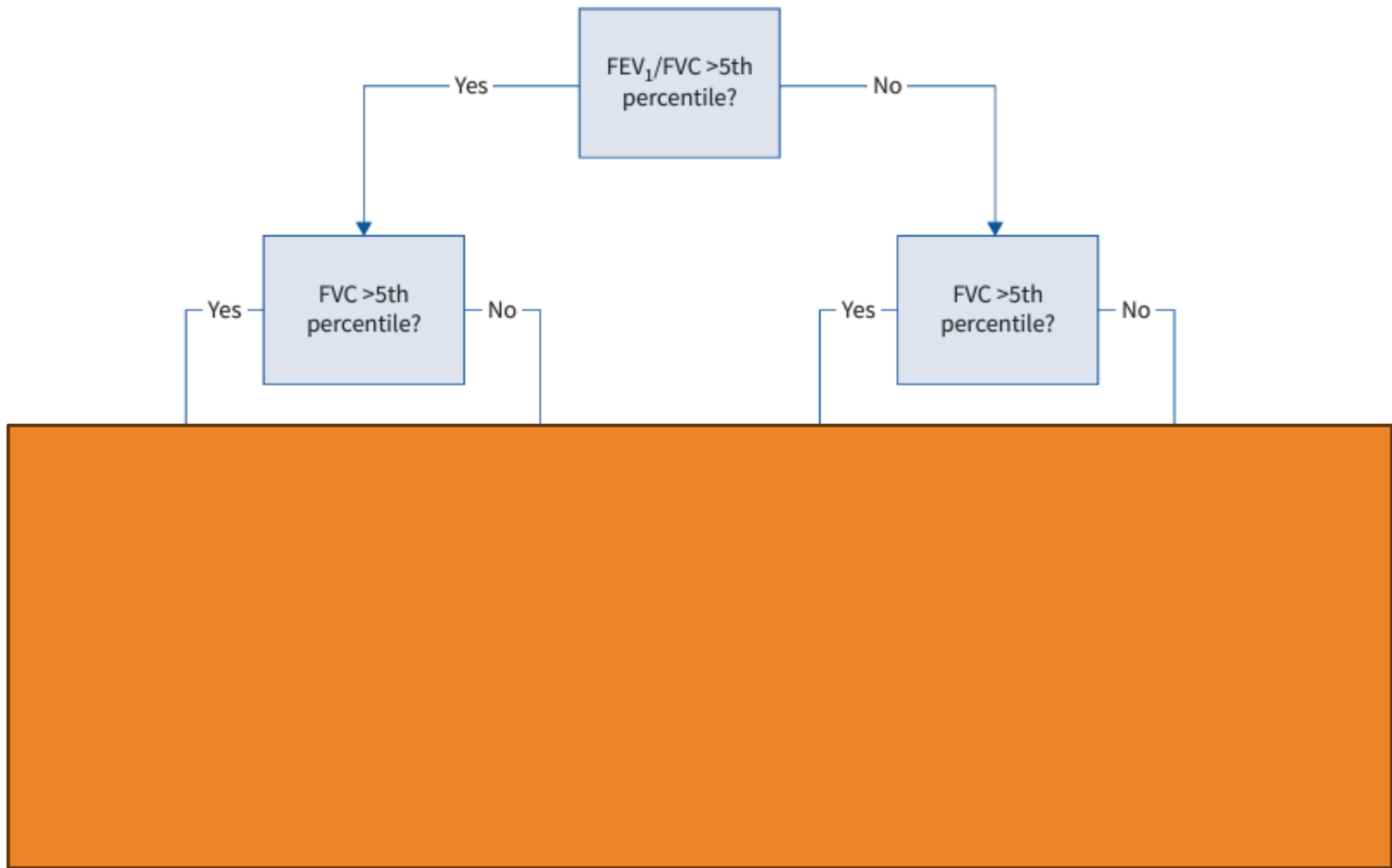
Yes

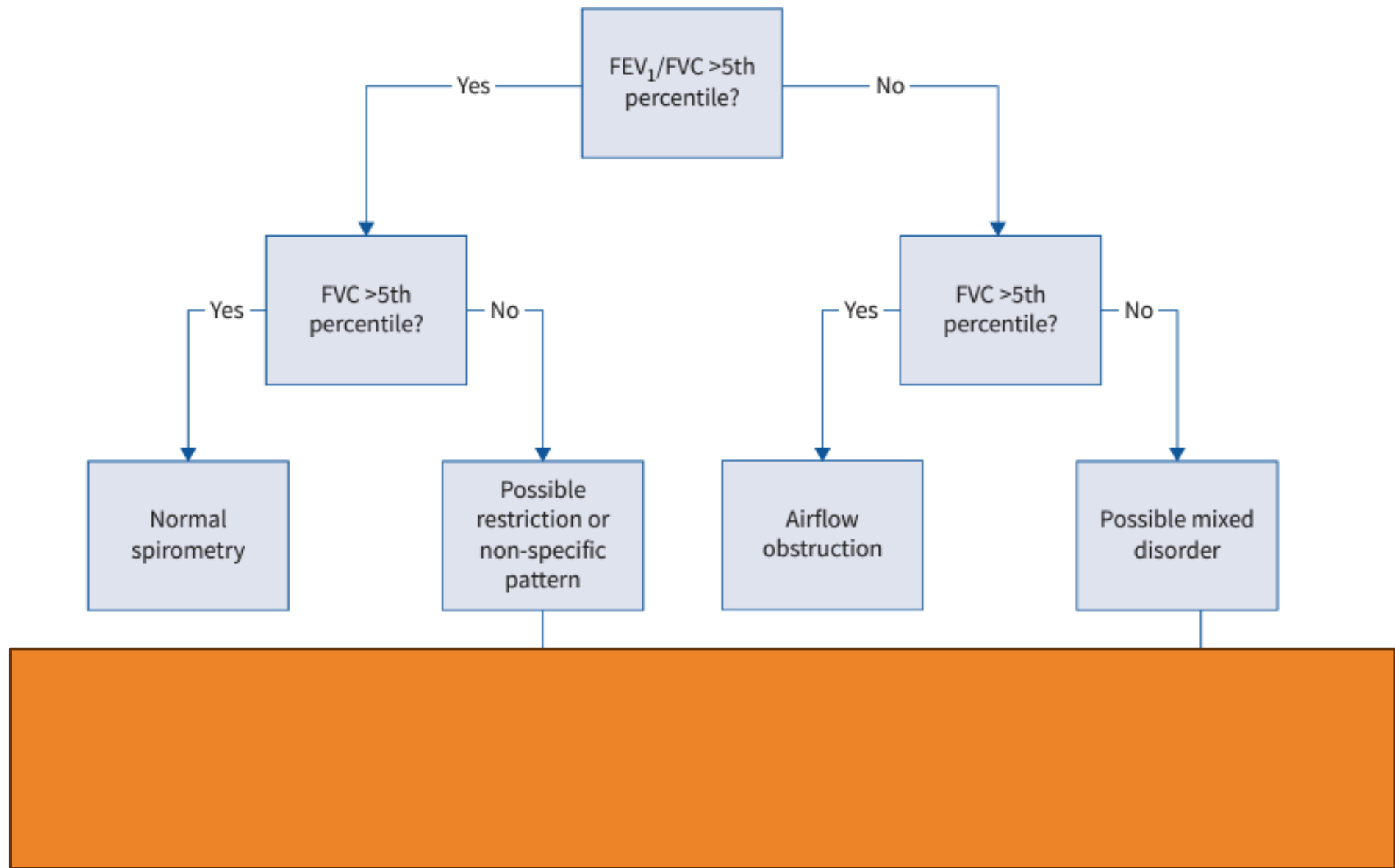
No

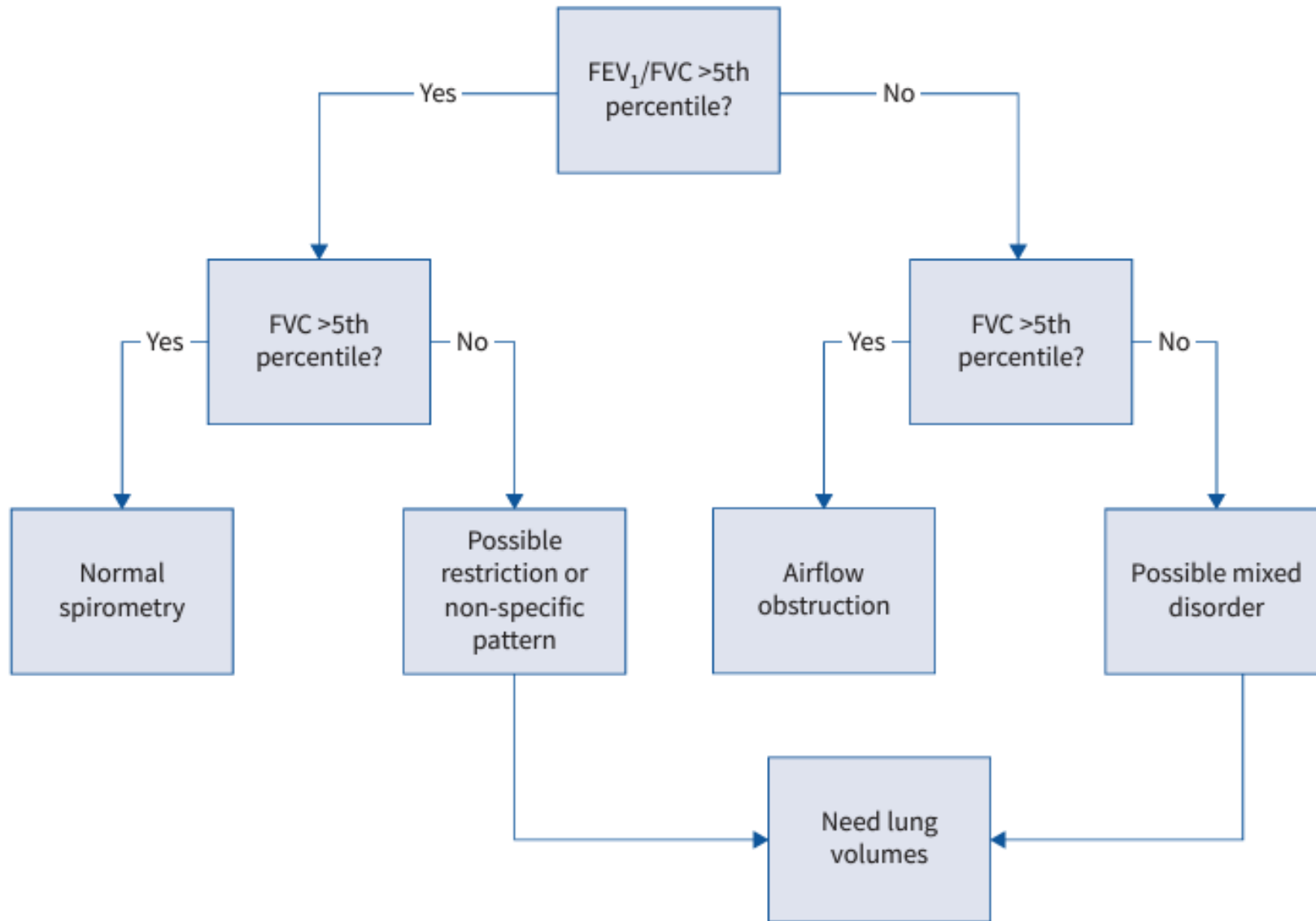


GLOBAL INITIATIVE  
FOR CHRONIC OBSTRUCTIVE  
**LUNG DISEASE**

> 0.7









# SEVERITY OF IMPAIRMENT

ATS/ERS

*A three-level system to assess the severity of lung function impairment using z-score values should be used; z-scores  $> -1.645$  are normal, z-scores between  $-1.65$  and  $-2.5$  are mild, z-scores between  $-2.51$  and  $-4$  are moderate, and z-scores  $< -4.1$  are severe.*

## GOLD Grades and Severity of Airflow Obstruction in COPD (based on post-bronchodilator FEV1)

Table 2.6

In COPD patients (FEV1/FVC  $< 0.7$ ):

<b>GOLD 1:</b>	Mild	FEV1 $\geq$ 80% predicted
<b>GOLD 2:</b>	Moderate	50% $\leq$ FEV1 $<$ 80% predicted
<b>GOLD 3:</b>	Severe	30% $\leq$ FEV1 $<$ 50% predicted
<b>GOLD 4:</b>	Very Severe	FEV1 $<$ 30% predicted

GOLD

# BRONCHODILATOR RESPONSE

↑ FEV<sub>1</sub> or FVC by ≥ 12% and ≥ 200ml



↑ FEV<sub>1</sub> or FVC >10%



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↑ FEV<sub>1</sub> or FVC >10%

## USEFUL

1. Asthma defined as reversible airflow obstruction
2. COPD defined by obstruction that persists after bronchodilator
3. Obstruction severity graded based on post-BD FEV<sub>1</sub>



# BRONCHODILATOR RESPONSE

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↑ FEV<sub>1</sub> or FVC >10%

## USEFUL

1. Asthma defined as reversible airflow obstruction
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3. Obstruction severity graded based on post-BD FEV<sub>1</sub>


## USELESS

1. Lack of BD response does not preclude BD therapy
2. Both asthma and COPD can have BD response
3. Presence of BD response can change over time
4. BD response is not connected to meaningful clinical outcomes



## **Bronchodilator Responsiveness in Asthma and Chronic Obstructive Pulmonary Disease: Time to Stop Chasing Shadows**

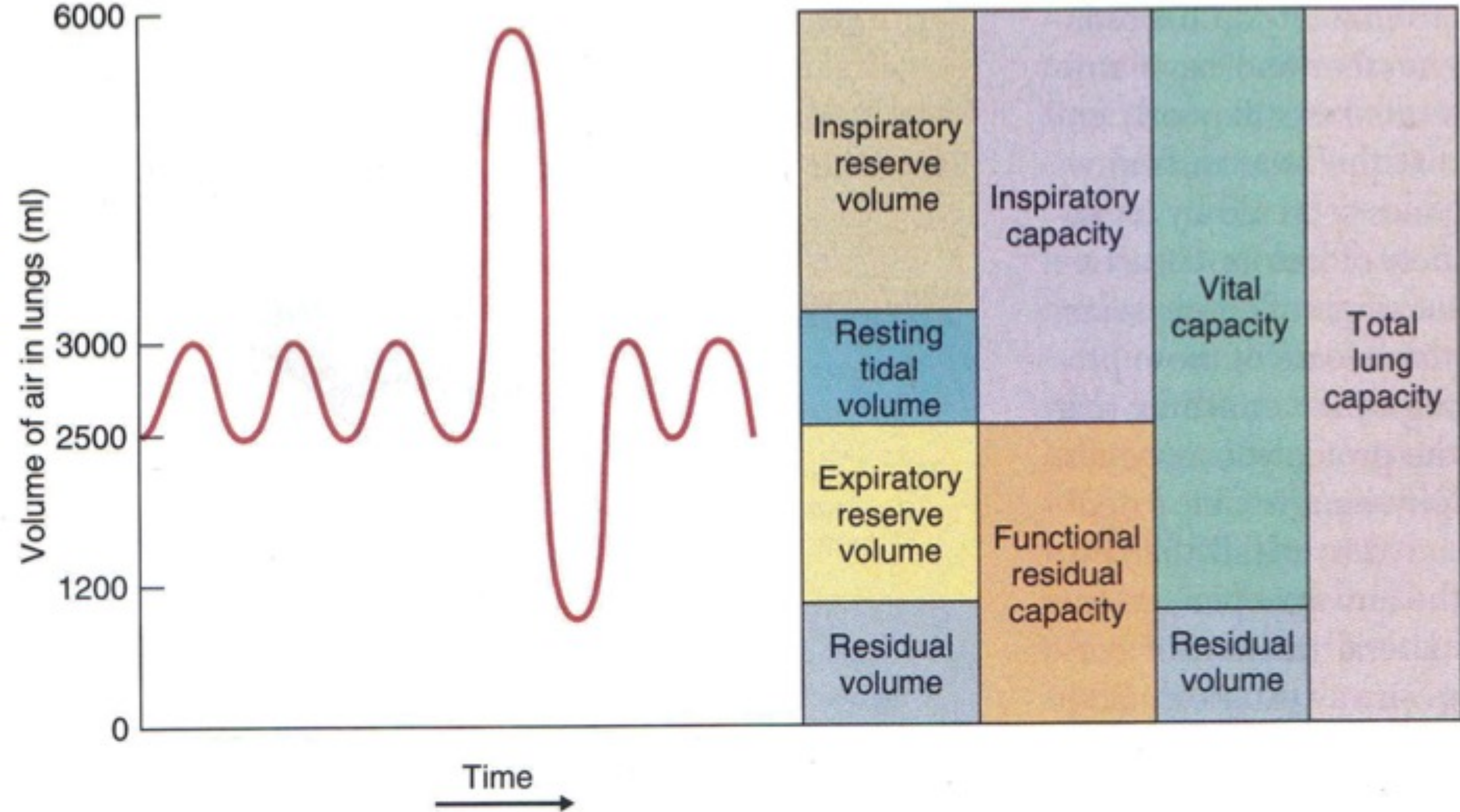
2024

 David M. G. Halpin

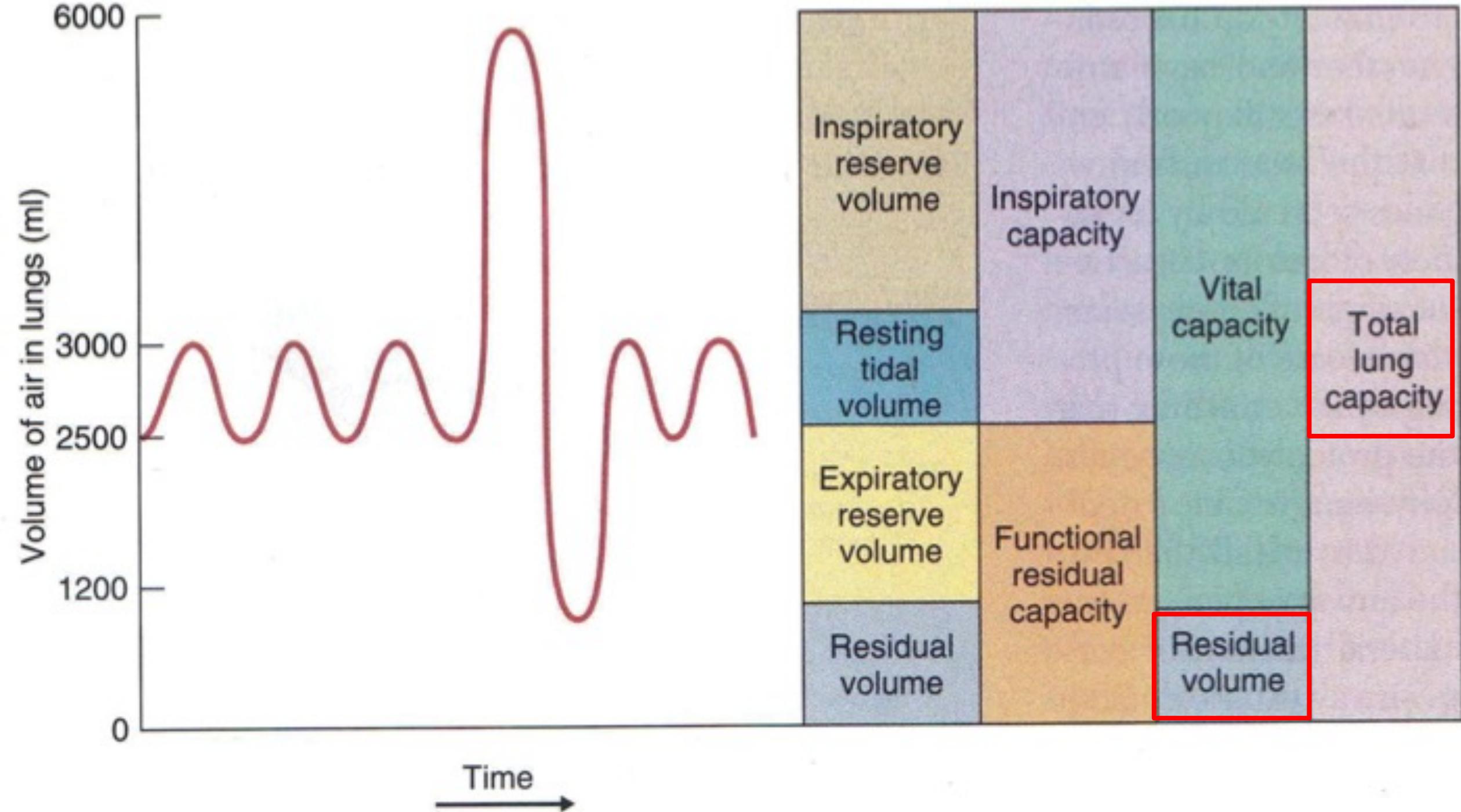




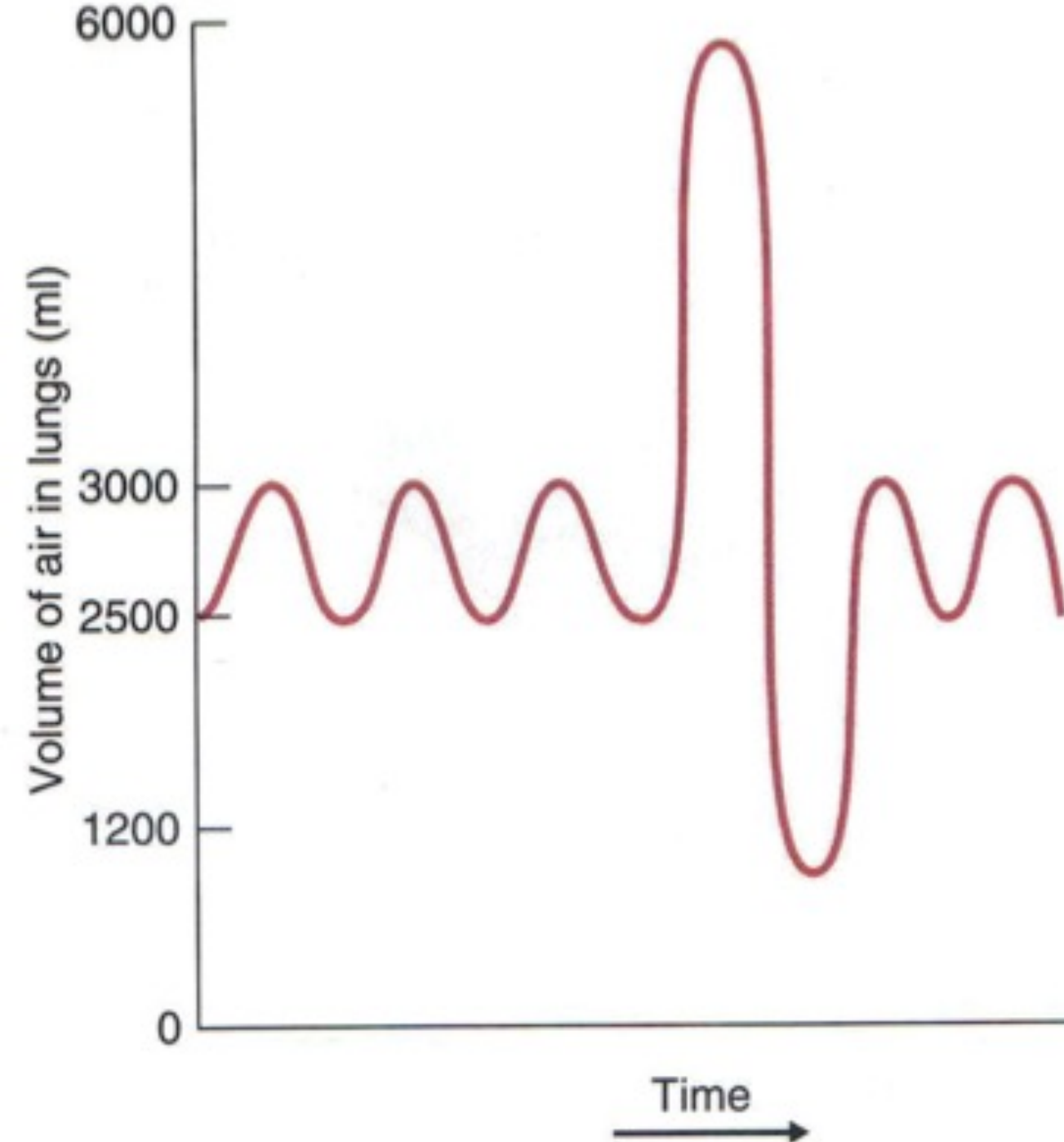
# LUNG VOLUMES









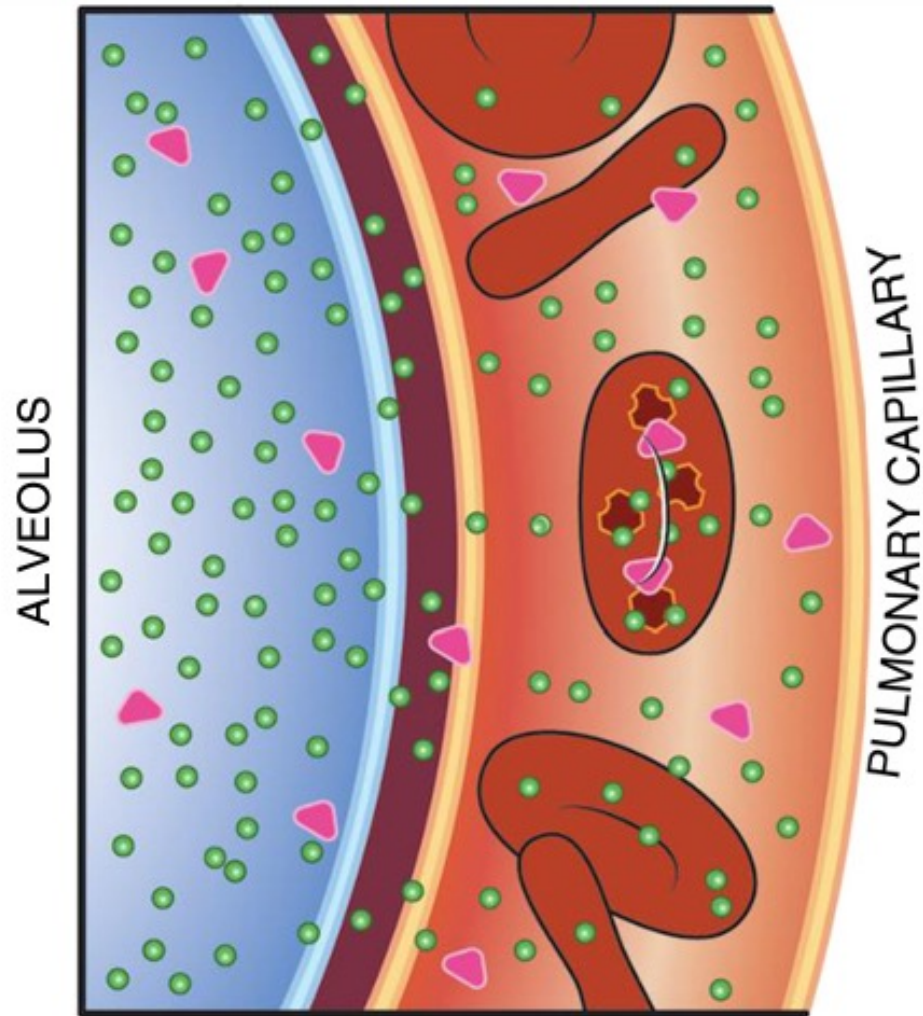





A reduction in TLC defines a *restrictive ventilatory impairment* and is characterized by a reduction in TLC below the LLN (5th percentile)

An increase in RV or RV/TLC above the 95th percentile may indicate hyperinflation or *air trapping* due to the presence of airway obstruction

Total lung capacity

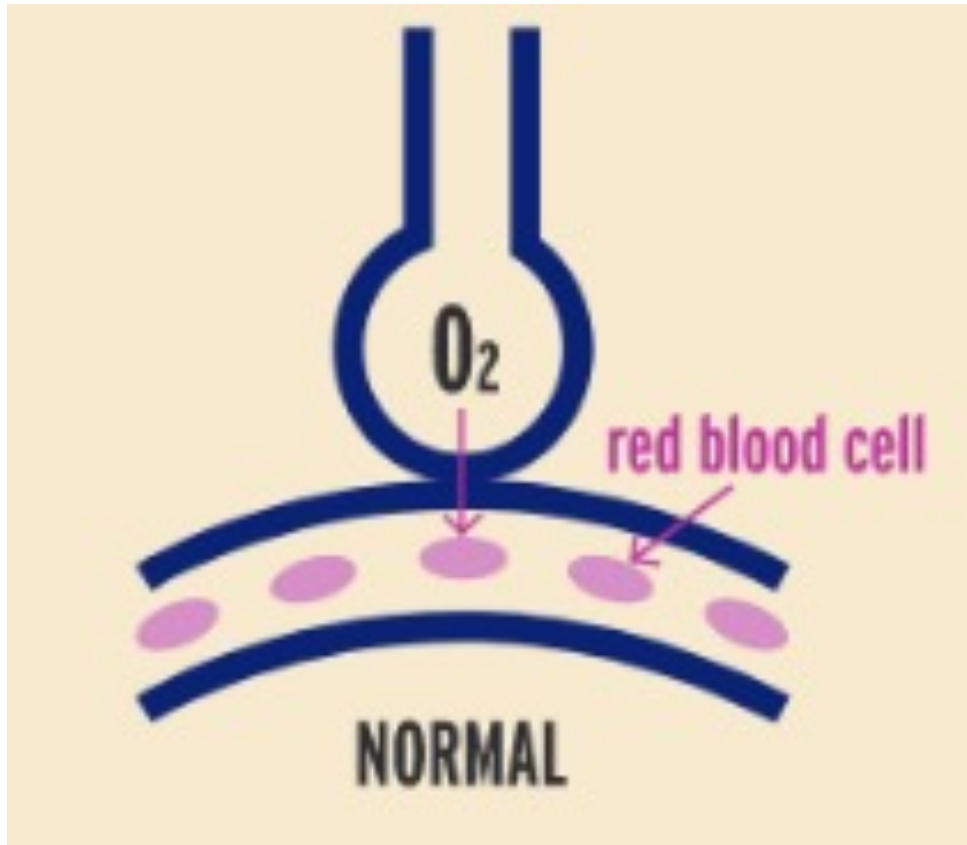
Residual volume



-  Carbon monoxide (CO)
-  Oxygen ( $O_2$ )
-  Hemoglobin

# DIFFUSION CAPACITY FOR CARBON MONOXIDE (DLCO)

## INCREASED DLCO



Supine position

Pulmonary hemorrhage

Polycythemia

Increase pulmonary blood flow

Exercise

Hyperthermia

Pregnancy

Asthma

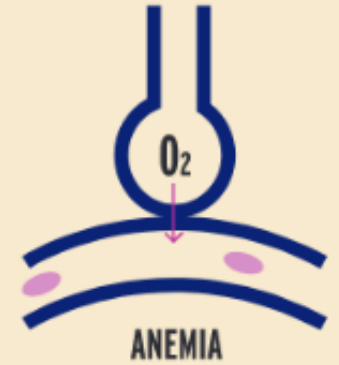
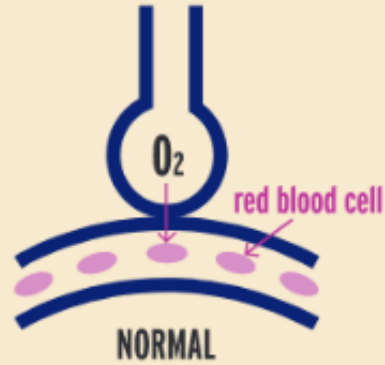
Obesity

L → R shunt

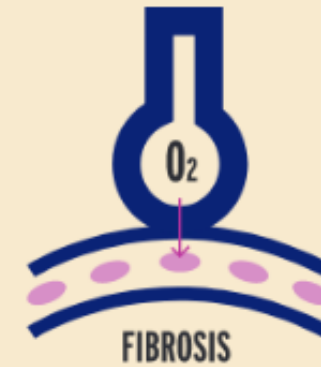
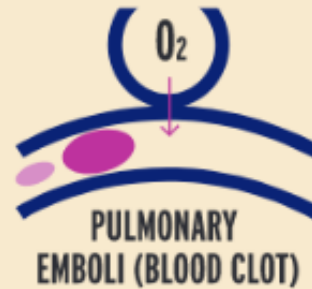
Hyperthyroidism

# DECREASED DLCO

CHANGES TO THE  
INTERFACE BETWEEN  
AIR SACKS AND  
BLOOD VESSELS  
IN VARIOUS LUNG  
CONDITIONS



AND  
PULMONARY  
VASCULAR  
DISEASE

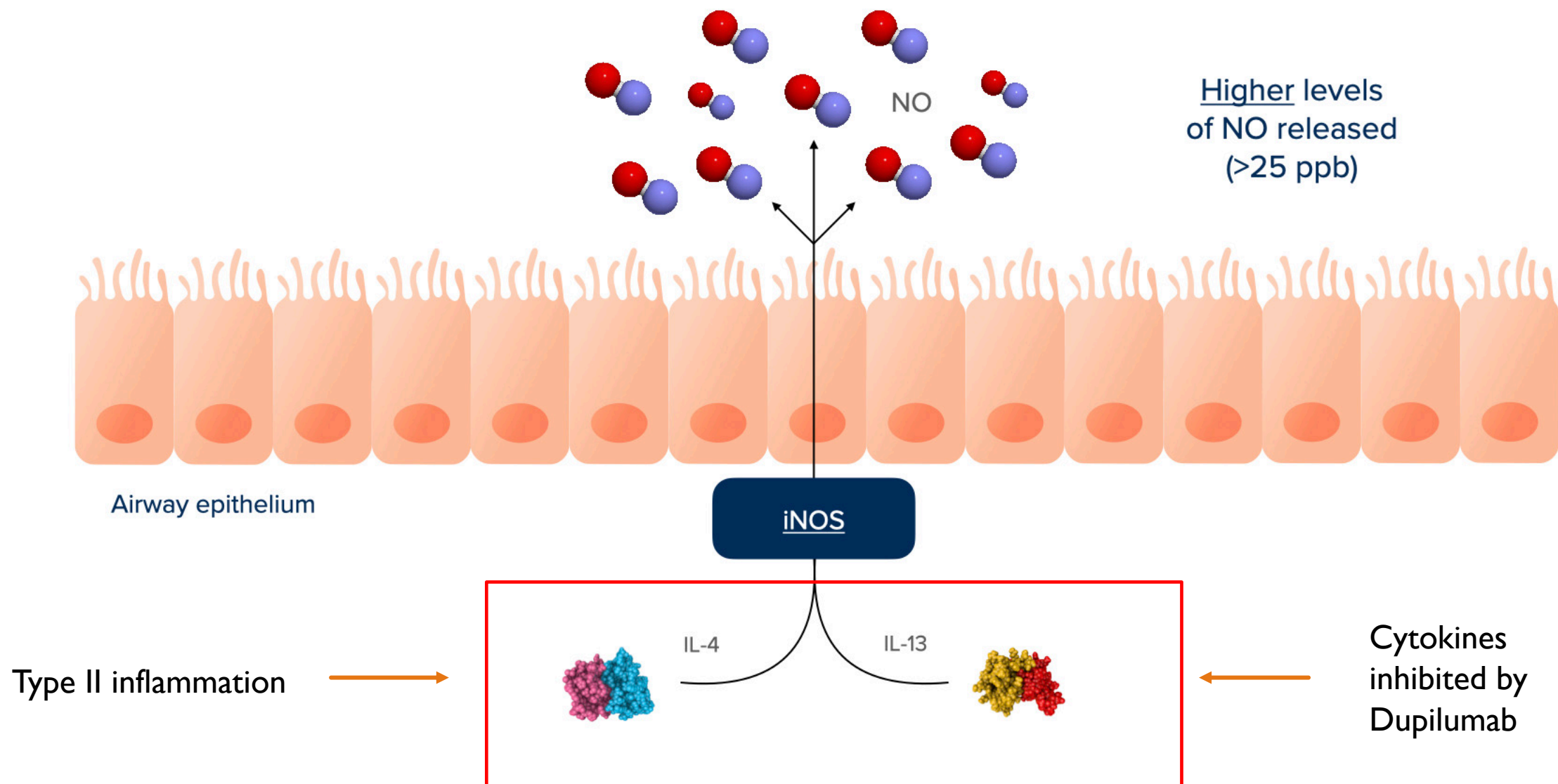




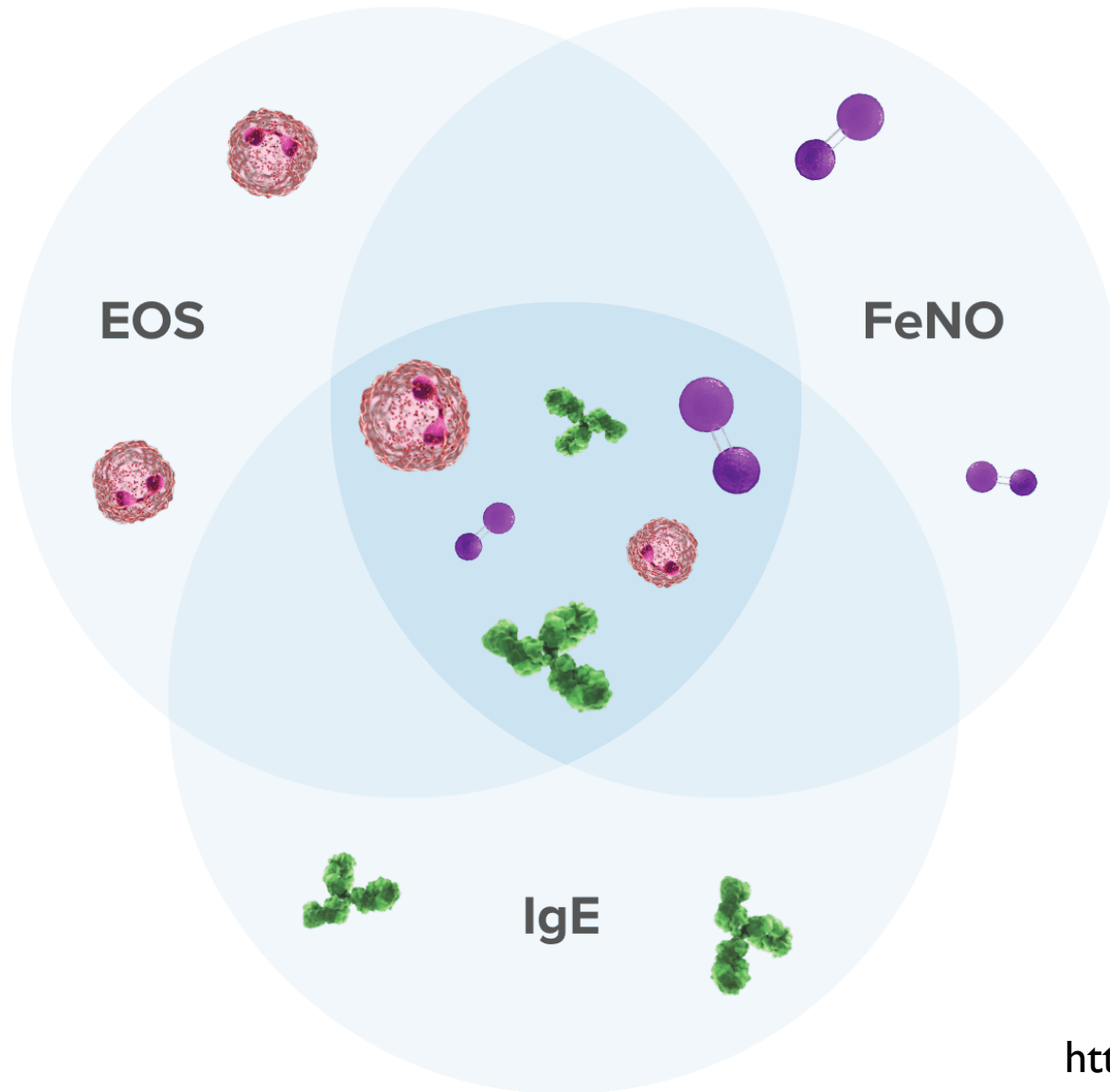
# FRACTIONAL EXHALED NITRIC OXIDE (FENO)



# Activated Epithelial Cells



## TYPE 2 INFLAMMATION



Biomarkers for asthma

Allergic and eosinophilic phenotypes

Generally more steroid-responsive

Targets for biologic agents

Omalizumab – IgE (IgE)

Mepolizumab – IL5 (eos)

Benralizumab – IL 5Ra (eos)

Dupilumab – IL4/13B (eos, steroid dependence)

# FRACTIONAL EXHALED NITRIC OXIDE (FENO)

Identify type II inflammation

Guide biologic therapy

Guide inhaled corticosteroid therapy

Check adherence





METHACHOLINE CHALLENGE

AKA

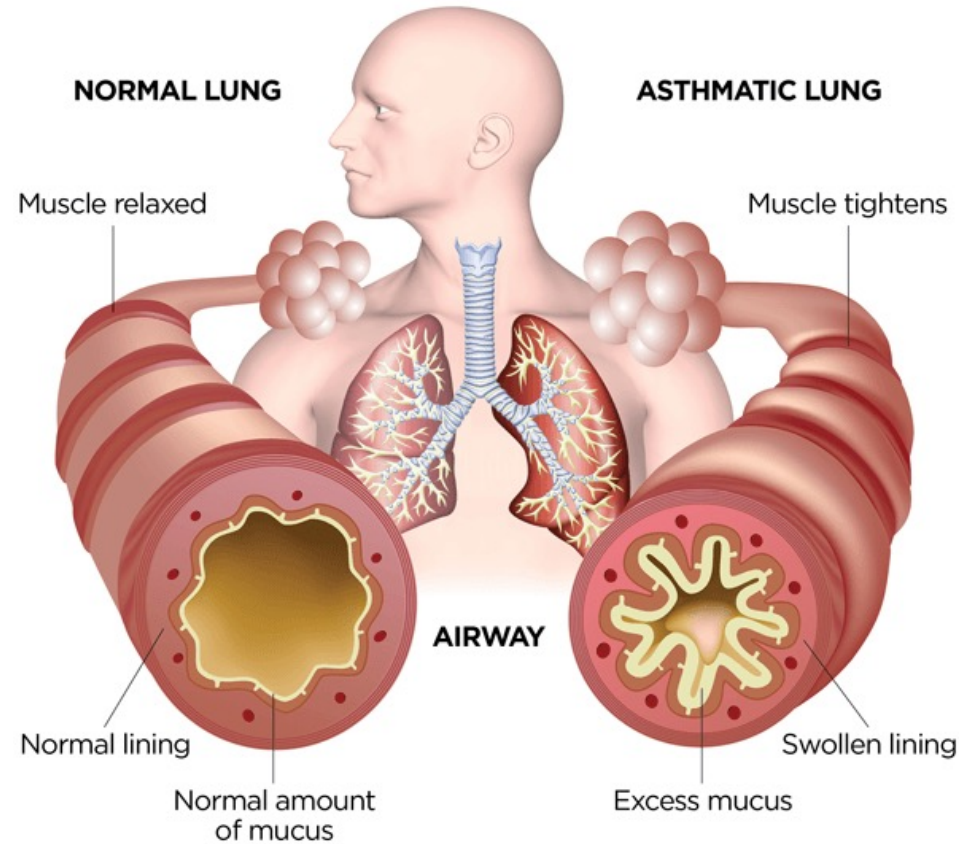
BRONCHOPROVOCATION TESTING

# DIAGNOSING ASTHMA CAN BE DIFFICULT

Reversible bronchoconstriction  
with a bronchodilator

Biomarkers: FeNO, eos, IgE

Suggests a clinical history –  
typical triggers, symptoms that  
linger, relief with inhaled corticosteroids,  
audible wheezing, family  
history



Unexplained dyspnea

Chronic cough

Occupational asthma

Arguing with the cardiologist



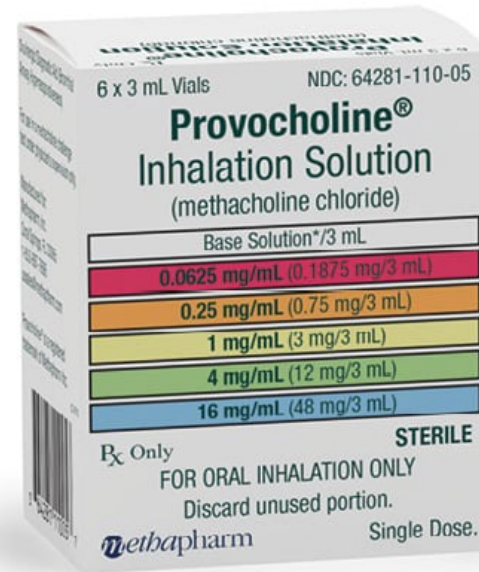
## Methacholine Challenge

PC<sub>20</sub> (mg/ml)

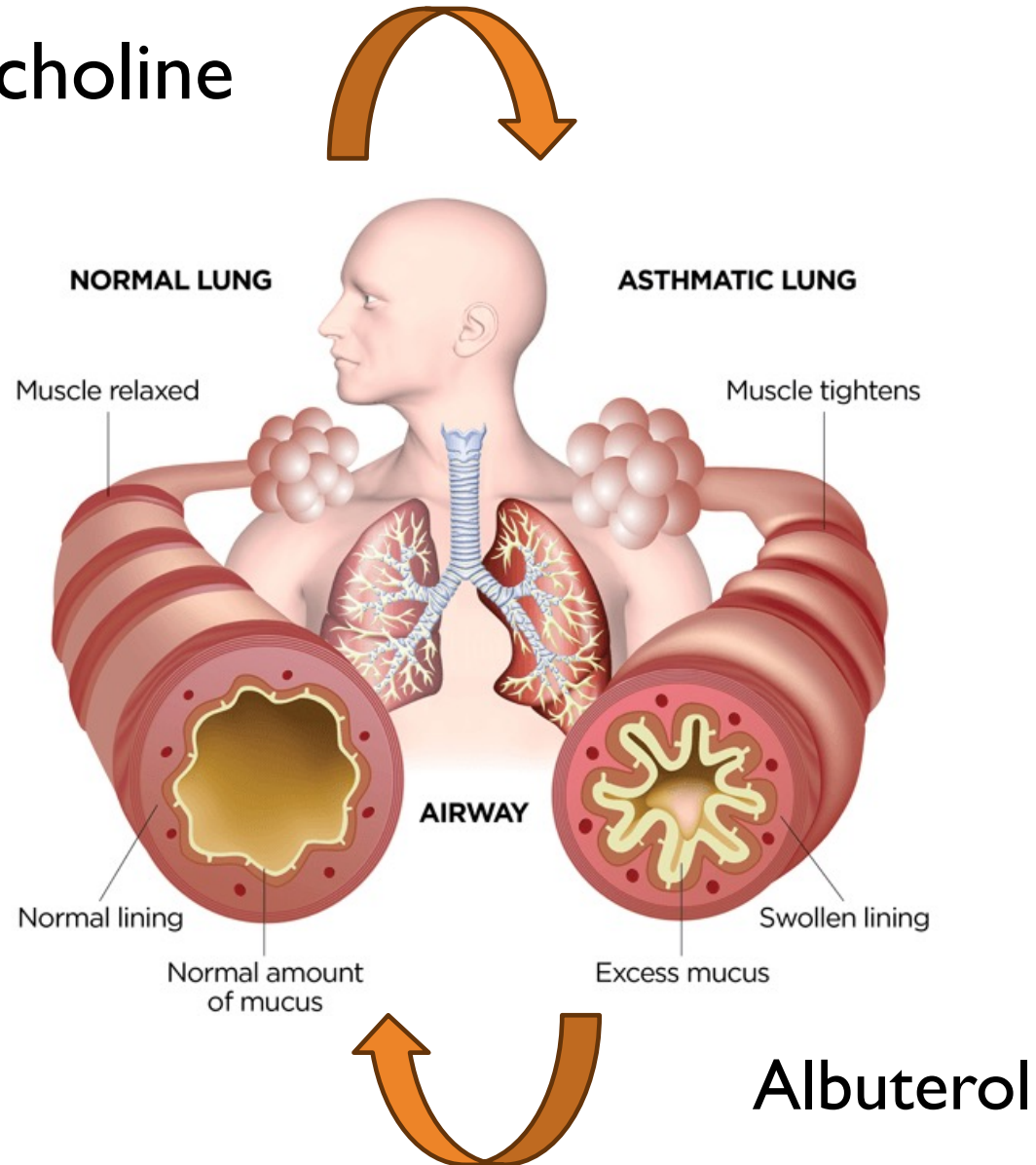
>16	Normal bronchial response
4-16	Borderline BHR
1-4	Mild BHR
<1.0	Moderate-severe BHR

PC<sub>20</sub> = provocation  
concentration at which there is  
a 20% decrease in FEV<sub>1</sub>

Contraindication = FEV<sub>1</sub> < 60%



# Methacholine

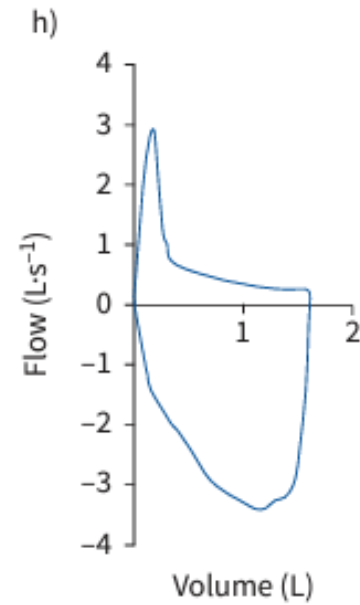
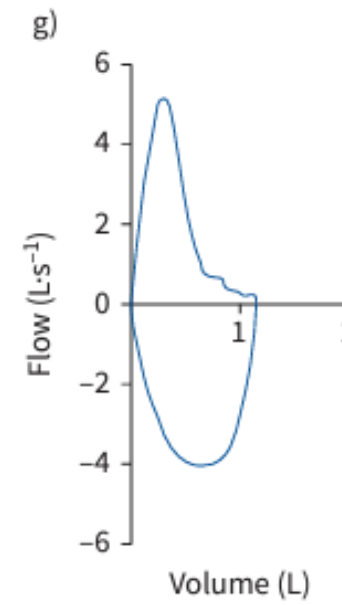
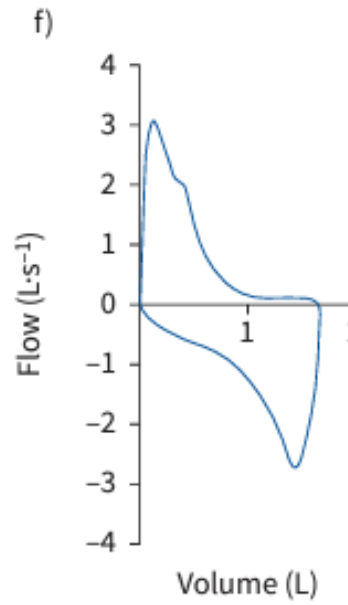
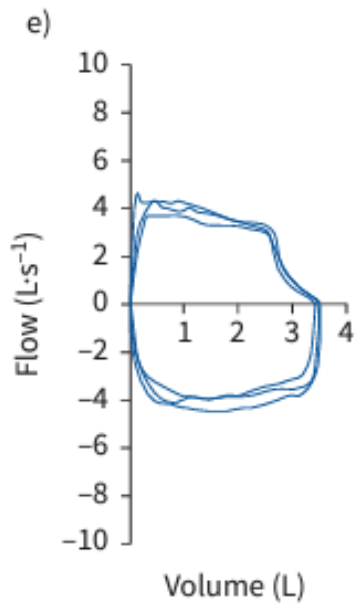
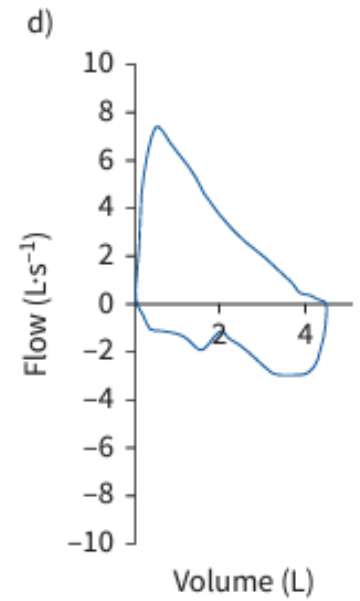
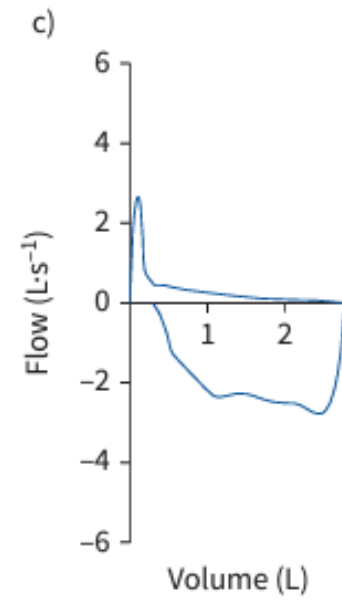
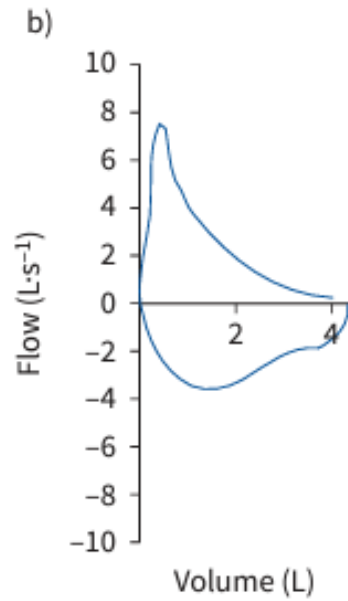
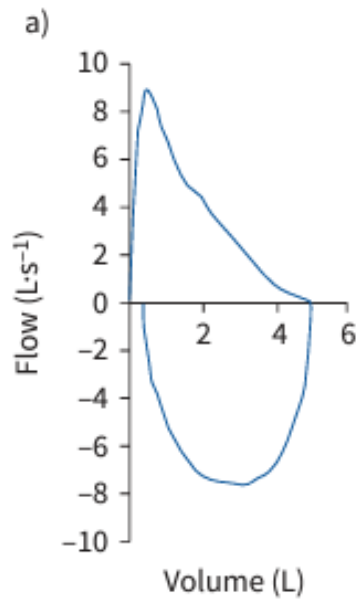


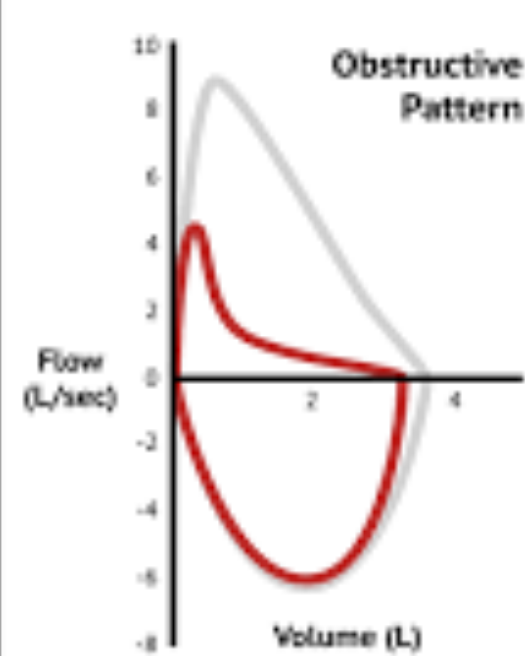
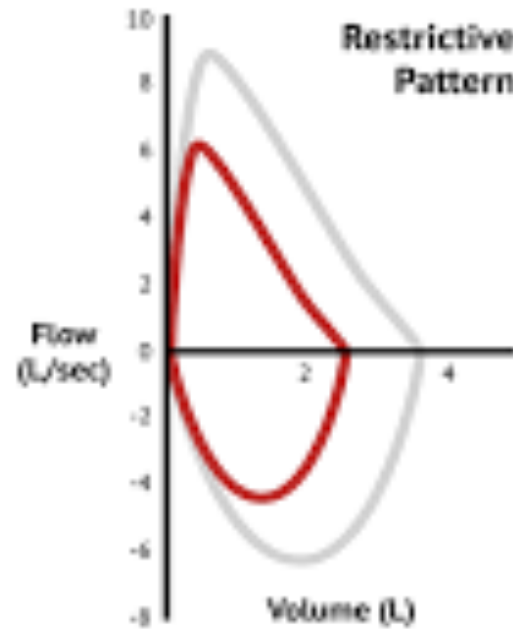
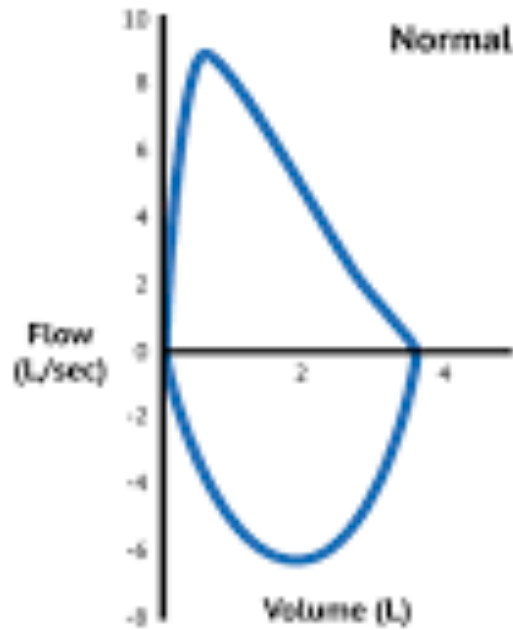


# FLOW VOLUME LOOPS

Expiration

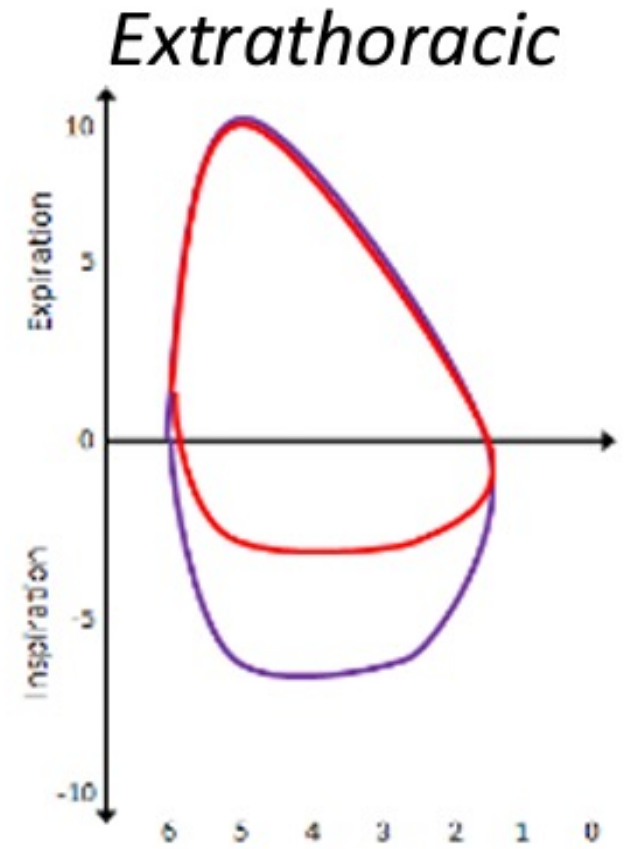
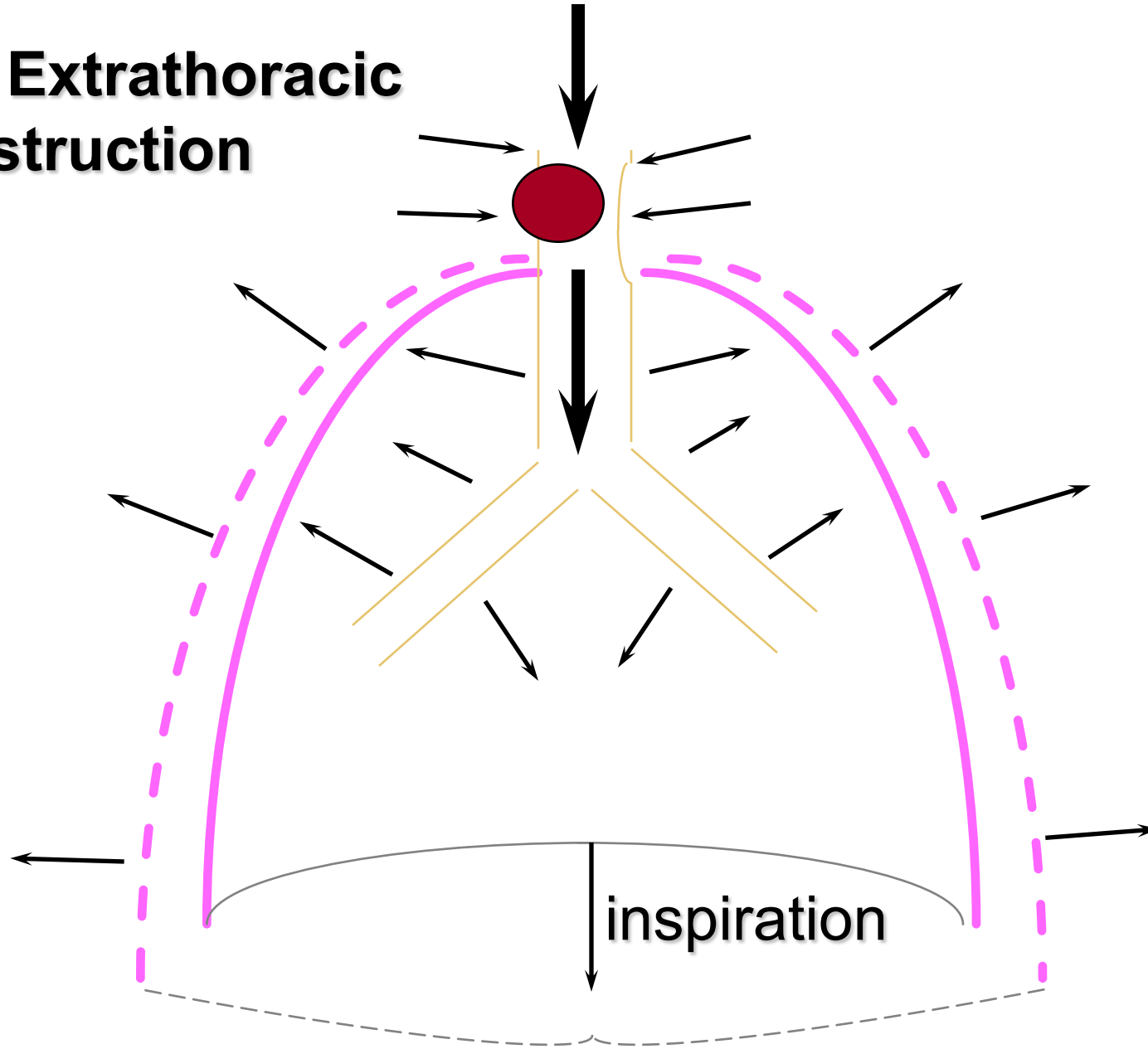
Inspiration





# FLOW VOLUME LOOPS OBSTRUCTION AND RESTRICTION

# Variable Extrathoracic Obstruction



# Inducible Laryngeal Obstruction (ILO)

Previously VCD

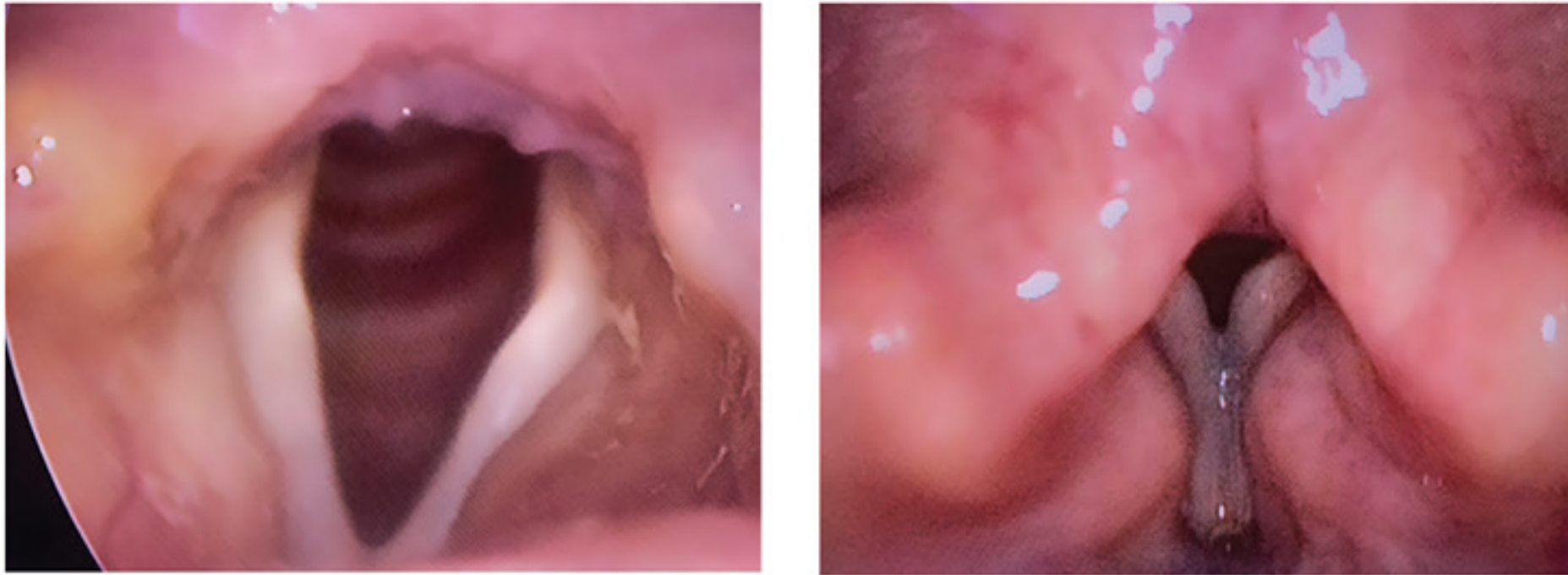
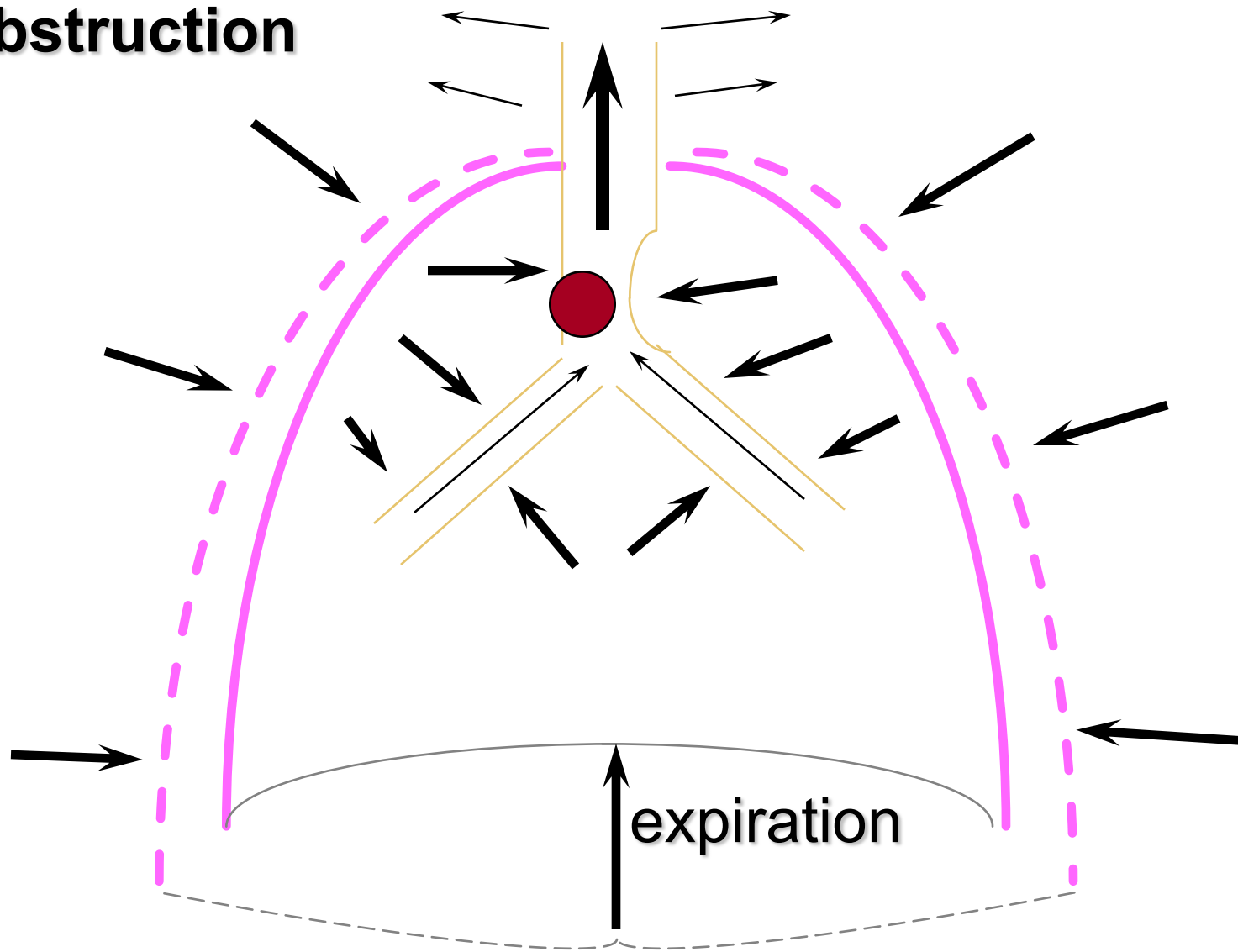


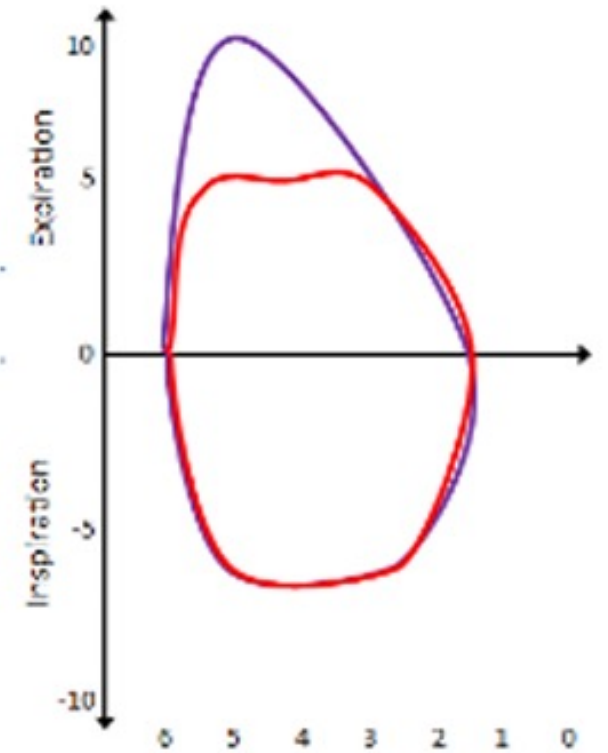
Figure 1. a (left). Normal vocal fold abduction during inhalation. b (right). Partial vocal fold adduction during inhalation with inducible laryngeal obstruction.



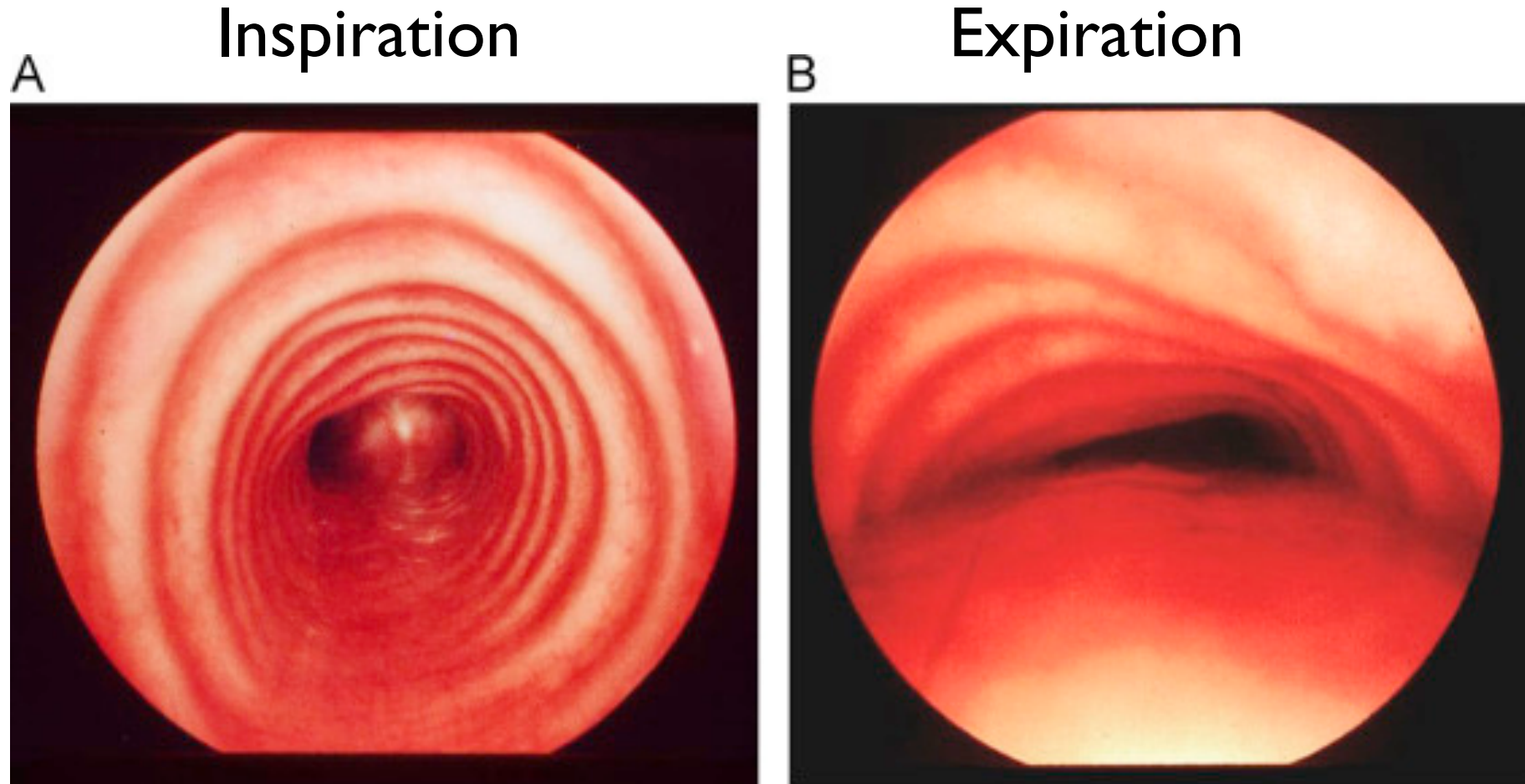
# Variable Intrathoracic Obstruction



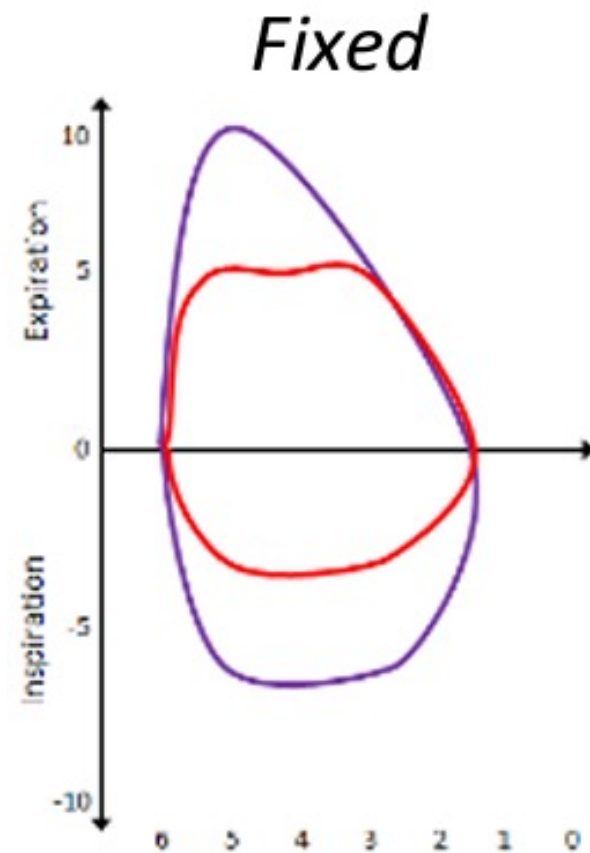
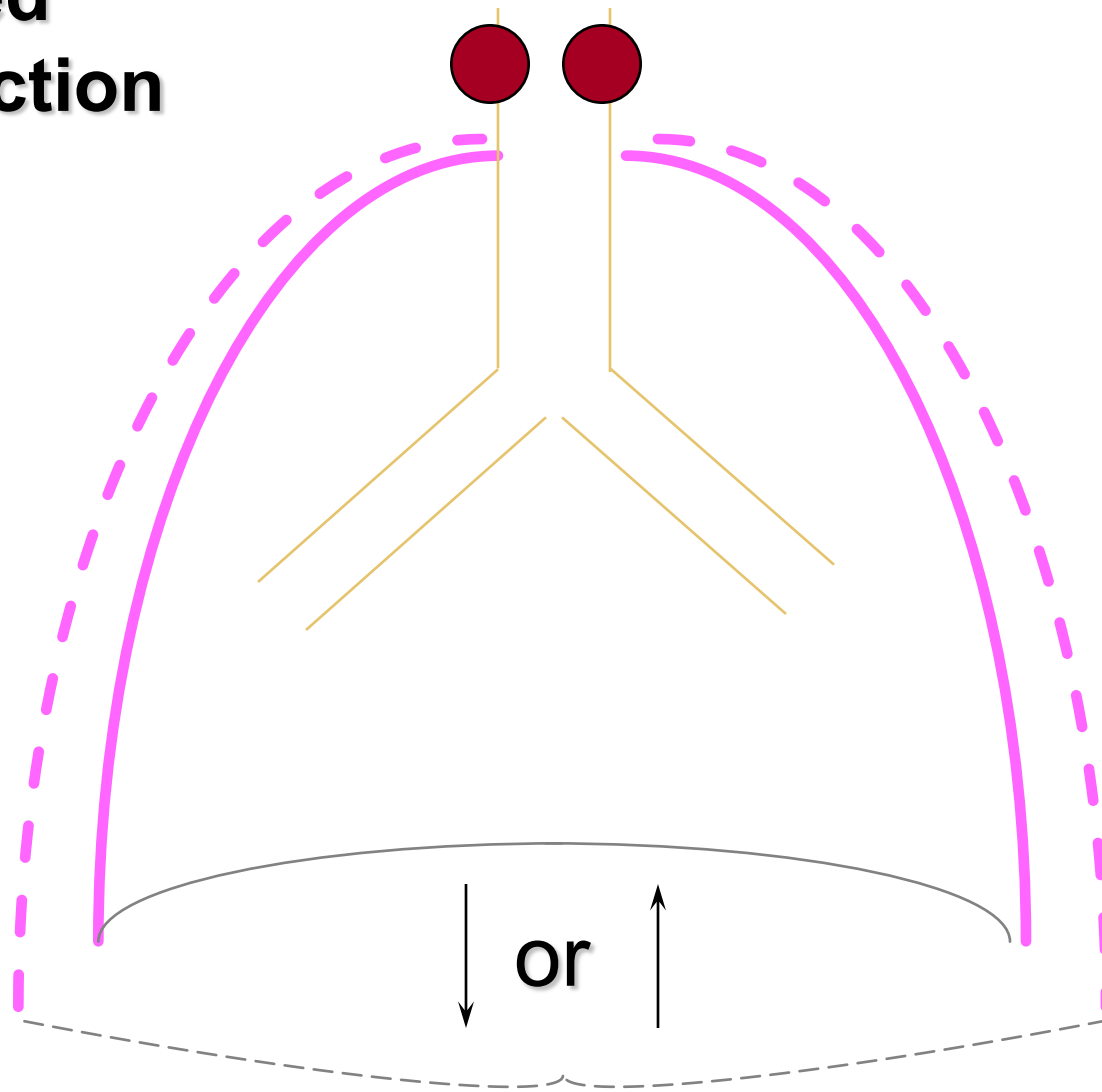
*Intrathoracic*



# Tracheomalacia

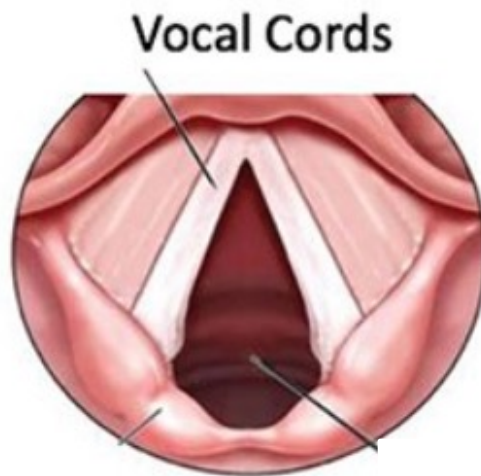


# Fixed Obstruction



# Subglottic stenosis

**A. Diagram**



**B. Healthy**



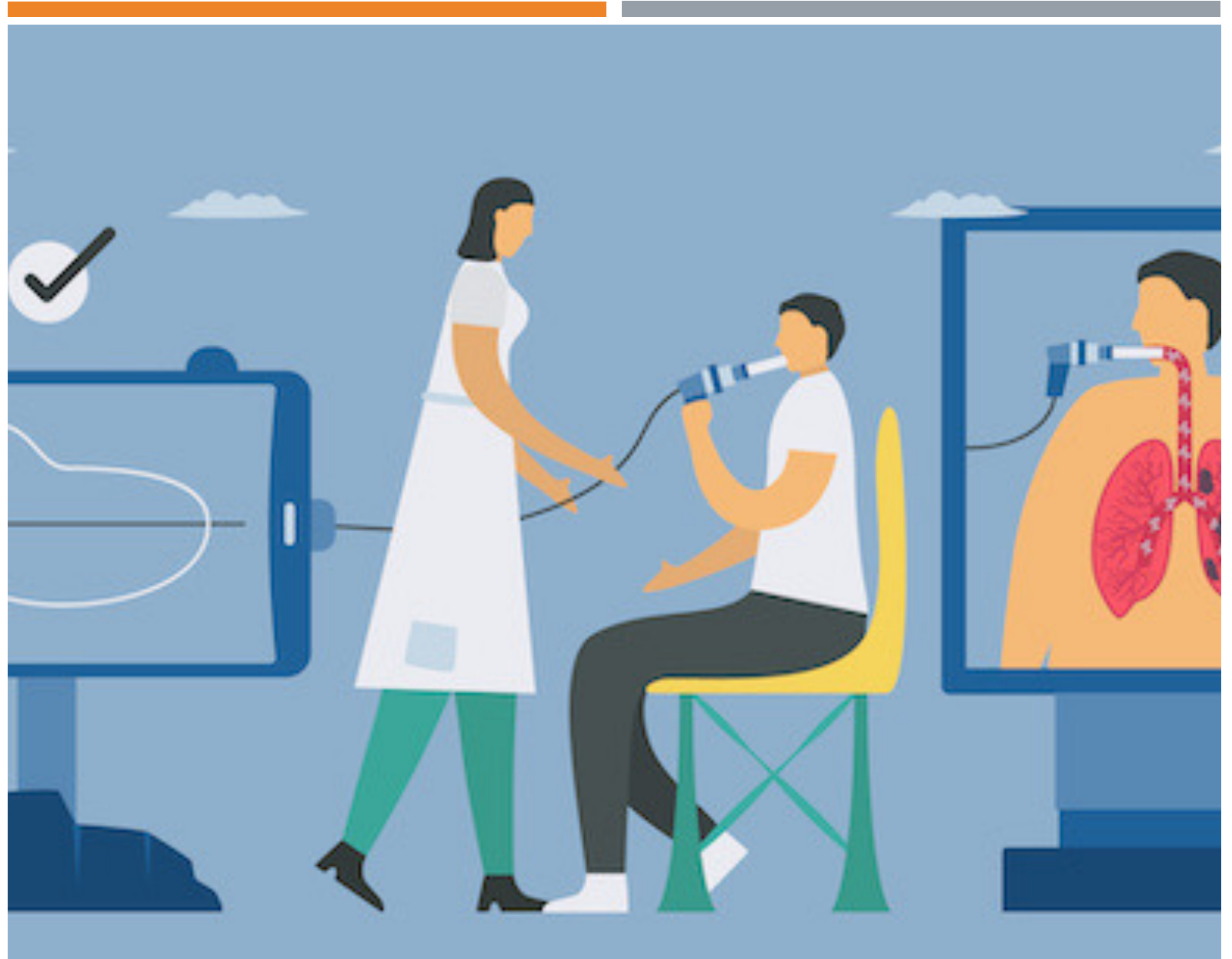
**C. SGS**



Doing PFTs? Get as much information as you can!

No downside to getting all of these on essentially everyone:

- Spirometry pre and post bronchodilator
  - Lung Volumes
    - DLCO
    - FeNO





# THANK YOU

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GLI reference population	GLI data sources	Population/ancestral origin	Considerations
<b>White</b>	Europe, Israel, Australia, USA, Canada, Brazil, Chile, Mexico, Uruguay, Venezuela, Algeria, Tunisia	White (European); Hispanic (European)	Suitable for use in White European populations [36, 175, 176]
<b>Black</b>	African American	Black (North America)	
<b>South East Asian</b>	Thailand, Taiwan, China (including Hong Kong)	Asian	
<b>North East Asian</b>	Japan, Korea		North East Asian equations demonstrate poor fit when applied to contemporary populations [29]
<b>Multi-ethnic</b>	Average of the other four GLI groups	Multiracial; Black South Africa [177]; India [178]; unknown	Indian [178] and South African [177] data based on a single prospective study in children