Patient Assessment & Diagnostic Evaluation of Dyspnea

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Disclosure

- Medical Communications Media/American Association of Nurse Practitioners/Boehringer Ingelheim (speaker honorarium – COPD lecture series)
- My husband is employed by Glaxo Smith Kline pharmaceuticals.

- Nothing related to this talk

Objectives

1. Describe the pathophysiologic mechanisms responsible for dyspnea.
2. Construct a differential diagnosis of acute and chronic dyspnea.
3. Apply foundational knowledge to the assessment and diagnostic evaluation of dyspnea through patient cases.

Dyspnea

- is the subjective sensation of an inadequate, unsatisfying, difficult, uncomfortable, tight, suffocating or labored breath that results from a myriad of physiologic and pathophysiologic conditions

- may not represent a single sensation

Burki, N & Lee, L., (2010). Mechanisms of Dyspnea. Chest. Nov; 138(5): 1196–1201; An Official American Thoracic Society Statement: Update on the Mechanisms, Assessment, and Management of Dyspnea (2011).

Dyspnea

- very common; 50% of patients presenting to acute or tertiary settings; > 25% outpatient
- 3 – 4 million ED visits annually
- is caused by more than one diagnosis in a number of patients
- is classified as acute or chronic - chronic if symptoms have been present for > 4 weeks

Burki, N & Lee, L., (2010). Mechanisms of Dyspnea. Chest. Nov; 138(5): 1196–1201; An Official American Thoracic Society Statement: Update on the Mechanisms, Assessment, and Management of Dyspnea (2011).

Dyspnea

- **Potent predictor of mortality**
  - Often surpasses common physiologic measures in predicting the clinical course of a patient

Pathophysiologic Examples

1. Run up and down the stairs
2. Hold breath - Breathe on top
3. Ace bandage to chest
4. Breathe through straw
5. Nose clip

Pathophysiology

- Complex and poorly understood
- PET and MR imaging localize regions of the brain that are activated during breathlessness

-

Herigstad M, et al. Dyspea-related cues engage the prefrontal cortex: evidence from functional brain imaging in COPD. Chest 2015; 148: 953

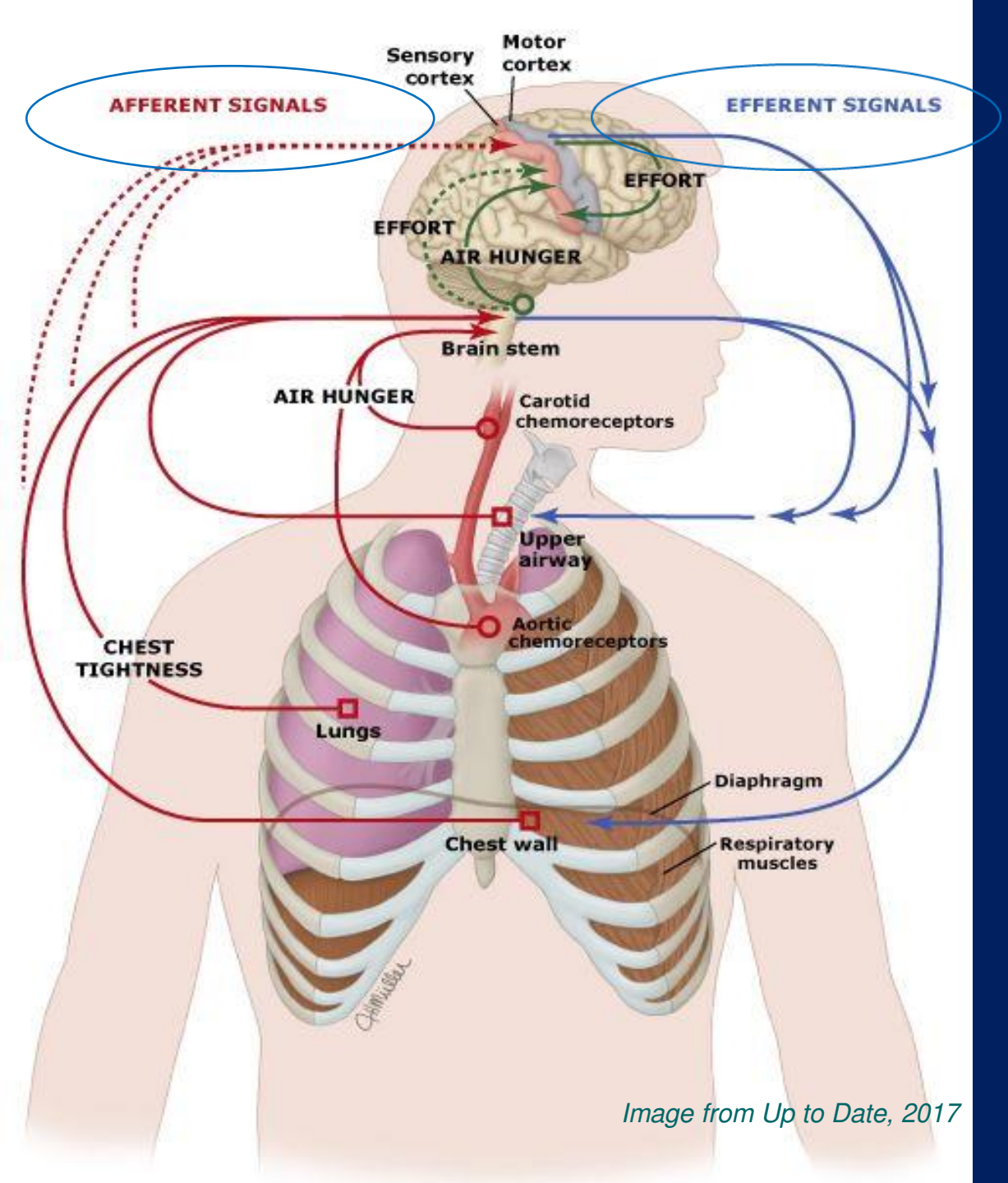
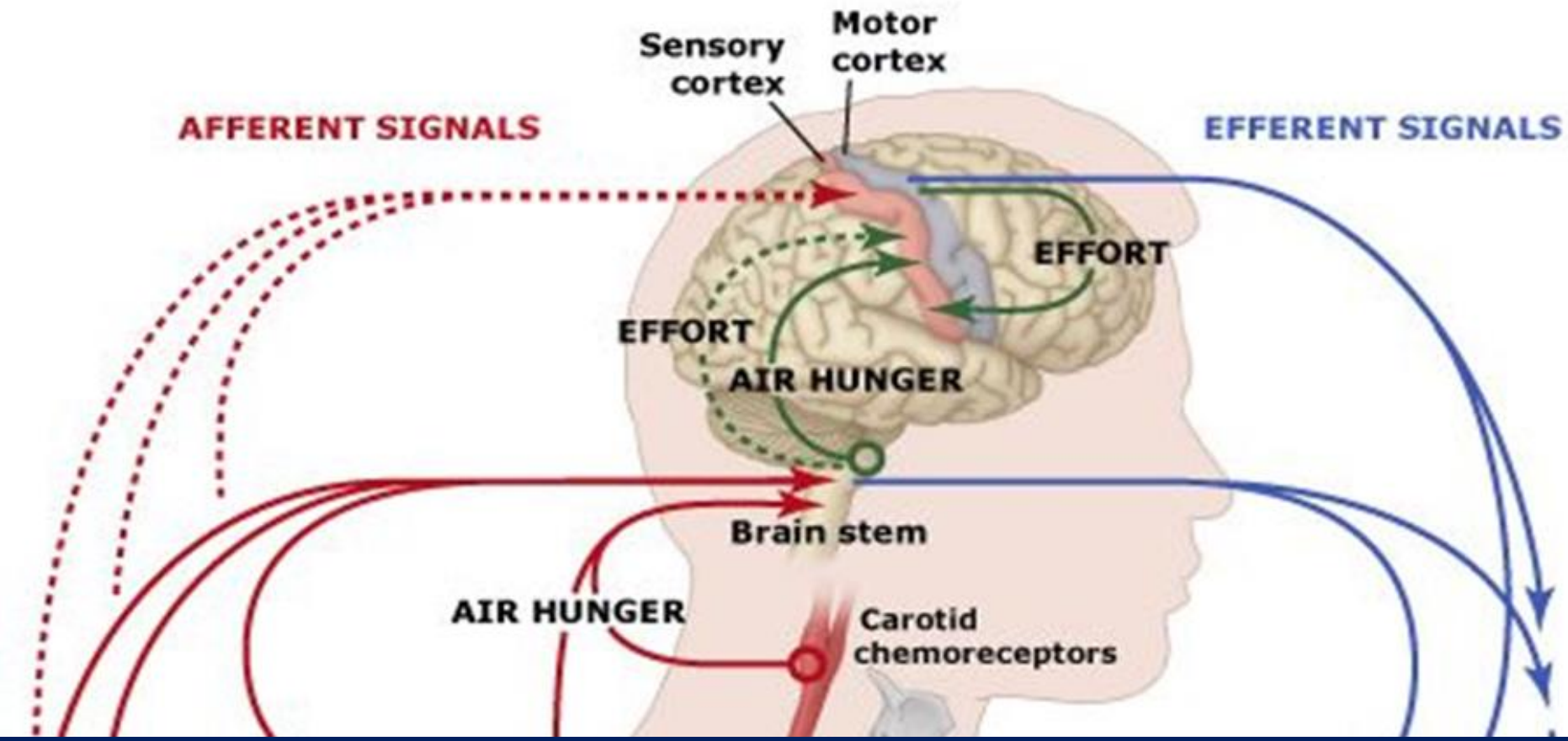


Image from Up to Date, 2017

An overly simplified but useful concept is that if afferent signals (signals to the brain) regarding metabolic demand or thoracic mechanics are NOT matched by adequate efferent responses (responses from the brain) to meet the body's needs, then dyspnea occurs.



- Experimentally-induced breathlessness activates areas within the insular cortex, limbic system, and to a lesser extent, brainstem, areas that are also involved in the perception of other uncomfortable sensations
- Dyspnea-related word cues activate the medial prefrontal cortex and anterior cingulate cortex in patients with COPD

The Unusual Contribution of the Upper Airway

- Upper airway mechanoreceptors may cause or relieve dyspnea in select patients
- Nasal congestion may lead to dyspnea
- Stimulation of upper airway receptors by cool air may relieve dyspnea, and may the reason some patients feel better in front of a fan

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An Official American Thoracic Society Statement: Update on the Mechanisms, Assessment, and Management of Dyspnea (2011).

Dyspnea results from a wide range of diseases/disorders

- Pulmonary
- Cardiac
- Hematologic
- Neuromuscular
- Metabolic
  - Medications
- Psychologic
- Deconditioning

Differential Diagnosis of Acute Dyspnea

Pulmonary
- Pulmonary embolism
- COPD or asthma exacerbation
- Upper airway/laryngospasm
- Pneumonia
- Pneumothorax

Cardiac
- Pulmonary edema
  - Commonly due to ischemic heart disease
  - Acute valvular insufficiency
  - Severe hypertension
- Cardiac tamponade
- Pulmonary embolism - right heart strain
- Arrhythmia

Psychiatric
- Panic/anxiety

Other
- Anaphylaxis
- Aspiration
- Acute respiratory muscle weakness (e.g. Guillain Barre)
- Metabolic acidosis
- Stimulant drugs

Differential Diagnosis of Chronic Dyspnea

Pulmonary
- Obstructive lung disease
- Restrictive / interstitial lung disease
- Upper airway obstruction
  - tumor, vocal cord dysfunction
- Pulmonary vascular disease
- Pleural effusion
- Malignancy
- Chronic infections (NTM)

Cardiovascular
- HFrEF, HFpEF
- PH
- Valvular heart disease
- Pericardial disease
- Arrhythmias

Hematologic – anemia

Psychiatric – panic/anxiety

Neuromuscular
- Myasthenia gravis
- ALS
- Muscular dystrophy

Other
- Chest wall abnormalities
- Deconditioning
- Obesity
- Pregnancy
- Hypothyroidism
- Medications

The words patient's use may point to the problem

- Heart failure patients may describe rapid and heavy breathing, a hunger for air, and suffocation
- Interstitial lung disease patients may sense increased effort, shallow breathing and grasping for air
- Asthmatic patients classically describe chest tightness
- Deconditioning is associated with heavy breathing
- Seemingly healthy subjects reporting that they "can't take a deep and satisfying breath" frequently have a negative work up for known causes of dyspnea

Simon PG, et al. Distinguishable Types of Dyspnea in Patients with Shortness of Breath. *ARRD* 1990; 142: 1009
-Elliott MW, et al. The Language of Breathlessness. *ARRD* 1991; 144: 826

History

- Patient's words
- Onset, duration, severity, periodicity, progression and aggravating and ameliorating factors
- Associated symptoms (such as chest pain, cough, excess phlegm and wheezing)
- Risk factors
  - smoking, environmental or occupational exposures, medication use
- Comorbidities

Physical Exam
Findings to Aid in Diagnosis

- Crackles, wheezes, decreased breath sounds
- Breathing pattern - including alterations in the inspiratory to expiratory ratio
- Pleural rub
- Jugular venous distension, gallop rhythm, pathologic murmur, peripheral edema, and clubbing

Modified MRC (mMRC) Dyspnea Scale

	Grade
"I only get breathless with strenuous exercise."	0
"I get short of breath when hurrying on the level or walking up a slight hill."	1
"I walk slower than people of the same age on the level because of breathlessness or have to stop for breath when walking at my own pace on the level."	2
"I stop for breath after walking about 100 yards or after a few minutes on the level."	3
"I am too breathless to leave the house." *or…* "I am breathless when dressing."	4

mMRC = Modified Medical Research Council Dyspnea Scale

Diagnostic Work-up

Acute Dyspnea:

- pulse oximetry
- complete blood count and differential
- blood chemistries
- arterial or venous blood gas
- troponin, brain natriuretic peptide (BNP)
- D-dimer
- chest imaging – consider angiography
- electrocardiogram
- echocardiogram

Diagnostic Work-up

Chronic dyspnea may also include:

- spirometry/full PFTs
- specialized CT chest imaging
  - ✓ such as a high resolution CT chest
- cardiac stress testing
- cardiac catheterization
- bronchoscopy, video assisted lung biopsy
- serologies
- neuromuscular function
- cardiopulmonary exercise testing

Case 1

- Ms. S is a 33 year-old woman presented to an ED in Chicago with the sudden onset of anxiety and dyspnea. She was in her usual state of good health prior to these symptoms, but was “very stressed” about an upcoming exam. She denied wheezing, cough, sputum, f/c/s and chest pain, but did feel her heart “was racing”.

- PMH: no history of asthma, pneumonia, anxiety or depression.

Case 1

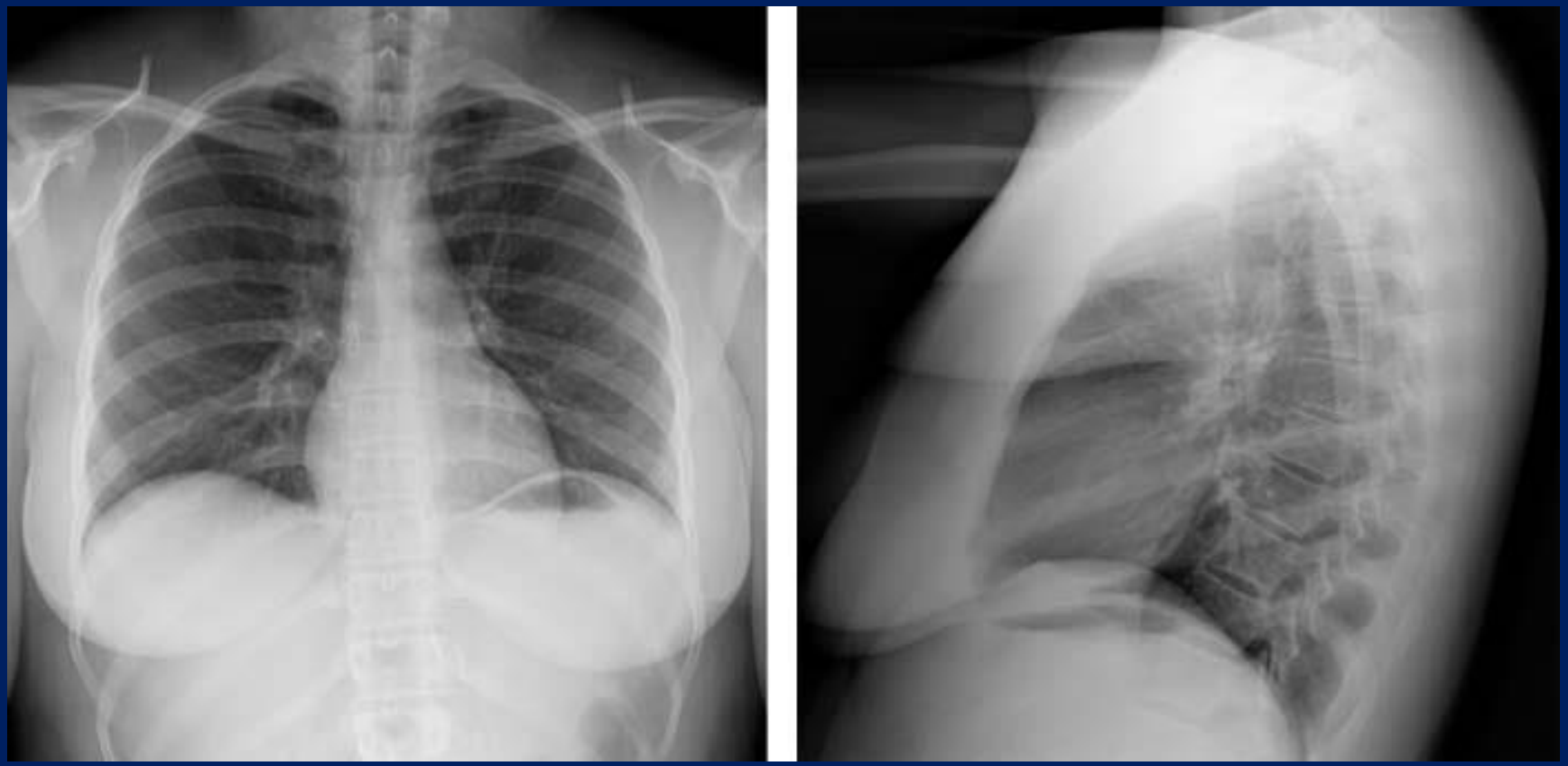
- FH: non contributory
- SH: ½ pack of cigarettes/day, occasional binge drinking, no illicit drugs, law student, single, no pets, no travel, no hobbies

Case 1

- PEx: RR 24/min, HR 100/min, BP 128/86, T 37.6, SpO_2 98% RA
  - Anxious
  - The trachea was midline
  - Lungs: clear to auscultation and percussion
  - CV: tachycardic/regular rhythm without m/r/g
  - ABD obese, NT, ND
  - No c/c/e

Case 1

- ECG: sinus tachycardia



Imaging courtesy of T. Corbridge

Case 1

pH 7.56, $PaCO_2$ 20 mmHg, PaO_2 95 mmHg

Case 1

pH 7.56, $PaCO_2$ 20 mmHg, PaO_2 95mmHg

PAO_2 = 150 – 20/0.8 = 125 mmHg

A – a difference = 125 – 95 (30 mmHg)

Case 2

Mr. O is a 65 yo man who presents with shortness of breath on exertion which has worsened over the past several years. He has no prior respiratory related hospitalizations or ED visits and reports no other problems. He started smoking at age 15 and smoked 3 packs per day until the age of 45.

Case 2 - continued

VS: BP 138/78; HR 88; RR 22; afebrile; BMI 21

O_2 saturation at rest on room air = 94%

No acute distress

Cardiac exam – distant heart tones

Lungs – diminished breath sounds; prolonged expiratory phase

No peripheral edema; no clubbing

Diagnostic Tests

- Patient brought the following to his pulmonary appointment (ordered previously by his PCP):
  - Echocardiogram
  - Chemistries, CBC w diff, TSH
  - Chest CT imaging
- PFTs and 6 minute walk test

Height(in): 73 Weight(lb): 277 Age: 60 Gender: Male
Date: 05/19/99 Race: Caucasian Physician: GMC

SPIROMETRY

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	5.04	2.19	43	2.55	51	16
FEV1	Liters	4.04	1.01	25	1.18	29	17
FEV1/FVC	%	79	46		46		
FEF25-75%	L/sec	4.02	0.49	12	0.56	14	13
FEF50%	L/sec	4.92	(0.41)	(8)	(0.52)	(10)	25
FEF75%	L/sec	1.87	(0.27)	(14)	(0.25)	(13)	-7
PEF	L/sec	9.33	4.09	44	3.92	42	-4
MVV	L/min	150	(42)	(28)			
MVV Length			12				

PLETHYSMOGRAPH LUNG VOLUMES

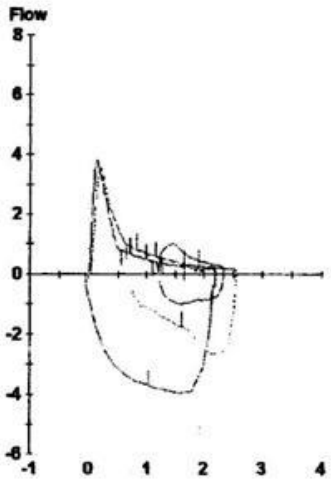
		Pre Meas	Ref	Pre % Ref
TLC	Liters	(8.82)	7.38	(120)
Vtg	Liters	6.65		
RV	Liters	(5.36)	2.58	(208)
FRC PL	Liters	(6.09)	3.51	(174)
VC	Liters	3.47	5.04	69
IC	Liters	2.74		
ERV	Liters	0.73		
Raw	cmH2O/L/sec	3.65	1.29	284
RV/TLC	%	(61)	37	

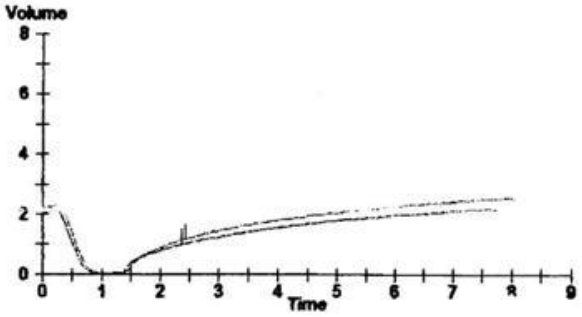
ARTERIAL BLOOD GAS

FIO2
pH
PCO2
PO2
HCO3
SaO2

DIFFUSING CAPACITY

		Pre Meas	Ref	Pre % Ref
DLCO	mL/min/mmHg	(12.5)	30.8	(41)
VA	Liters	6.19		
DLCO/VA	1/min/mmHg	2.03	3.83	53





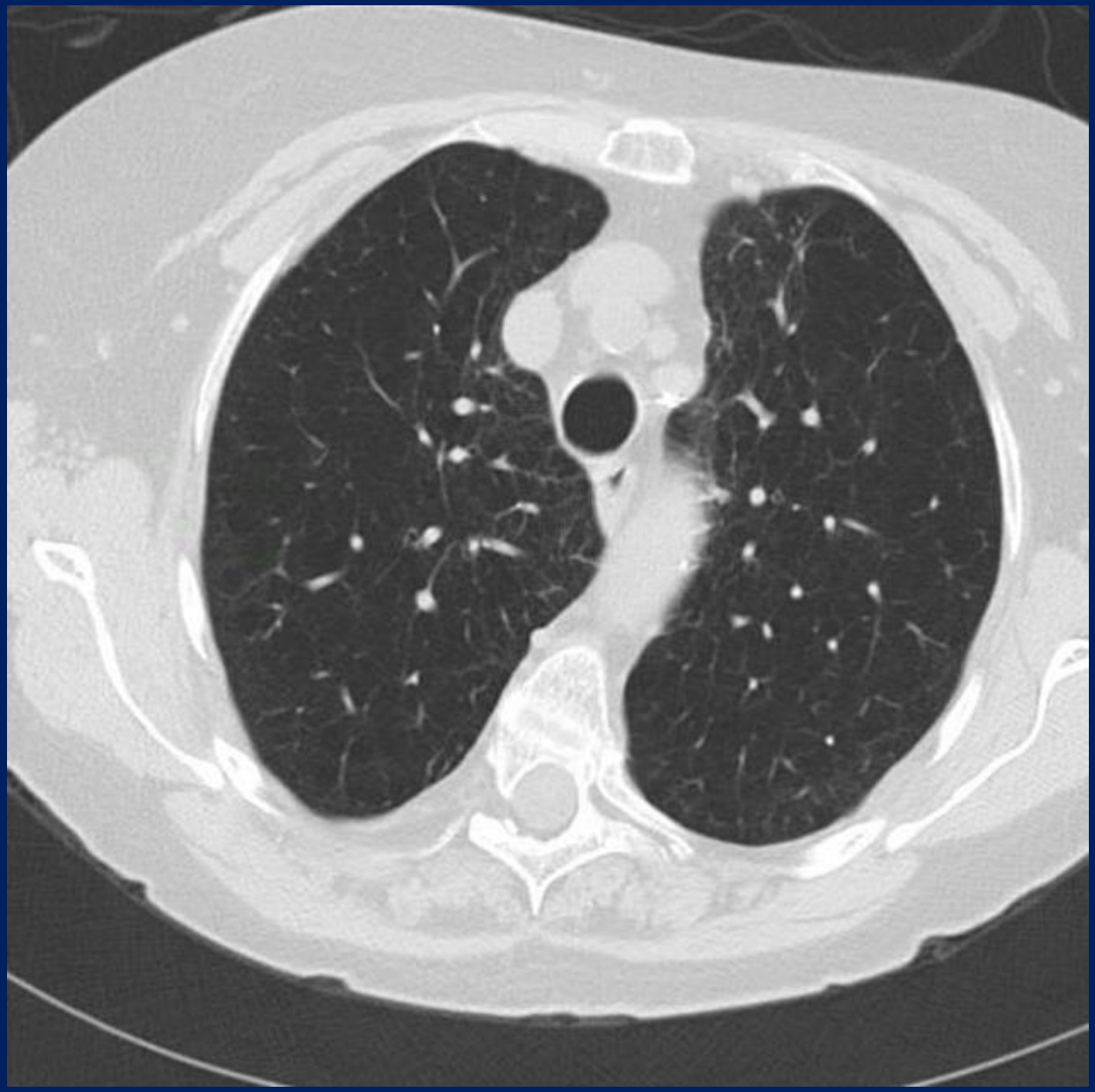


Photo: University of Illinois at Chicago. Used with permission.

TWO-DIMENSIONAL STUDY AND DOPPLER EVALUATION

Right Atrium: Right atrial size is normal.
Right Ventricle: The right ventricular size is normal. Global RV systolic function is normal.
Left Atrium: The left atrium is normal.
Left Ventricle: The left ventricular cavity size is decreased. Ventricular wall thickness is moderately increased. There is global normal left ventricular function. Overall left ventricular ejection fraction by visual estimate is 60%. **Moderate concentric left ventricular hypertrophy**.
Aortic Valve: No indication of aortic valve regurgitation. The aortic valve is normal.
Mitral Valve: No mitral valve regurgitation. No evidence of mitral valve stenosis. The mitral valve is normal.
Tricuspid Valve: No tricuspid valve regurgitation is present. The tricuspid valve structure is normal. PA systolic pressure was unable to be assessed due to an inadequate degree of tricuspid insufficiency.
Pulmonic Valve: The pulmonic valve is not well seen.
Pericardium: There is no pericardial effusion.
Aorta: The aortic sinuses and root appear normal.
Venous: IVC size is normal consistent with normal RA pressure.

Case 3

- Ms. B is a 46 yo morbidly obese never smoker woman who presents with dry cough and dyspnea on exertion for one year.
- Pertinent + ROS:

  morning stiffness over the past six months
  daytime somnolence, morning HA's
- Lung examination reveals inspiratory crackles over the lower third of the chest bilaterally.

Case 3

- Resting oxygen saturation is 98% on room air.
- On 6 minute hallwalk in clinic, she desaturates to 94%.

Case 3

- CXR (Chest CT imaging)
- PFTs
- EKG
- Chemistries, CBC w differential, TSH, BNP
- Echocardiogram

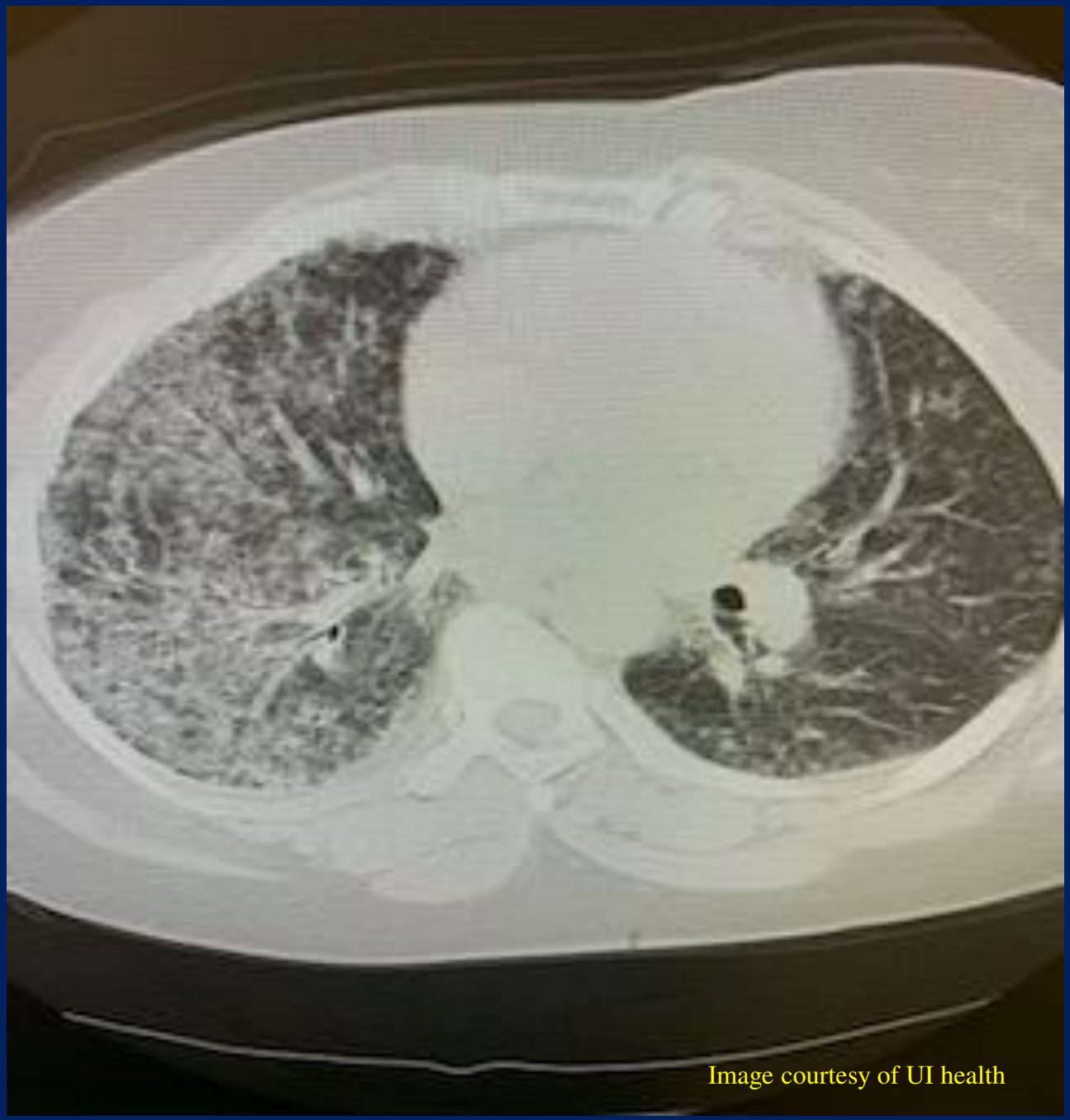


Image courtesy of UI health

SPIROMETRY

		Pre Meas	Ref	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	(2.38)	5.56	(43)			
FEV1	Liters	(2.04)	4.23	(48)			
FEV1/FVC	%	(86)	76				
FEF25-75%	L/sec	2.94	3.51	84			
FEF25%	L/sec	8.69	8.89	98			
FEF50%	L/sec	5.14	5.23	98			
FEF75%	L/sec	1.10	2.03	54			
PEF	L/sec	9.52	10.36	92			
FEF/FIF50		1.70	<1.00				
MVV	L/min		158				

PLETHYSMOGRAPHY LUNG VOLUMES

		Pre Meas	Ref	Pre % Ref
TLC	Liters	(3.84)	7.66	(50)
FRC PL	Liters	(2.22)	4.16	(53)
FRC N2	Liters		4.16	
RV	Liters	(1.46)	2.60	(56)
RV/TLC	%	38	36	
VC	Liters	(2.38)	5.29	(45)
IC	Liters	(1.62)	3.57	(45)
ERV	Liters	(0.68)	1.79	(38)
Raw	cmH2O/L/sec	1.65	1.04	159
sGaw	L/s/cmH2O/L	0.203	0.231	88

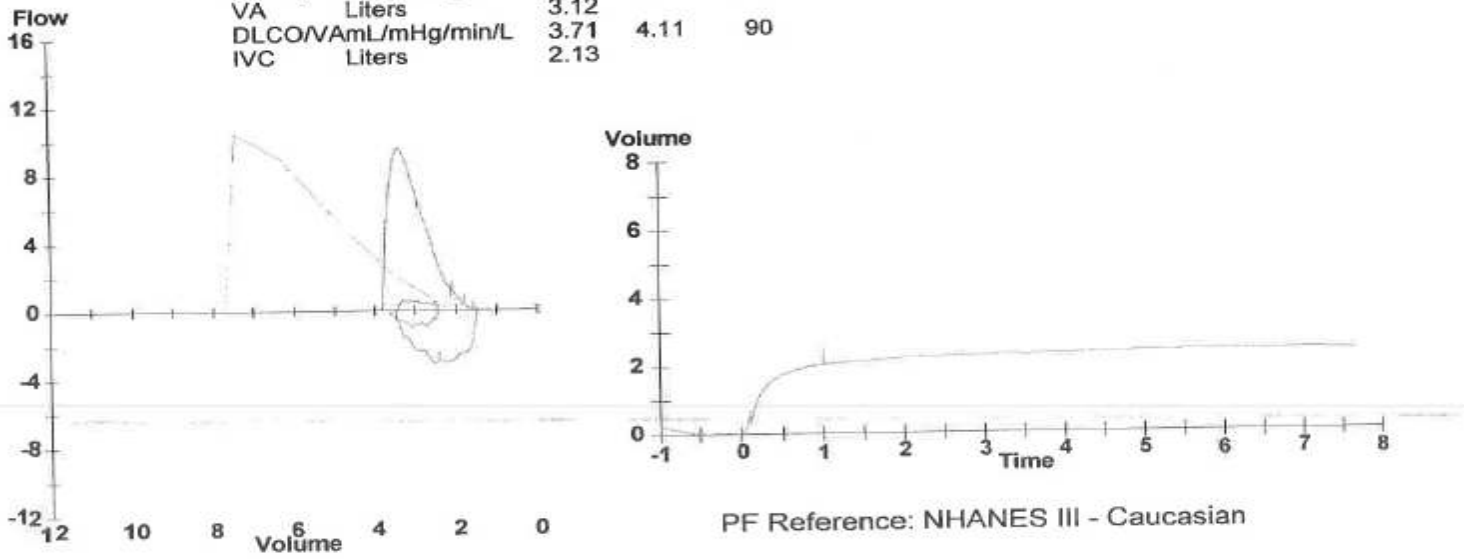
PULSE OXIMETRY

FIO2 21.00 %

SaO2 98.0 %

DIFFUSING CAPACITY

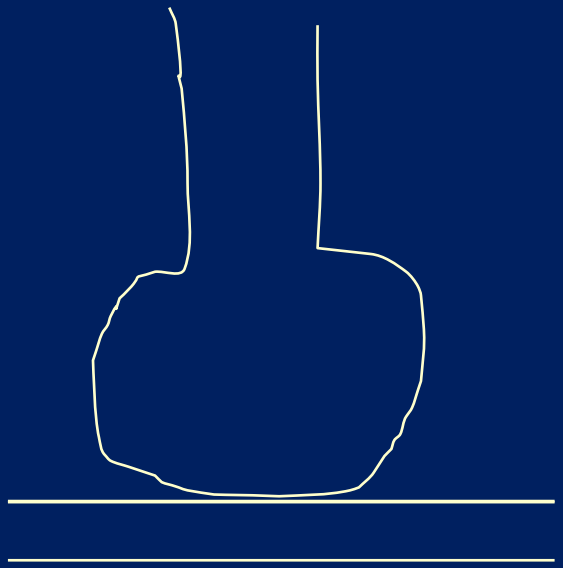
		Pre Meas	Ref	Pre % Ref
DLCO	mL/mmHg/min	(11.6)	30.8	(38)
DL Adj	mL/mmHg/min	(11.6)	30.8	(38)
VA	Liters	3.12		
DLCO/VA	mL/mHg/min/L	3.71	4.11	90
IVC	Liters	2.13		



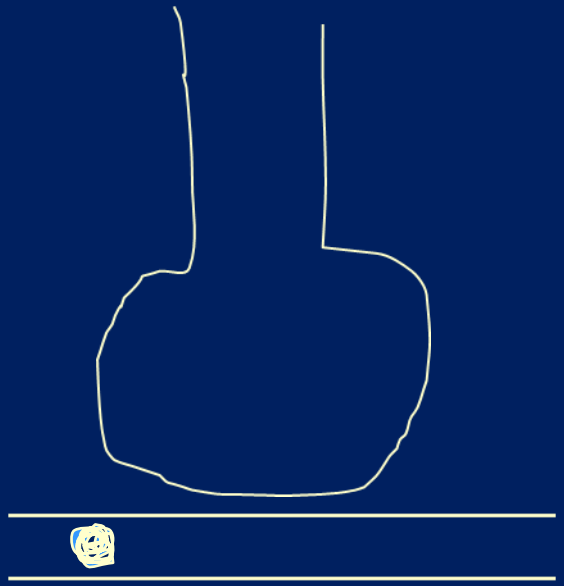
PF Reference: NHANES III - Caucasian

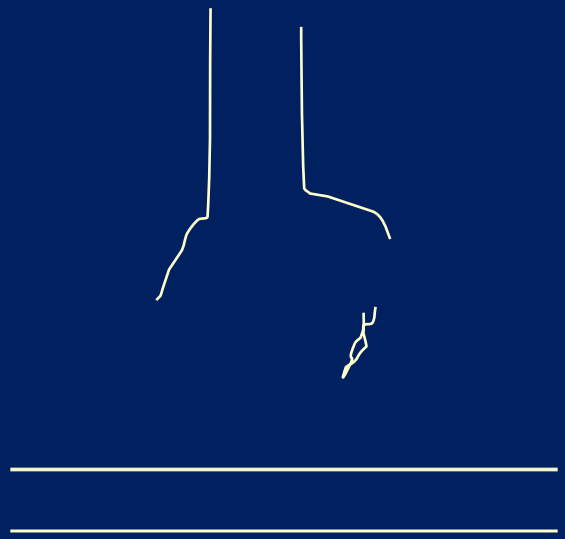
Decreased Diffusing Capacity

- Anemia
- Emphysema
- Interstitial Lung Disease
- Pulmonary Vascular Disease



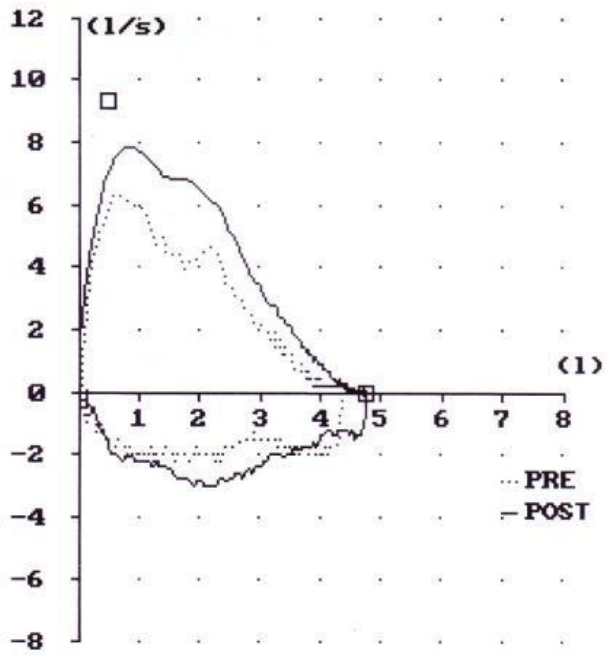
Decreased Diffusing Capacity for Carbon Monoxide (DLCO)

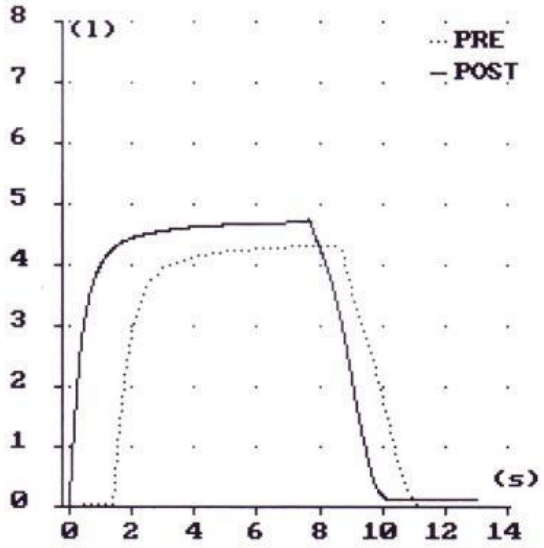




Case 4

Ms. T is a 28 yo woman who presents with throat tightness and wheeze for approximately 1 year. She is a professional tennis player and has no significant past medical history. She denies nocturnal awakenings due to respiratory symptoms. Exercise triggers symptoms. She is in no acute distress, vital signs are normal and resting room air oxygen saturation is 98%. Lung examination is normal.

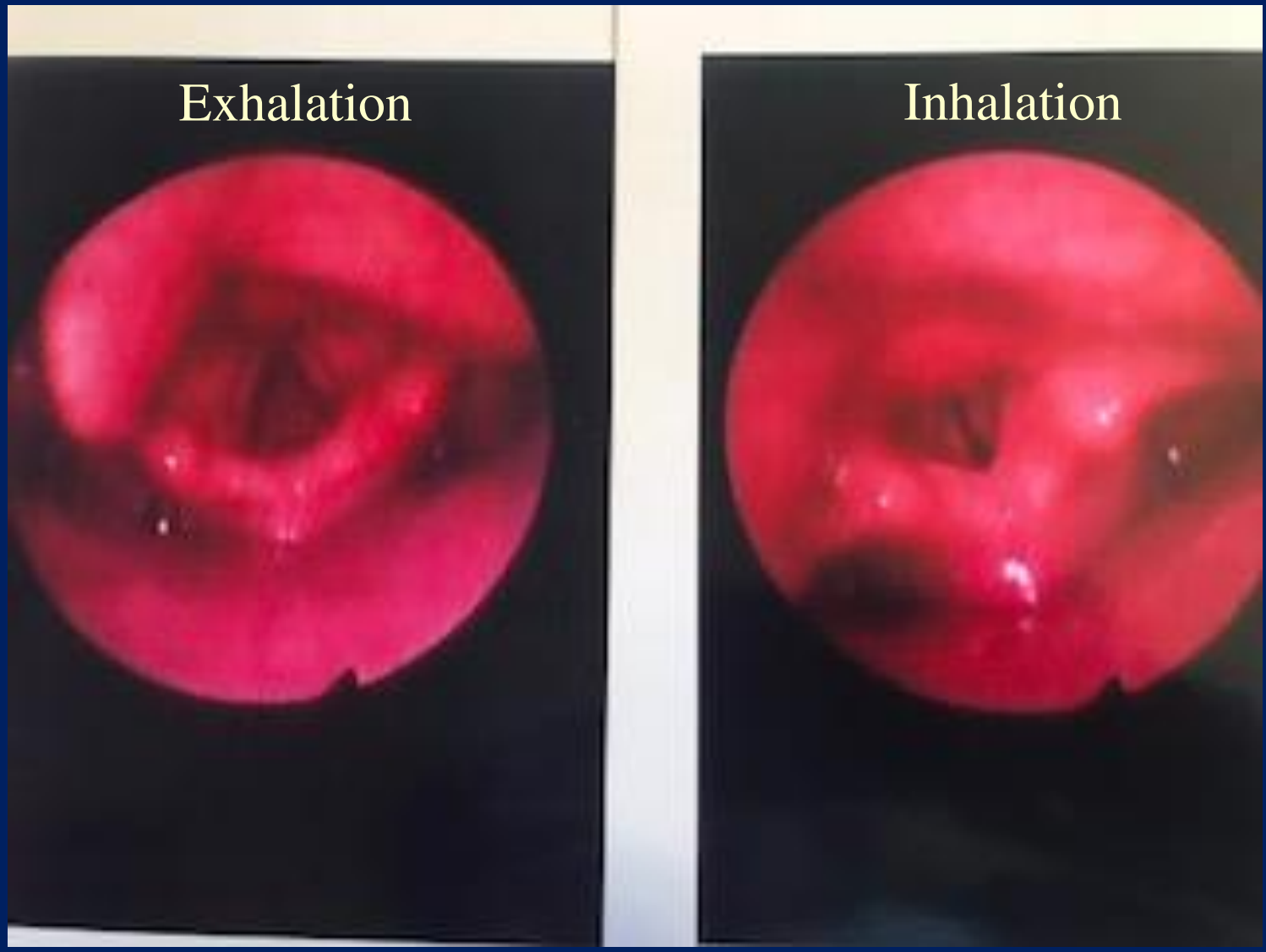


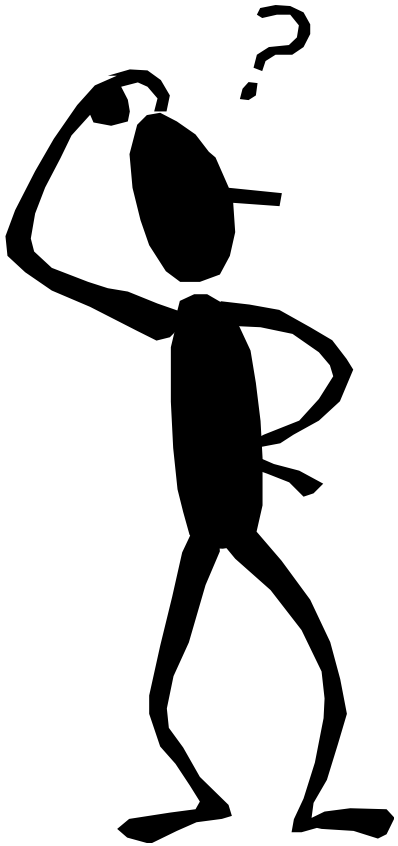


Her predicted FVC is 4.5 L

Her predicted FEV_1 is 3.6 L

Laryngoscopy





Questions

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