# Pulmonary Function Testing

## *The Basics of Interpretation*

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# Objectives

- Identify the components of PFTs
- Describe the indications
- Develop a stepwise approach to interpretation
- Recognize common patterns
- Apply this information to patient care

# Pulmonary Function Testing

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b. Degree of responsiveness to bronchodilators
c. Forced vital capacity (FVC)
d. Forced expiratory volume in 1 second
e. Diffusing capacity (DLCO)

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a. Diffusing Capacity (DLCO)
b. If no obstruction present, add trial of bronchodilator
c. If no obstruction present, perform methacholine challenge
d. Flow volume loop
e. b and c

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a. Pulmonary edema
b. Aspiration pneumonitis
c. Pulmonary emboli
d. Alveolar hemorrhage
e. Interstitial lung disease

# The Purpose

**Provide *quantifiable, reproducible* measurement of lung function**

# Description

- Spirometry
- Flow Volume Loop
- Bronchodilator response
- Lung volumes
- Diffusion capacity (DLCO)
- Bronchoprovocation testing
- Maximum respiratory pressures
- Simple and complex cardiopulmonary exercise testing

# Indications — Diagnosis

- Evaluation of signs and symptoms
  - SOB, exertional dyspnea, chronic cough
- Screening at-risk populations
- Monitoring pulmonary drug toxicity
- Abnormal study
  - CXR, EKG, ABG, hemoglobin
- Preoperative assessment

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Smokers > 45yo
(former & current)

# Indications — Diagnosis

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  - SOB, exertional dyspnea, chronic cough
- Screening at-risk populations
- Evaluation of occupational symptoms
- Monitoring pulmonary drug toxicity
- Abnormal study
  - CXR, EKG, ABG, hemoglobin
- Preoperative assessment

# Indications — Prognostic

Assess severity

Follow response to therapy

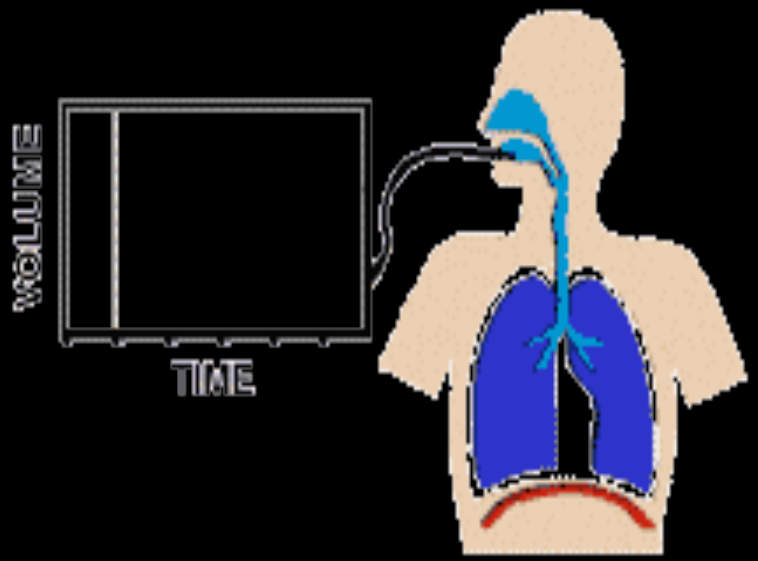
Determine further treatment goals

Referral for surgery

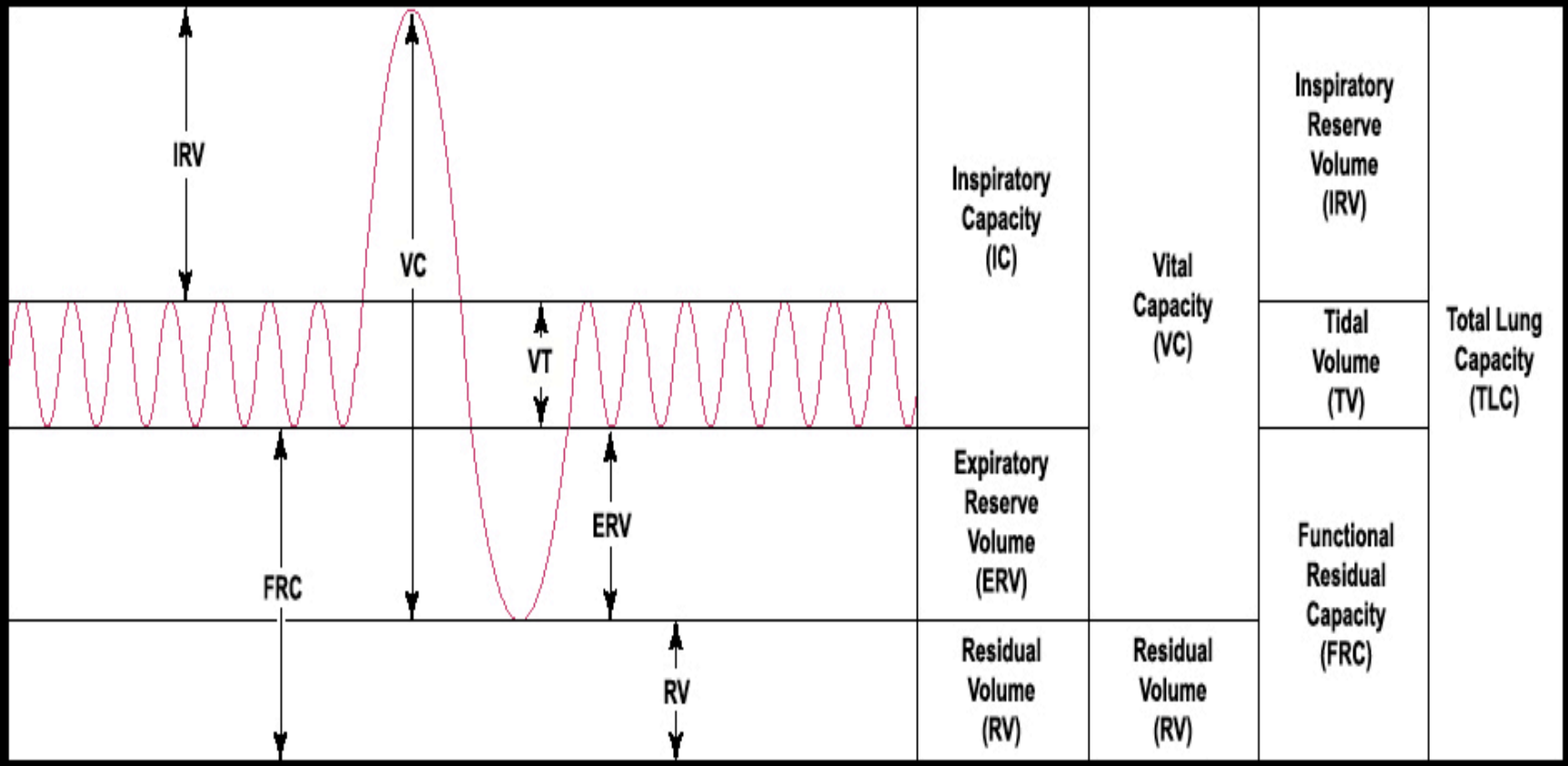
Disability

# Spirometry

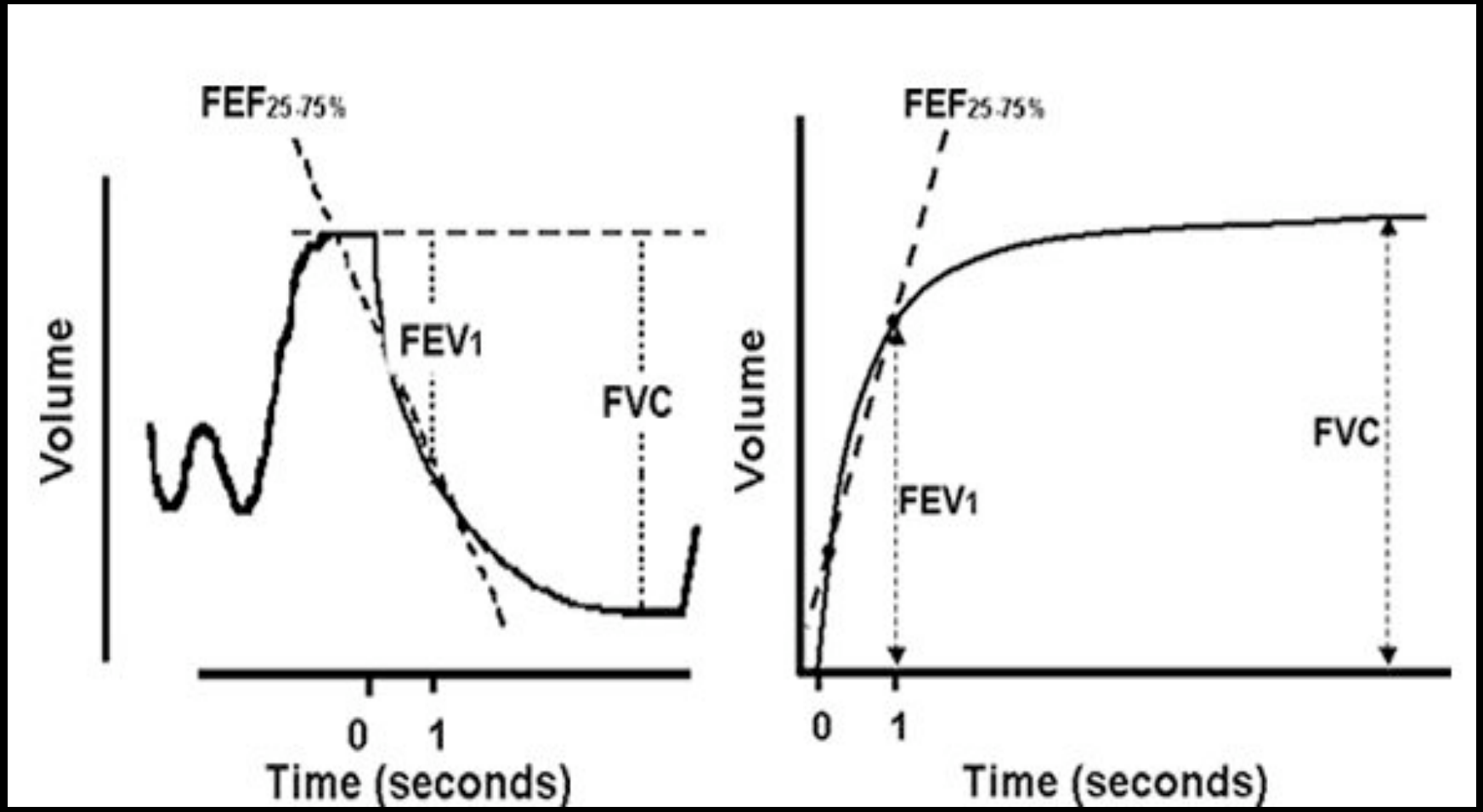
- Simple, office-based
- Measures flow, volumes
- Volume vs. Time
- Can determine:
  - Forced expiratory volume in one second ($FEV_1$)
  - Forced vital capacity (FVC)
  - $FEV_1$/FVC
  - Forced expiratory flow 25%-75% ($FEF_{25-75}$)



# Lung Volumes

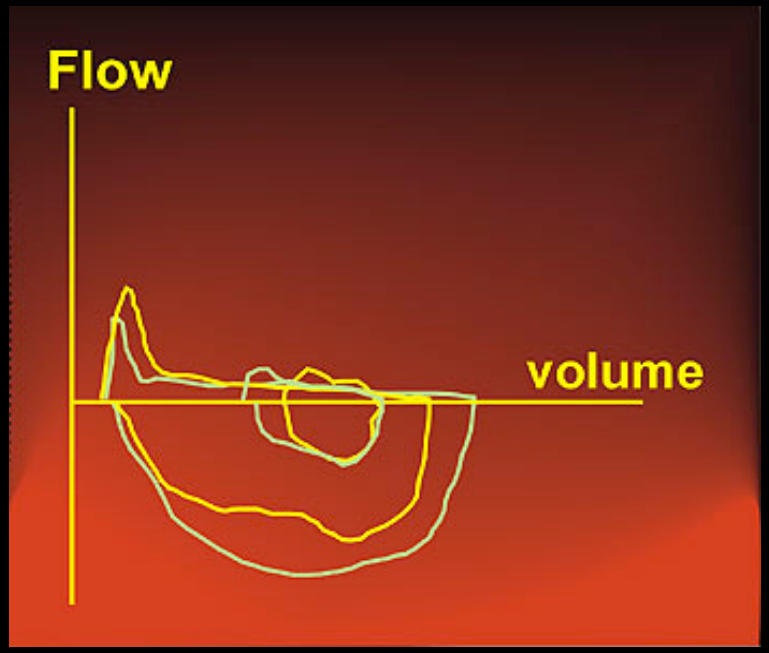


# Spirometry


FEF25-75%
Volume
FEV1
FVC
0
1
Time (seconds)
FEF25-75%
Volume
FEV1
FVC
0
1
Time (seconds)

# Normal Spirometry

# Obstructive Pattern




Decreased $FEV_1$

Decreased FVC

Decreased $FEV_1$/FVC

- <70% predicted

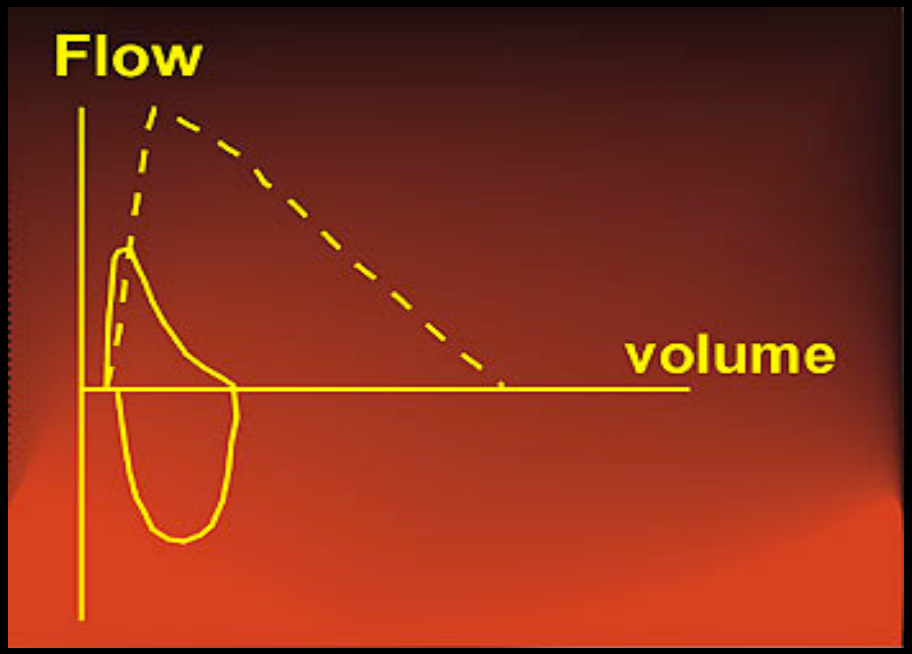
$FEV_1$ used to follow severity in COPD

# Obstructive Lung Disease — *Differential Diagnosis*

- Asthma
- COPD
  - chronic bronchitis
  - emphysema
- Bronchiectasis
- Bronchiolitis
- Upper airway obstruction

# Restrictive Pattern

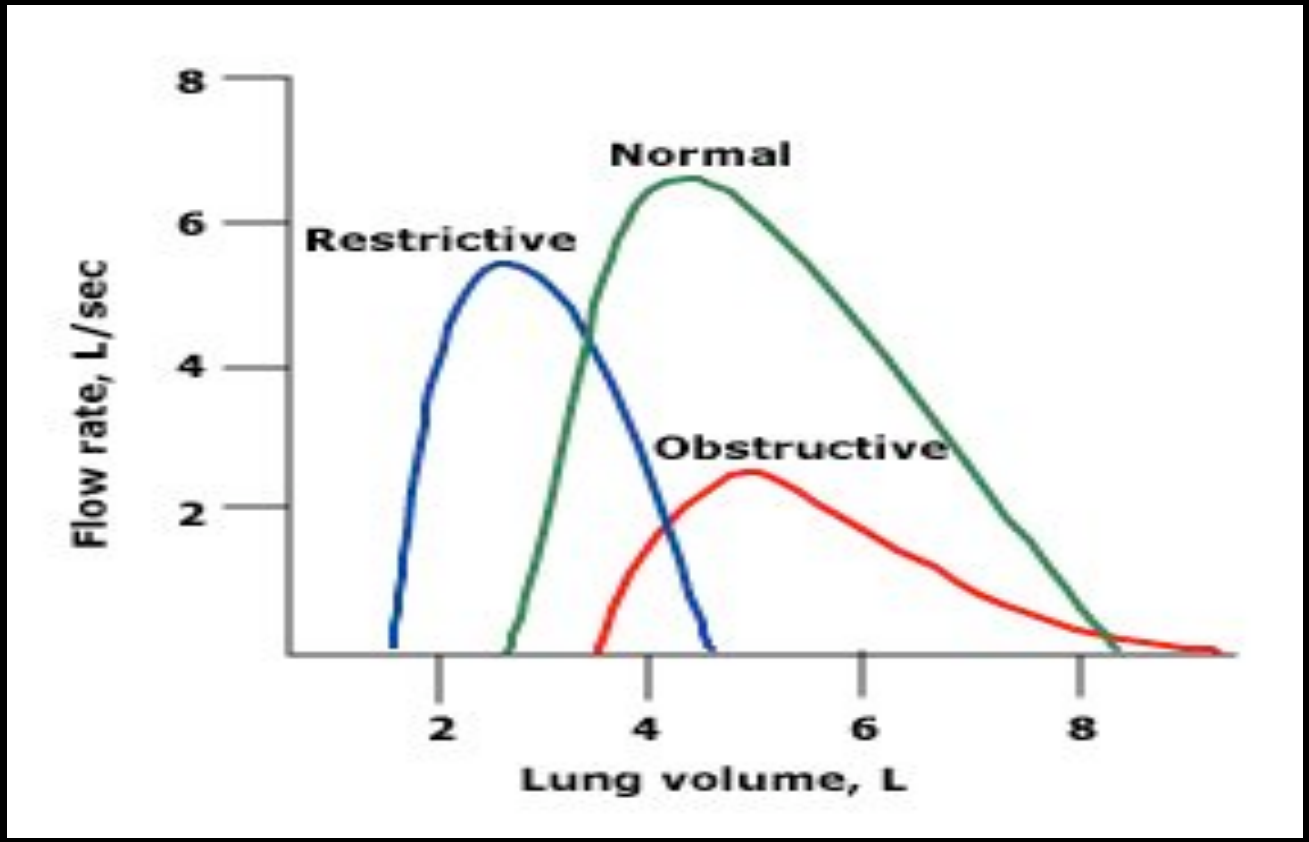
- Decreased $FEV_1$
- Decreased FVC
- $FEV_1$/FVC *normal* or *increased*



# Restrictive Lung Disease —*Differential Diagnosis*

- Pleural
- Parenchymal
- Chest wall
- Neuromuscular

# Spirometry Patterns



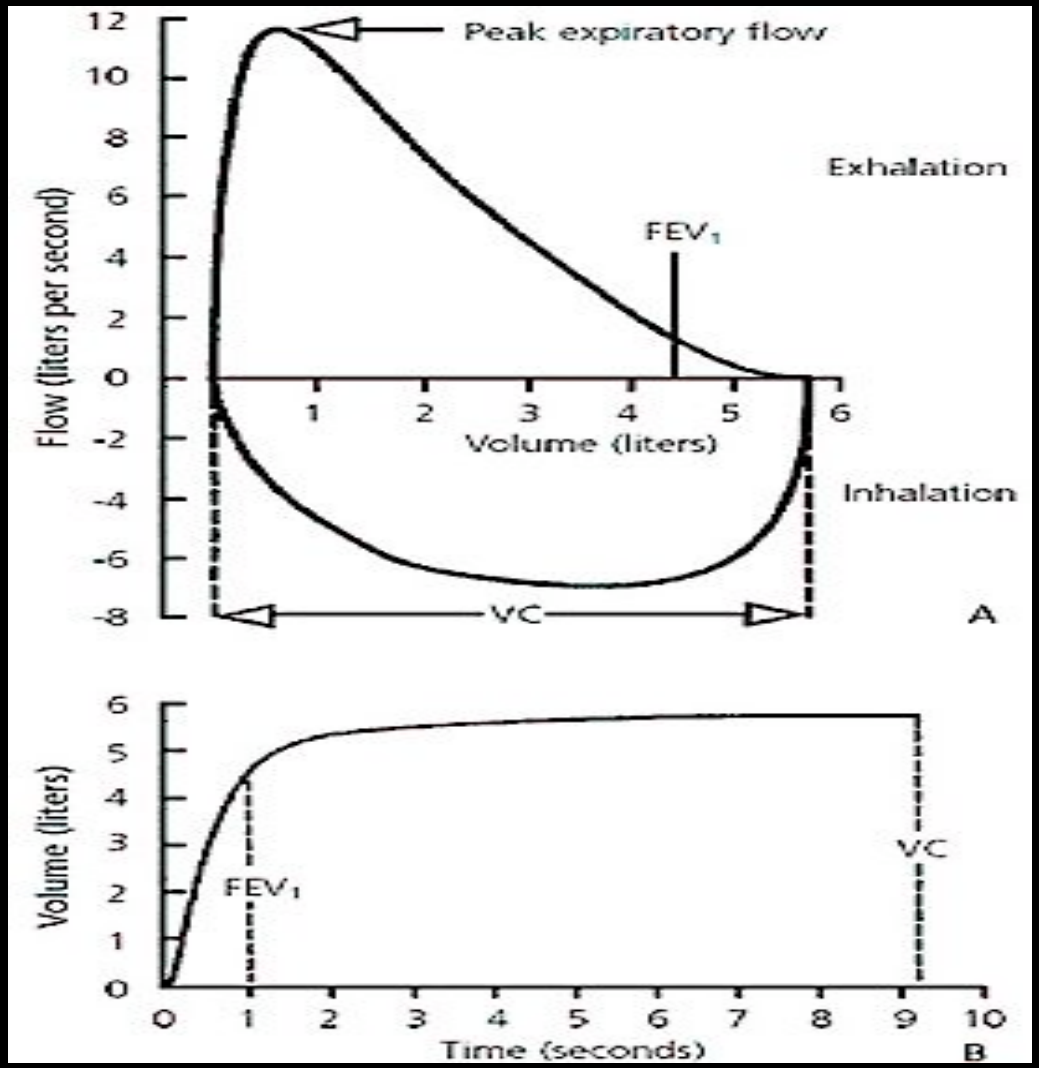
# Bronchodilator Response

- Degree to which $FEV_1$ improves with inhaled bronchodilator
- Documents *reversible* airflow obstruction
- Significant response if:
  - $FEV_1$ increases by 12% and >200ml
- Request if obstructive pattern on spirometry

# Flow Volume Loop

- “Spirogram”
- Measures forced inspiratory and expiratory flow rate
- Augments spirometry results
- Indications:  evaluation of upper airway obstruction (stridor, unexplained dyspnea)

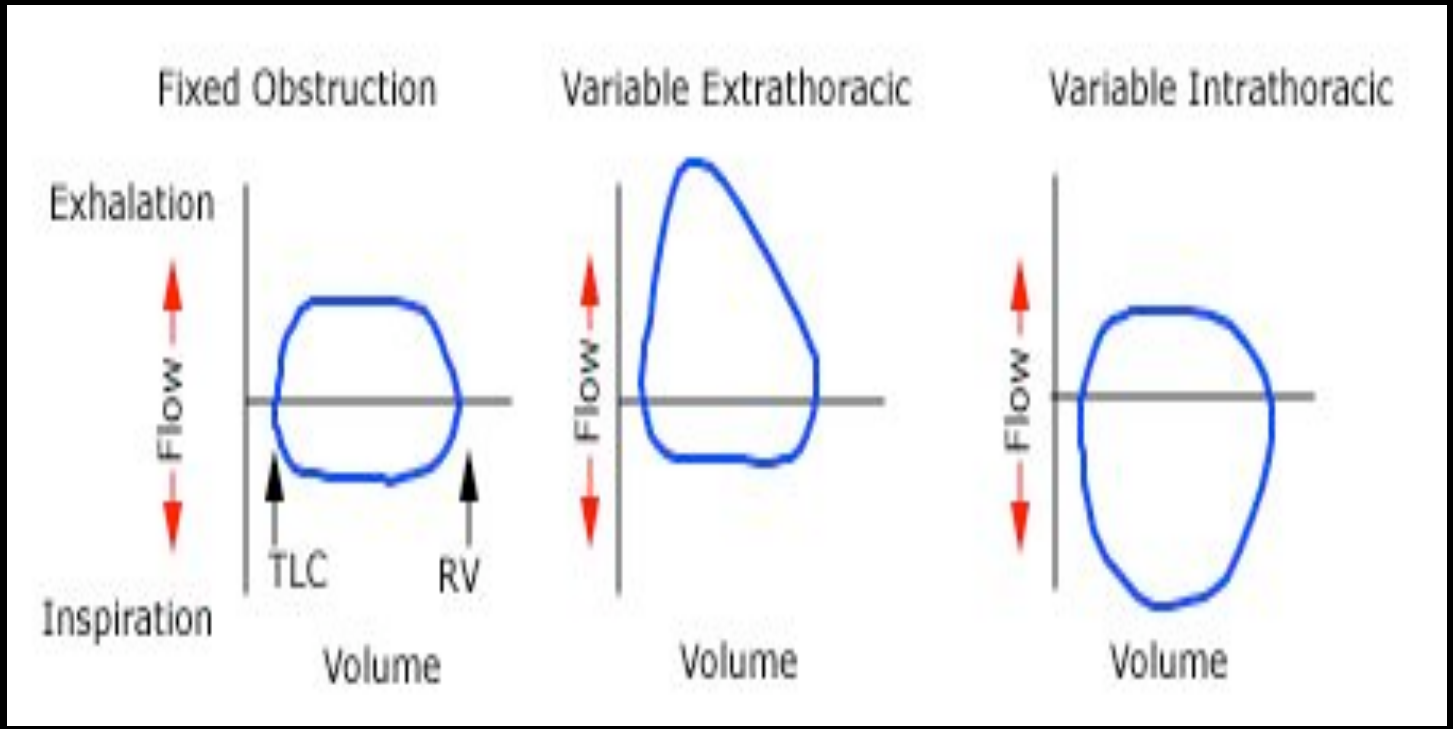
# Flow Volume Loop



# Upper Airway Obstruction

- Variable intrathoracic obstruction
- Variable extrathoracic obstruction
- Fixed obstruction

# Upper Airway Obstruction



# Lung Volumes

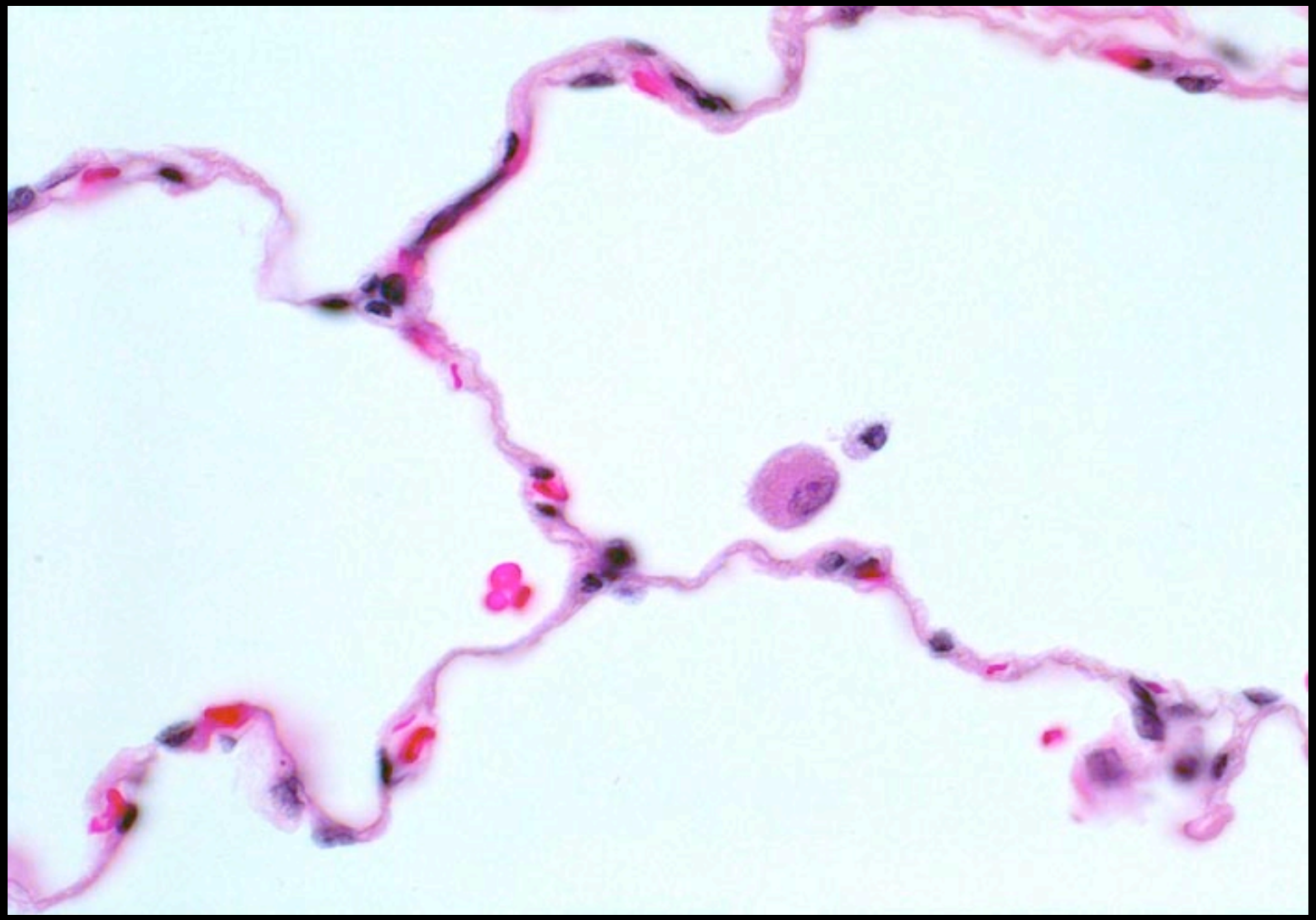
- Measurement:
  - helium
  - nitrogen washout
  - body plethsmography
- Indications:
  - Diagnose restrictive component
  - Differentiate chronic bronchitis from emphysema

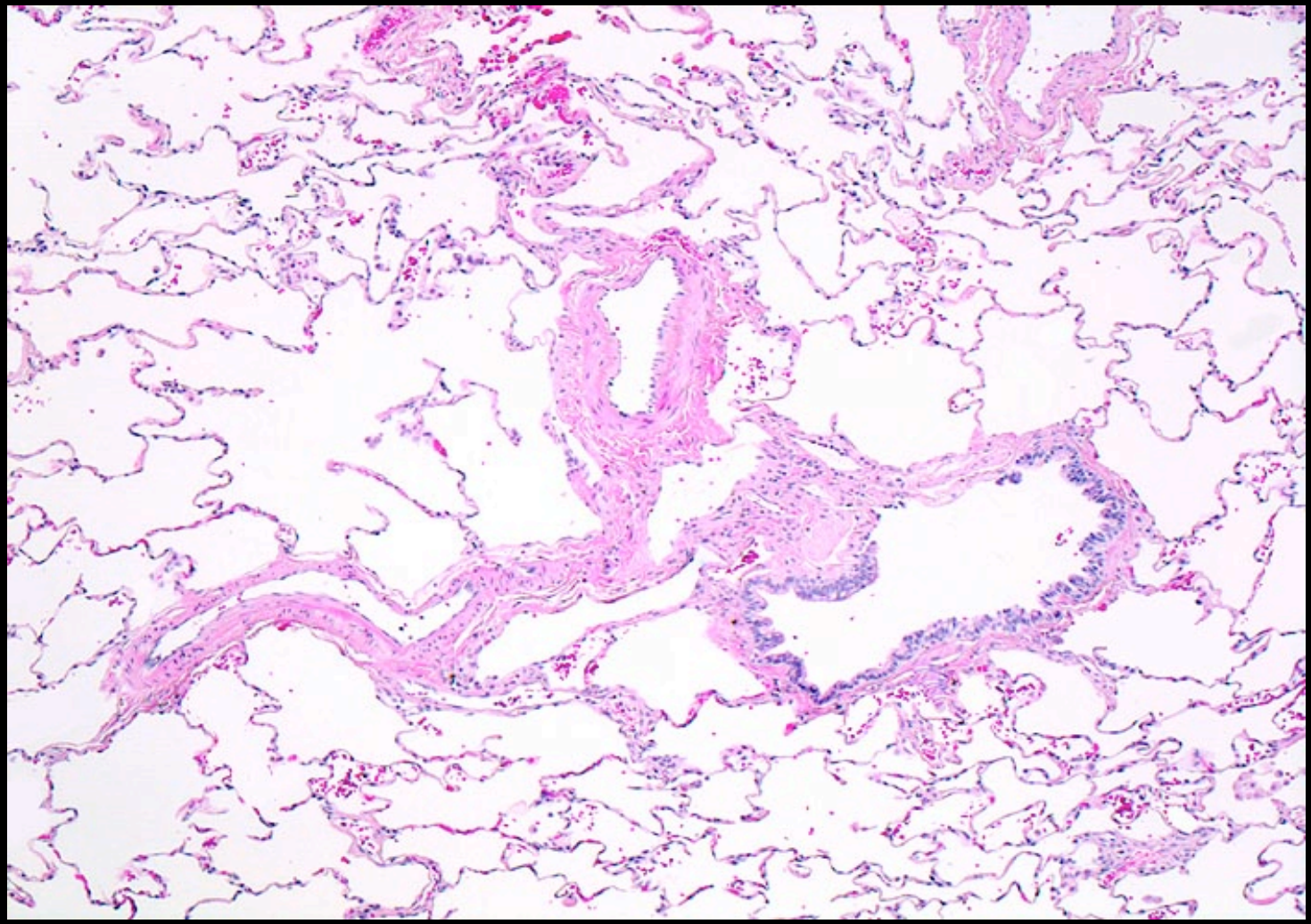
# Lung Volumes – Patterns

- Obstructive
  - TLC > 120% predicted
  - RV > 120% predicted
- Restrictive
  - TLC < 80% predicted
  - RV < 80% predicted

# Diffusing Capacity

- Diffusing capacity of lungs for CO
- Measures ability of lungs to transport inhaled gas from alveoli to pulmonary capillaries
- Depends on:
  - alveolar—capillary membrane
  - hemoglobin concentration
  - cardiac output





# Diffusing Capacity

- **Decreased DLCO**

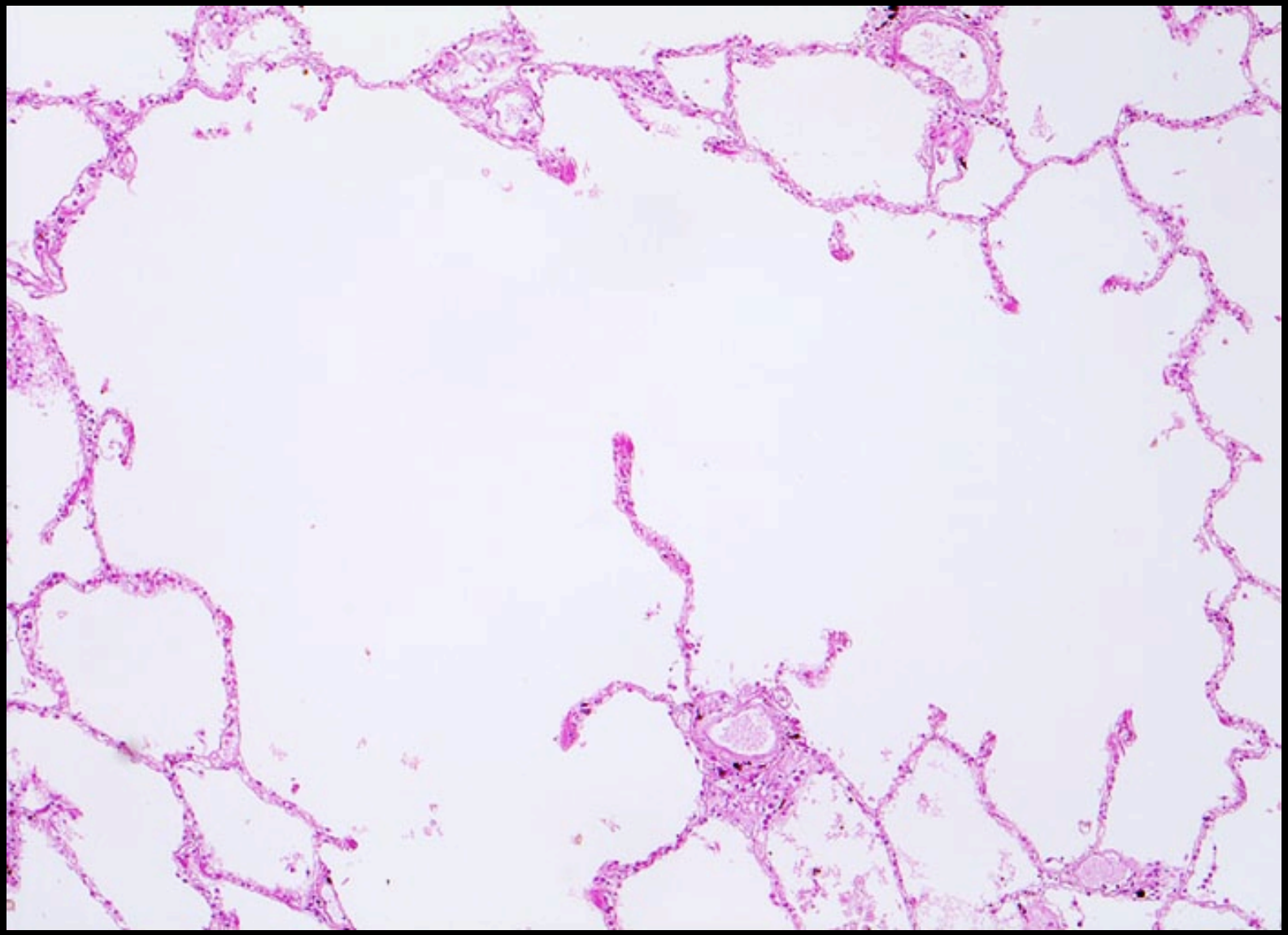
  (<80% predicted)

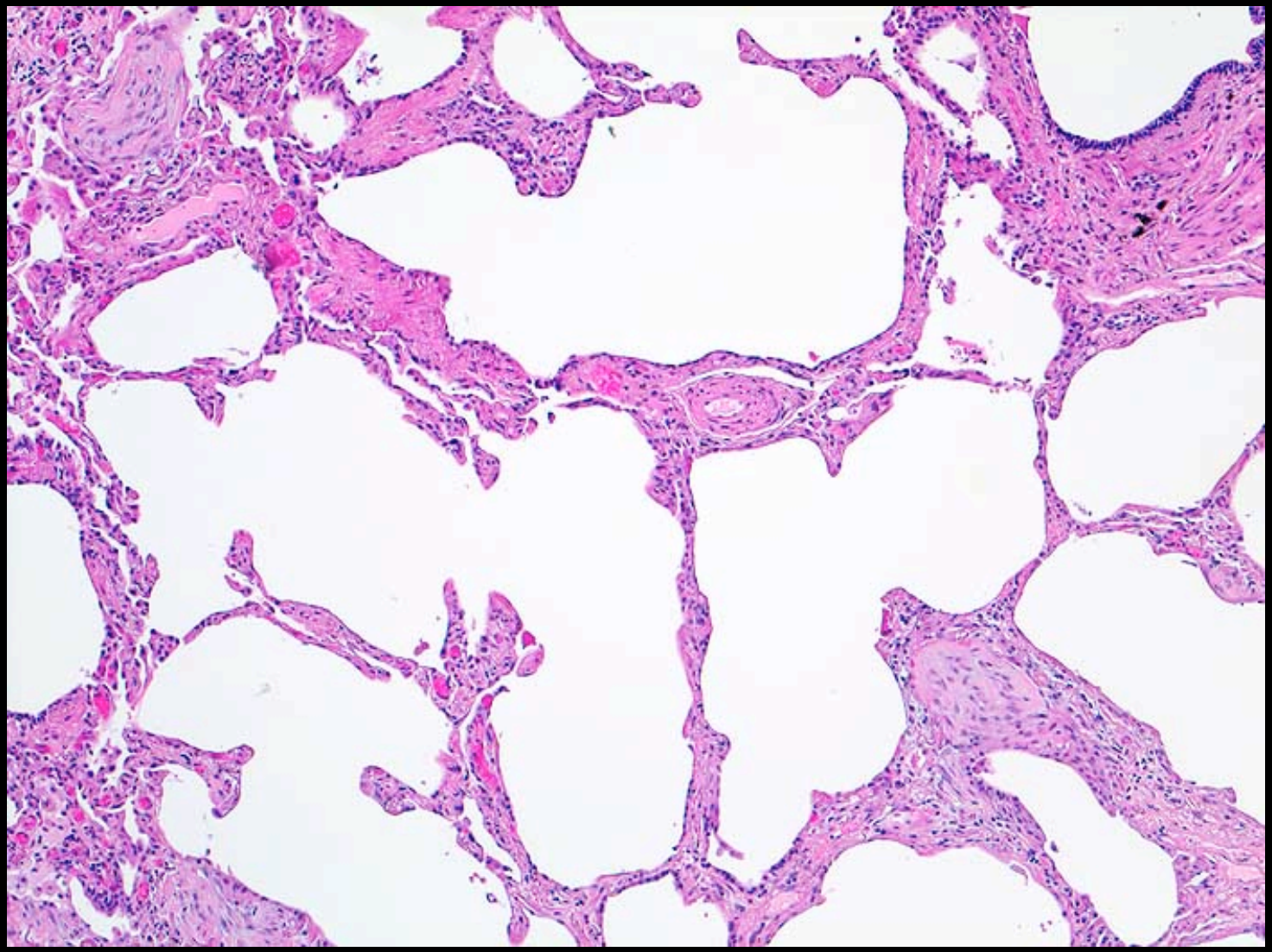
  - Obstructive lung disease
  - Parenchymal disease
  - Pulmonary vascular disease
  - Anemia

- **Increased DLCO**

  (>120-140% predicted)

  - Asthma (or normal)
  - Pulmonary hemorrhage
  - Polycythemia
  - Left to right shunt





# DLCO — Indications

- Differentiate asthma from emphysema
- Evaluation and severity of restrictive lung disease
- Early stages of pulmonary hypertension
- Expensive!

# Case 1

CC/HPI: A 36yo WM, nonsmoker, presents to your clinic with c/o episodic cough for 6mo. Also reports occasional wheezing and dyspnea with exertion during softball practice.

Exam: Heart RRR, no murmurs; Lungs CTAB, no labored breathing

Based on your exam and a thorough review of systems, you suspect asthma and decide to order spirometry for further evaluation.

## *Continued…*

PFTs: $FEV_1$ 86% predicted

$FEV_1/FVC$ 82% predicted

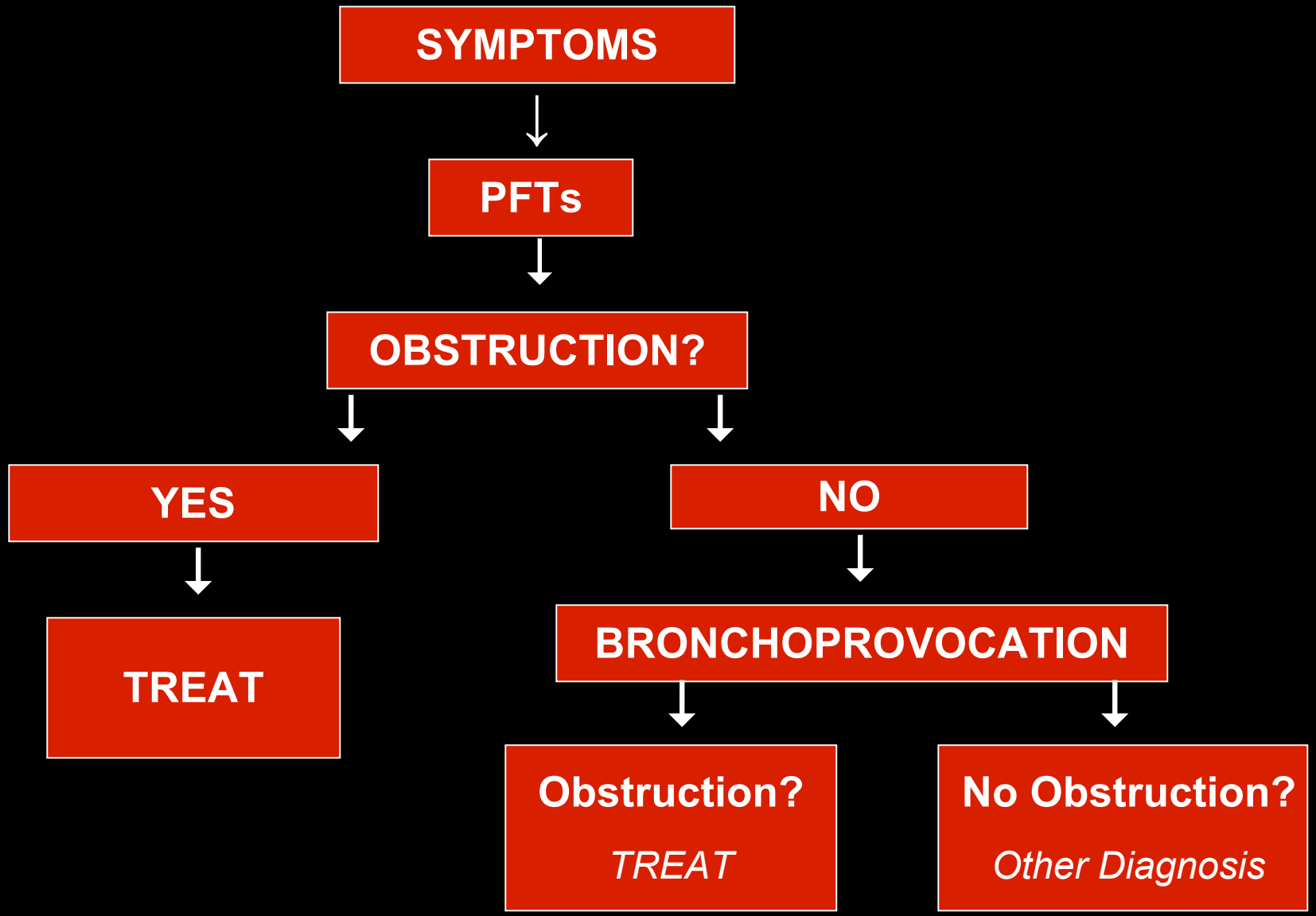
Flow Volume Loop: normal inspiratory and expiratory pattern

You still suspect asthma. What is your next step in the workup of this patient?

# Bronchoprovocation

- Useful for diagnosis of asthma in the setting of *normal* pulmonary function tests
- Common agents:
  - Methacholine, Histamine, others
- Diagnostic if: ≥20% decrease in $FEV_1$

## *Continued…*


SYMPTOMS
PFTs
OBSTRUCTION?
YES
TREAT
NO
BRONCHOPROVOCATION
Obstruction?
TREAT
No Obstruction?
Other Diagnosis

# PFT Interpretation Strategy

- What is the clinical question?
- What is "*normal*"?
- Did the test meet American Thoracic Society (ATS) criteria?
- Don't forget *(or ignore)* the flow volume loop!

# Obstructive Pattern — Evaluation

- **Spirometry**
  - $FEV_1$, FVC: decreased
  - $FEV_1$/FVC: decreased (<70% predicted)
- **FV Loop** "scooped"
- **Lung Volumes**
  - TLC, RV: increased
- Bronchodilator responsiveness

# Restrictive Pattern – Evaluation

- **Spirometry**
  - FVC, $FEV_1$: decreased
  - $FEV_1$/FVC: normal or increased
- **FV Loop** "witch's hat"
- **DLCO** decreased
- **Lung Volumes**
  - TLC, RV: decreased
- Muscle pressures may be important

# PFT Patterns

- **Emphysema**
  - $FEV_1/FVC$ <70%
  - "Scooped" FV curve
  - TLC *increased*
  - Increased compliance
  - DLCO *decreased*
- **Chronic Bronchitis**
  - $FEV_1/FVC$ <70%
  - "Scooped" FV curve
  - TLC *normal*
  - Normal compliance
  - DLCO usually *normal*

# PFT Patterns

- Asthma
  - $FEV_1/FVC$ normal or decreased
  - DLCO normal or increased

*But PFTs may be normal → bronchoprovocation*

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# *Questions?*

# References


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