LUNG DISEASE and PULMONARY FUNCTION TESTS

The **RESPIRATORY SYSTEM** is addressed in the AMA Guides, 4th Edition in Chapter 5.

As per Section 5.1, *"Assessment of the respiratory system should begin with the patient's description of the specific complaints related to respiration.* ***Then a review should follow of personal habits and workplace exposures to potentially toxic substances that might explain or contribute to the existence of the symptoms".*** This is a component of many DD evaluations for pulmonary complaints, but is imperative to consider causation, aggravation and assign an appropriate IR if necessary. This will be discussed further.

The Guides also recommend, *"During the physical examination, the physician evaluates structural or movement abnormalities of the chest and its contents.* There will be a minimum physical exam that is best practice physical exam to consider whether potential symptoms related to the respiratory system are due to an occupational exposure, or there is an alternate explanation not related to an occupational exposure that is the cause. At a minimum, this will include: 1. Vital signs, 2. Inspection / observation, 3. Palpation / Measurement of chest wall, 4. Percussion, 5. Auscultation evaluating for rales, rhonchi, wheezing, or decreased breath sounds, 6 Vascular check, 7. Lymphatic system.

"*Radiologic techniques provide visual evidence of internal anatomic abnormalities that are not apparent by external inspection of the chest wall or auditory".*

The Guides also state, *"Pulmonary function testing, on the other hand, provides an objective assessment of the severity of respiratory abnormality but only a small amount of diagnostic information. The appropriate techniques are discussed below, the major emphasis being on the quantitation of abnormalities in terms of pulmonary function testing".*

SYMPTOMS:

There are many symptoms that can be consistent with respiratory dysfunction. These symptoms overlap with non-respiratory causes that must also be considered.

According to the AMA Guides, **dyspnea** and **wheezing** are the most common presenting complaints of those with pulmonary dysfunction. Another term for dyspnea is shortness of breath. As per the Guides:

DYSPNEA:

"Dyspnea *is the most common presenting symptom in patients with any type of pulmonary impairment. Its importance is matched only by its* ***non-specificity*** *and resistance to quantification".*

"Dyspnea can be caused by diseases of cardiac, hematologic, metabolic, or neurologic origin; anxiety also can play a major role in its genesis". PLEASE be aware that these are alternate explanations for occupational claims.

"Various schemes have been used to grade dyspnea. The one proposed by the American Thoracic Society (ATS) and shown in Table 1 (below) has been used widely. It is important to remember that the proper function of the classification is to enable comparison of the individual's symptoms with objective measurements of the individual's respiratory function".

"If there is a great disparity between the subjective and the objective findings, a non-respiratory component of the dyspnea should be suspected".

WHEEZING

Wheezing is productive *of "high-pitched, musical sounds often are reported as wheezing by patients with partial airway obstruction. These sounds can be generated at any point along the respiratory tract from the glottis to the bronchioles. The symptomatic manifestations of wheezing are helpful clues to the anatomic site of abnormality".*

Inspiratory wheezing, known as stridor, suggests laryngeal disease.
Expiratory wheezing indicates bronchospasm or localized bronchial narrowing.
Information about the seasonal occurrence of wheezing also is of diagnostic significance. Intermittent wheezing suggests a bronchospastic, allergic, or asthmatic cause, while persistent wheezing raises the suspicion of a fixed bronchial obstruction.

"Symptomatic triggers of wheezing, such as exposures to allergens, chemicals, cigarette smoke, and strong odors, and seasonal occurrence of distress are highly suggestive of asthma. Wheezing that follows several minutes of exercise indicates a diagnosis of exercise-induced asthma, while wheezing that usually accompanies respiratory tract infections is classified as asthmatic bronchitis".

OTHER CONSIDERATIONS

Cough, Sputum Production, and Hemoptysis

As per the Guides, *"Although cough is an important indicator of disease in the respiratory tract, there are few generally accepted measures of the severity of that symptom. For this reason, the presence of a cough should not be used as an objective determinant of pulmonary impairment. Nonetheless, it is incumbent on the physician to document its presence or absence, its productive or nonproductive nature, its duration, and its association with hemoptysis. The purpose of this documentation is to identify individuals who require further evaluation of the respiratory system".*

"A subacute or recurrent nonproductive cough may be a manifestation of asthma and should be investigated further with pulmonary function testing".

*"A chronic, productive cough is often a marker of bronchitis; according to ATS criteria, the term "*chronic bronchitis" *may be used to describe a cough productive of sputum that occurs on most days of at least 3 consecutive months per year, for at least 2 years in succession".*

"Hemoptysis frequently accompanies bronchitis and pneumonia, usually in the form of blood streaking of the sputum. The more serious causes of hemoptysis include bronchogenic carcinoma, pulmonary emboli, bronchiectasis, tuberculosis, aspergilloma, and arteriovenous malformations. The presence of hemoptysis requires radiologic evaluation, which may uncover a disease that might lead to a respiratory or other type of impairment".

ALTERNATE CAUSES of "PULMONARY" SYMPTOMS:

It is notable that potential symptoms of pulmonary disease such as Cough, Dyspnea / Shortness of breath (SOB), fatigue, and chest discomfort are non-specific to pulmonary disease. Please consider these etiologies:

- **Cough** # Cough is one of the most common medical complaints account for as many as 30 million clinical visits per year. [Sharma et al 2023.]. Other causes:

Gastroespophgeal reflux
Post-nasal drip
Heart failure
Pulmonary embolism.

- **SOB (dyspnea)** # Cardiac - Heart failure, angina, Cardiomyopathy, Pericarditis, Arrhythmia,
Pulmonary Embolism
Hypotension
Anemia
Anxiety disorders and panic attacks
Physical deconditioning or inactivity
Pregnancy
Medications such as statins and beta-blockers.

- **Fatigue** # Insufficient Sleep / poor sleep quality due to any cause, including Obstructive Sleep Apnea,
Thyroid disease,
DM or other chronic diseases,
Mental health conditions like depression and anxiety,
Some medications
Contributions from lifestyle factors like stress, poor diet, lack of or excessive physical activity

- **Chest Discomfort** # Cardiovascular Disease,
MSK disorders,
Rheumatologic Disorders,
GERD,
Static or dynamic postural dysfunction

NON-OCCUPATIONAL CAUSES OF PULMONARY DISEASE:

Lung disease is common in the population that does not have occupational exposure. In addition to occupational hazards, lung damage or symptoms can be caused by:

1. **Pre-existing medical conditions.**
2. **Lifestyle choices**
3. **Environmental exposures**

Pre-existing Medical Conditions:

As seen from the common symptoms of respiratory disease, other medical conditions can produce the same / similar symptoms. Important to consider are several cardiovascular conditions. These include congestive heart failure, cardiac ischemia, cardiomyopathy, pericarditis and arrythmias. Cardiac diseases can have significant impact to the pulmonary system, resulting in damage. This is because the heart and lungs are intimately connected. Dysfunction in one system can easily affect the other. When the heart's ability to pump blood is compromised, there can be increased pressure in the pulmonary arteries, causing pulmonary hypertension, which results in pulmonary edema and damage to the tissues of the pulmonary system.

There are other important pre-existing non-respiratory medical conditions that can produce respiratory complaints and / or affect the respiratory system that are not frequently discussed or considered. In addition to

those listed in the prior section, these include Obesity (especially Class III or higher), Obesity Hypoventilation Syndrome and Obstructive Sleep Apnea (OSA). Unfortunately, these are becoming more common in the US population with increasing obesity rates and higher classes of obesity.

Obesity has consequences to most body systems via the inflammatory mechanism of adipokines and other inflammatory mediators. This results in specific consequences to many body systems due to the inflammatory process. Additionally, obesity can result in hypoxia due to two different processes. These are obesity-hypoventilation syndrome (OHS) and obstructive sleep apnea (OSA). The hypoxia of these conditions affects the cells of the different body systems.

Obesity hypoventilation syndrome (OHS) is a condition where obesity is associated with chronically low levels of oxygen and high levels of daytime carbon dioxide in the blood (hypercapnia = arterial PaCO2 greater than 45 mmHg). This is thought to be a consequence of diminished ventilatory drive and capacity related to obesity (BMI over 30 kg/m^2) in the absence of an alternate respiratory, neuromuscular, or metabolic explanation for hypoventilation. The hypoventilation of OHS are obesity induced reduced chest wall compliance, making it harder for the lungs to expand and contract effectively and the effects of obesity in general and abdominal obesity specifically on the diaphragm and muscles involved in breathing. This essentially produces a restrictive lung disease.

OHS is often associated with sleep-disordered breathing (typically obstructive sleep apnea), but there are differences in the underlying pathology, which differentiates the two conditions. **Sleep-Disordered Breathing** is disrupted breathing patterns during sleep, which can include apnea (pauses in breathing) and hypopnea (shallow breaths). This is most often due to OSA, as approximately 90% of OHS patients also have obstructive Sleep Apnea. In a decade old study by Flegal et al, *"in a study of hospitalized patients with a BMI over 35 kg/m^2, the prevalence of OHS was 31%. Additionally, the prevalence of OHS in individuals with OSA is estimated to be between 20% to 30%".* Daytime symptoms of OHS can include the obvious sleepiness, but also complaints of fatigue, shortness of breath, headaches, dizziness and signs of cyanosis.

Obstructive sleep apnea (OSA) is one form of sleep disordered breathing. OSA occurs when various tissues in the airway and throat obstruct airflow during sleep. This can be due to relaxation of the muscles in the back of the throat, which allows the soft palate, uvula or tongue to obstruct airflow. This is more common the higher the BMI and often coexists with metabolic syndrome. OSA causes episodes of hypopnea and apnea. As per Mayo Clinic online resource, the most common signs and symptoms of OSA are loud snoring, gasping for air during sleep, episodes of cessation of breathing, difficulty staying asleep, daytime sleepiness / narcolepsy, headache and dry mouth in the morning. These symptoms are not just a nuisance. As discussed for OHS, when there is apnea, the brain (and other tissues) is deprived of oxygen. Those with OSA often demonstrate higher blood pressure and heart rate during sleep compared to the usual lowering of HR and BP that occurs in those without this disorder during sleep. OSA-related hypoxemia has been demonstrated to change the structure and function of blood vessels, including in the brain, adversely affecting cognition, in addition to increased mortality and morbidity. As per the meta-analysis by Aloia et al, "*the primary daytime sequelae of the disorder include patient reports of excessive daytime sleepiness, depression, and attention and concentration problems."*

The hypoxia and hypercapnia of OSA is associated with hypertension, cardiovascular diseases, neurocognitive conditions, and increased all-cause mortality. In the general population, the prevalence of moderate-to-severe OSA is increasing, in part due to increased obesity rates. It is estimated that the prevalence rates in the literature are low, as the majority of cases are likely undiagnosed and untreated or sub-optimally treated.

The gold standard for the diagnosis of OSA is polysomnography. However, the simple STOP-BANG questionnaire for screening of adults with OSA provides a convenient tool to identify sleep-disordered breathing

for further diagnostic testing and treatment. Criteria are **S** = Snoring, **T**= Tired, fatigued or sleepy, **O** = Observed Cessation of Breathing / gasping / choking during sleep. **P** = Pressure or High Blood Pressure (HBP), **B** = BMI > = 35 kg/m2, **A** = Age > = 50, **N** = Neck Circumference > 16 inches / 40 cm, **G** = Gender Male. Scoring of this scale is low risk (0-2 points), intermediate risk (3-4 points), or high risk (5-8 points) for moderate to severe OSA

Lifestyle choices:

While some lung damage can stem from external factors or underlying medical conditions, there are several ways individuals can contribute to or worsen lung problems through their **lifestyle choices** and behaviors. We cannot forget that self-inflicted causes of lung damage are commonplace. Causes that must be considered are:

1. Smoking
2. Vaping
3. Recreational drug use

Smoking is the leading preventable cause of lung disease, including lung cancer, emphysema, and chronic bronchitis. It is important to understand that tobacco smoke contains thousands of harmful chemicals, many that are poisonous and carcinogenic and includes carbon monoxide. The mechanism of injury to the lung tissue is chronic inflammation, oxidative stress, and direct damage to lung cells and DNA, causing impairment of lung function in the short and long term.

While many see **vaping** (e-cigarettes) as a *"benign"* option, vaping involves inhaling aerosols containing nicotine, flavorings, and other potentially harmful chemicals. The latter includes like diacetyl, formaldehyde, and heavy metals! Like smoking, vaping can irritate and inflame the lungs, resulting in lung scarring, asthma / reactive airway disease and conditions like bronchiolitis obliterans ("popcorn lung"). Research links vaping to an increased risk of chronic bronchitis and may potentially contribute to lung cancer risk over time.

Lung dieses can also be caused by **recreational drug use**. Inhaling or smoking various recreational drugs, including marijuana, crack cocaine, and other illicit substances, can directly irritate and damage the lungs such as with smoking or vaping. Marijuana smoke has similar effects as cigarettes, but mostly without the added chemicals. Cocaine constricts blood vessels, damages the alveoli (air sacs), and can result in pulmonary edema, emphysema, and lung hemorrhage. Inhalants are used to give the user an immediate high. These can include spray paint, paint thinners, dry cleaning fluids, gasoline, glues, felt-tip marker fluid, hair spray, deodorants, and whipped cream dispensers. These chemicals displace oxygen, leading to hypoxia and contribute to respiratory failure and death. Lastly, humans are creative and also inject crushed pills. Talc is a filler or excipient of oral medications, like amphetamines, methylphenidate, propoxyphene, and methadone. Injected talc particles can block capillaries in the lungs, causing blood clots, scarring, and pulmonary hypertension. In addition, this type of Illicit drug use is often associated with lowered immunity and increased susceptibility to infections like pneumonia and tuberculosis.

It is important to specifically ask about these potential habits in your medical history in respiratory cases and consider them based on lifestyle without being prejudicial. Be alert on your exam as to these potential habits.

Environmental exposures

Environmental exposures may be related non-occupational exposures and occupational exposures.

- Non-occupational exposures may be related to air quality (wildfire or other smoke in the environment), fossil fuel combustion and very commonly, allergens.

- Occupational exposures may be related to silica, coal mining and other hazardous chemicals. The later may include carbon monoxide, ammonia, chlorine, hydrochloric acid sulfuric acid, high dose acetic acid, but can also include cleaning agents, pesticides, solvents such as toluene and heavy metals such as lead and cadmium. In general, these create oxidative stress and inflammation in the lungs. When this exposure is sustained or in high dose, this can result in DNA damage, mitochondrial dysfunction, which then impairs critical repair mechanisms. The latter leads to premature destruction of the lung parenchyma.

SUMMARY:

In your evaluation of respiratory impairment, you should inquire as to the frequency, duration and intensity of their symptoms. Discuss their activities of daily living and how respiratory symptoms affect them.

If there is a claimed occupational exposure, INQUIRE as to what the specific exposure was and the frequency, dose and duration of exposure.

Make sure you get a complete medical history and keep a high index of suspicion as to alternate causes of the claimed symptoms.

YOU WILL NOT BE ACCURATE in your determination of impairment due to a claimed occupational event or exposure IF YOU DO NOT discuss or consider ALL the potential triggers, exposures or conditions that can cause potential symptoms of respiratory dysfunction, OTHER than the claimed condition.

PHYSICAL EXAM:
[Items noted in quotes come directly from the AMA 4th.]

1. **Vital Signs**
   a. Make sure to assess BMI, as obesity can result in a restrictive disease pattern and there are associated conditions that can produce non-respiratory caused symptoms that overlap with respiratory symptoms.
   b. Pulse and Blood Pressure
   c. Oxygen Saturation (get a cheap pulse oximeter)

2. **Observation:**
   a. Observe if there is SOB at rest or with activity, and what level of activity produces the SOB.
   b. Does the IE smell of cigarette smoke or nicotine stained digits?
   c. Breathing Pattern:
      i. Observe the depth, rate, and rhythm of breathing.
      ii. Is there use of accessory muscles (using muscles in the neck, shoulders, or abdomen to assist with breathing)
      iii. *"A breathing pattern characterized by pursing the lips during expiration suggests the presence of chronic obstructive pulmonary disease (COPD).*

   d. Posture, Chest Shape and Symmetry:
      i. *"The thoracic cage should be inspected for vertebral or rib cage deformity, wasting of the intercostal muscles"*
      ii. *"A barrel shape may indicate hyperinflation of the chest,*
      iii. Is there a kyphosis that is fixed? Or postural?

iv. Check *"movement of the ribs with inspiration and expiration"* while palpating ribs.
v. Measurement of the chest wall with inspiration and expiration
   a) Chest expansion measurements (the difference in circumference between maximal inspiration and expiration) ranges from 2 to 5 cm (or roughly 4-7 cm for a healthy individual).
   b) Can vary based on age and body type.

3. **Palpation:**
   a. **Chest Wall Tenderness:** Feel for any areas of tenderness or pain, especially at costochondral junction.
   b. **Vocal Fremitus:** Assess the vibrations produced by the patient's voice (e.g., asking the patient to say "99").
   c. **Chest Expansion:** Evaluate the symmetry and extent of chest expansion during inspiration.
   d. **Lymph Nodes:** Palpate lymph nodes in the neck and supraclavicular regions.
4. **Percussion:**
   a. **Chest Resonance:** Tap on the chest wall to assess the resonance of the underlying lung tissue.
   b. **Dullness or Hyperresonance:** Identify areas of dullness (fluid) or hyperresonance (air trapping).
5. **Auscultation:**
   a. **Lung Sounds:** Listen to breath sounds using a stethoscope, noting any abnormal sounds. (If you have lost practice, listen to You-tube videos.) The *"intensity, quality, and location of wheezing, rhonchi, and rales should be described, as well as whether they are heard during inspiration, expiration, or both."*
   b. **Wheezes** (high-pitched whistling noises, typically indicate a narrowing or obstruction of the airways. Can be caused by inflammation, swelling, mucus buildup, or damage within the airways).
      i. "The presence of wheezing cannot be excluded until the physician performs auscultation during both quiet breathing and forced expiration."
      ii. "The presence of wheezing cannot be excluded until the physician performs auscultation during both quiet breathing and forced expiration".
      iii. "Diffuse, bilateral, expiratory wheezing indicates generalized bronchospasm, while unilateral or localized wheezing may be caused by partial bronchial obstruction due to an endobronchial tumor or pressure on the wall of the bronchus".
   c. **Crackles** (Brief, discontinuous, popping, or bubbling noises heard during inspiration or sometimes expiration. These indicate the presence of fluid, mucus, or inflammation in the small airways or alveoli of the lungs).
      1) *"Early inspiratory crackles may be heard in diseases of airflow obstruction and particularly in bronchiolitis obliterans".*
   d. **Rhonchi** (These are low-pitched, rattling, or snoring noises consistent with air passing through obstructed or narrowed airways. Rhonchi may be more pronounced during expiration > inspiration).
   e. **Rubs** (indicates inflammation of the pleura)
   f. **Increased** (hyperresonance) or **decreased** breath sounds (consolidation).
   g. **Voice Sounds:** Auscultate for vocal resonance (e.g., egophony, bronchophony).

6. **Vascular**
   a. **Cyanosis:** Look for central (lips, tongue) or peripheral (extremities) cyanosis. [See the Figure to follow.]
      i. This is a *"striking but unreliable indicator of severe pulmonary impairment. Poor lighting in the examination room, anemia, and skin pigmentation can interfere with assessing its magnitude."*
   b. **Clubbing:** Check for clubbing of the fingertips, which can be a sign of chronic hypoxia.
      i. "Digital clubbing is characterized by loss of the angle at the junction of the cuticle and the nail, softening of the nail bed, increased curvature of the nail, and widening of the distal portion of the fingers."
   c. **Capillary Refill:** Assess capillary refill time (CRT). Normal CRT refers to the time it takes for the color to return to the skin after pressure is applied.
      i. Adults: Less than 3 seconds
      ii. Children: Less than 2 seconds

Differentiating features between central and peripheral cyanosis		
	Central cyanosis	*Peripheral cyanosis*
Mechanism	Arterial destauration	Increased peripheral utilization
Sites	Skin, mucous membrane of oral cavity	Only skin involved
Temperature	Warm	Cold clammy
Clubbing	Present	Absent
Secondary erythrocytosis	Present	Absent
On warming	Cyanosis same	Cyanosis reduces
Oxygen therapy	Pulmonary cause can improve	Cyanosis reduces
Exercise	Cyanosis worsens	Cyanosis same or improves
Arterial blood gas	pO_2 low	pO_2 normal

Source : Essentials of Postgraduate Cardiology 2018

7. **Neck:**
   a. **Jugular Venous Pressure (JVP):** Examine the JVP as an indirect measure of central (right atrial pressure) venous pressure.
      i. JVP is the estimated measured by assessing the height of the pulsations in the right internal jugular vein in the neck.
      ii. A non-invasive indicator of fluid status and right heart function, with an elevated JVP resulting from fluid overload or right heart abnormalities such as heart failure
8. **Lymphatic System**
      i. Palpate for enlarged or tender lymph nodes cervical and axillary. Can indicate an infectious or cancerous cause of symptoms
      ii. Evaluate for peripheral edema

   a) Peripheral edema indicates systemic diseases like heart failure, kidney disease, or liver failure, which can lead to pulmonary edema.

9. **ENT eval:** Perforated nasal septum (snorting illicit drugs), sinus tenderness (sinusitis with post nasal drip), cloudy eardrums (can be seen in individuals with chronic sinusitis),

10. **Additional Assessments**
    a. **Lab:** Evaluate for erythrocytosis seen due to chronic hypoxia from smoking, COPD, pulmonary hypertension or cardiac diseases.
    b. **Imaging:** Chest X-ray or CT of the chest can evaluate for
        i. Rib abnormalities
        ii. Pneumothorax
        iii. Hyperinflation c / w COPD
        iv. Opacity/consolidation c / w Pneumonia
        v. Atelectasis (lung collapse),
        vi. Pulmonary edema
        vii. Nodules or masses
        viii. Pleural effusions or pleural thickening
        ix. Cardiac enlargement or congestive heart failure
    c. **Pulmonary Function Tests.** [More on this later.]

IN YOUR REPORT, give a through discussion of the claimed occupational exposure and how it can affect the pulmonary system, a thorough review of symptoms with specific frequency and intensity of respiratory symptoms and a robust physical exam such that you can defend your position as to the compensable diagnosis and any question posed on an Extent of Injury question.

PATTERNS OF LUNG DISEASE:

There are two basic patterns of lung disease: a restrictive lung disease (RLD) or an obstructive lung disease (OLD). At times there may be a combined or mixed pattern.

Obstructive lung disease (OLD) is characterized by increased resistance to airflow due to obstruction, either partial or complete at any level, from the trachea to the terminal bronchioles. This condition makes it difficult to exhale.

The hallmark diagnoses that fall in this category are chronic obstructive pulmonary disease (COPD) and asthma. The type of OLD can be determined by response to bronchodilator therapy; asthma responds, and COPD does not.

COPD is a result of damage to the air sacs (alveoli), chronic inflammation of the airways or in asthma with inflamed, hyper-responsive airways. The most common cause is smoking**,** but genetics, air pollution and occupational exposure can all factor in**.**

Common symptoms of OLD include shortness of breath (SOB), chest tightness, chronic cough (potentially with mucus), and wheezing. SOB occurs especially during physical activity or at rest in later stages. This symptom is not exclusive to OLD, as many other medical conditions can produces SOB.

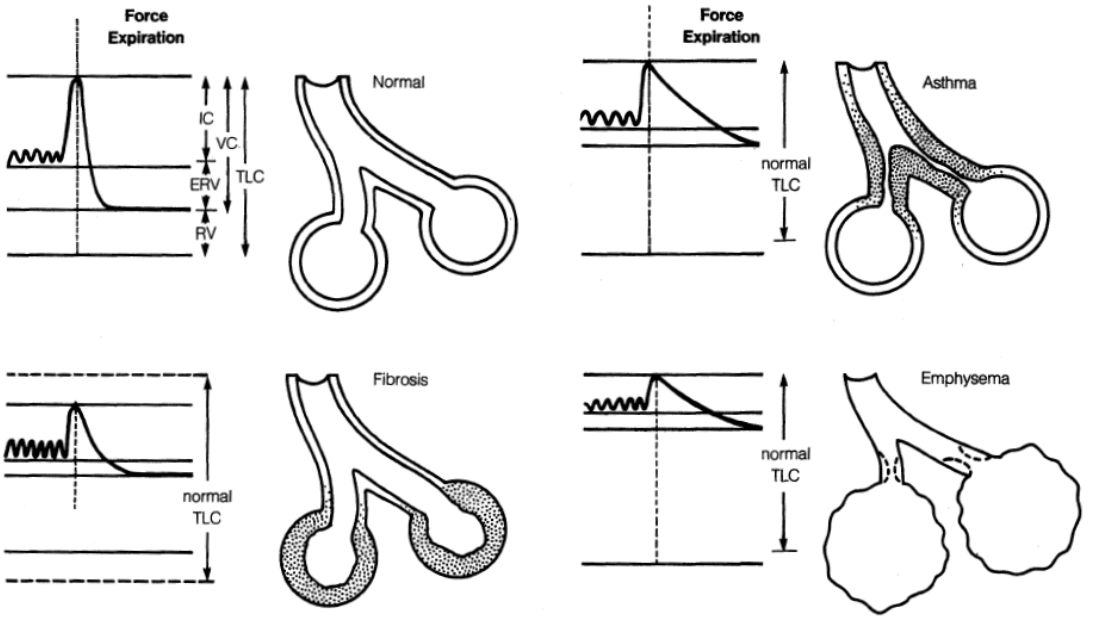
Restrictive lung disease (RLD) is characterized by the lungs' inability to fully expand, leading to a reduction in lung volume and therefore difficulty taking in adequate oxygen. RLD has intrinsic causes and extrinsic causes.

Intrinsic causes of RLD are any cause of inflammation, recurrent infection or toxins that cause destruction of the functional tissue of the lungs that is responsible for gas exchange (distal lung parenchyma). This consists of the alveoli air sacs, the alveolar ducts, bronchioles capillaries.

Extrinsic causes of RLD are conditions that limit neuromuscular function and chest wall movements. Causes may include neuromuscular diseases, pleural disorders, obesity, or any other cause that results in a physical barrier to inspiration. Obesity, including Class III obesity is increasing in prevalence, so this is becoming a more common cause of RLD.

FIGURE 1: Chapter 5 – RESPIRATORY SYSTEM (page 155)

Figure. Lung Capacities and Volumes in the Normal State and in Three Abnormal Conditions*



IC-inspiratory capacity, VC-vital capacity, TLC-total lung capacity, RV-residual volume, ERV-expiratory reserve volume.
* Residual volume, and therefore total lung capacity, cannot be measured by spirometry alone.

Diseases or conditions that are a barrier to gas exchange at the alveoli level result in decreased diffusion capacity. This is measured with DLCO. These diseases include:

1. Silicosis / asbestosis
2. Post-Covid
3. Pulmonary Fibrosis – a condition where lung tissue thickens and scars. Causes are:
    a. Idiopathic
    b. Auto-immune diseases
    c. Medications
    d. Environmental Exposures (non-occupational and occupational)

IT is important to know what type of lung disease the claimed condition should cause AND whether there are other medical conditions / exposures that could be productive of the same / similar findings on Pulmonary Function Tests.

PULMONARY FUNCTION TESTS:

Since the symptoms of pulmonary diseases overlap between OLD and RLD as well as non-pulmonary conditions, the type of lung disease can be assessed further by **Pulmonary Function Tests (PFTs).**

Pulmonary Function tests (PFTs) evaluate an individual's ability to inhale and exhale air relative to time. These tests allow physicians to evaluate the respiratory function of their patients, diagnose the cause of respiratory symptoms and monitor patients with known respiratory disease.

The different elements of PFTs are:

- Spirometry (without and with bronchodilator therapy)
- Lung volumes
- Diffusion capacity

SPIROMETRY

[Definitive information can also be obtained from The American Lung Association - SPIROMETRY IMPLEMENTATION QUICK GLANCE GUIDE. This is posted at the end of this educational module.]

The most common parameters documented on spirometry are:

FVC = Forced Vital Capacity or the total amount of air a person can forcefully exhale in one breath after a deep inhalation.

FEV1 = Forced Expiratory Volume is the volume exhaled in the first second. This can be reduced in obstructive lung disease.

FEV1 / FVC % = the ratio of the two prior values.

FEF2575 = Forced Expiratory Flow 25 – 75 % is a measure of airflow during a forced exhalation, specifically the average flow rate between 25% and 75% of the FVC. It is a sensitive indicator of airflow in the small and medium airways. An altered FEF2575 can detect airway obstruction before other PFT values such as FEV1 may detect it.

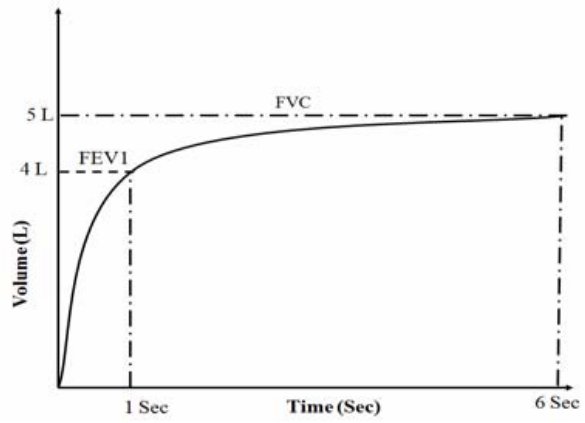
According to the American Academy of Family Physicians, the spirometry portion *"should include at least three acceptable tracings of flow-volume and volume-time curves. These curves should demonstrate consistent results and be of acceptable quality, with **the best two efforts within 0.2 L of each other."***

Also*, "the volume-time curve should also reach a plateau and expiration should last at least six seconds"*. A time-volume curve does not last 6 seconds or falls off (rather than plateau), can be a sign that the spirometry test was not performed correctly, leading to unreliable results. Causes include:

1. **Submaximal effort**: The patient stopped exhaling too soon due to poor coaching, lack of understanding or other non-injury related factors.

2. **Incomplete inhalation**: The patient did not take a full, deep breath before exhaling. The resulting curves will be smaller than expected.
3. **Air leak**: An air leak around the mouthpiece will cause the spirometer to register less volume.

FIGURE 2: Time-Volume Curve



Findings on Spirometry - Obstructive Lung Disease:

1. Reduced FEV1. This is due to several mechanisms:
    a. Airway narrowing and collapse
    b. Inflammation and edema
    c. Increased mucus production and impaction
    d. Bronchospasm
    e. Loss of elastic recoil
2. Normal to reduced FVC
3. FEV1/ FVC ratio significantly reduced (typically less than 0.70 or below the lower limit of normal for the individual)
4. Vital Capacity decreases with increasing severity of COPD
5. Flow - Volume Loop has a “scooped out” appearance

Findings on Spirometry - Restrictive Lung Disease:

1. Low expired volume
2. Both FVC and FEV1 are reduced, but they are typically reduced to a similar degree.
3. FEV1/FVC ratio remains normal or even elevated.
4. Decreased Total Lung Capacity and Forced Vital Capacity.
5. In a flow-volume loop, restrictive airway disease presents with a smaller overall loop size, reflecting reduced lung volumes, and a characteristic "witch's hat" appearance with a steep descending limb during exhalation.

FIGURE 3: FLOW-VOLUME LOOPS

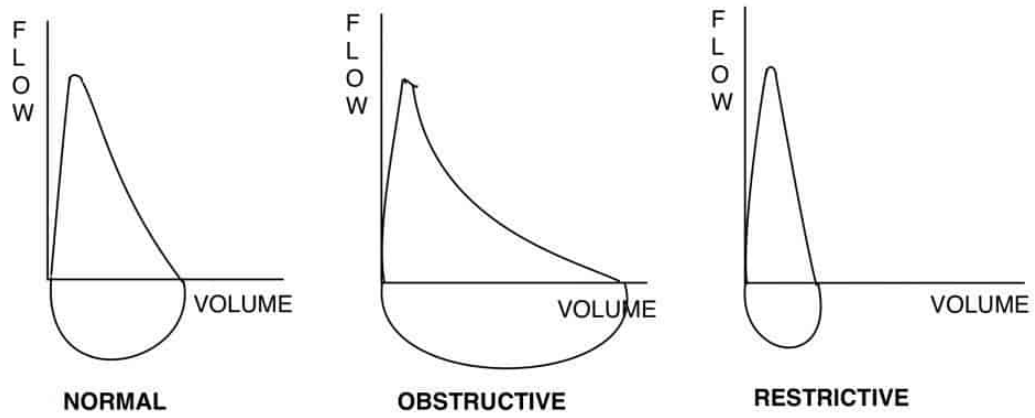
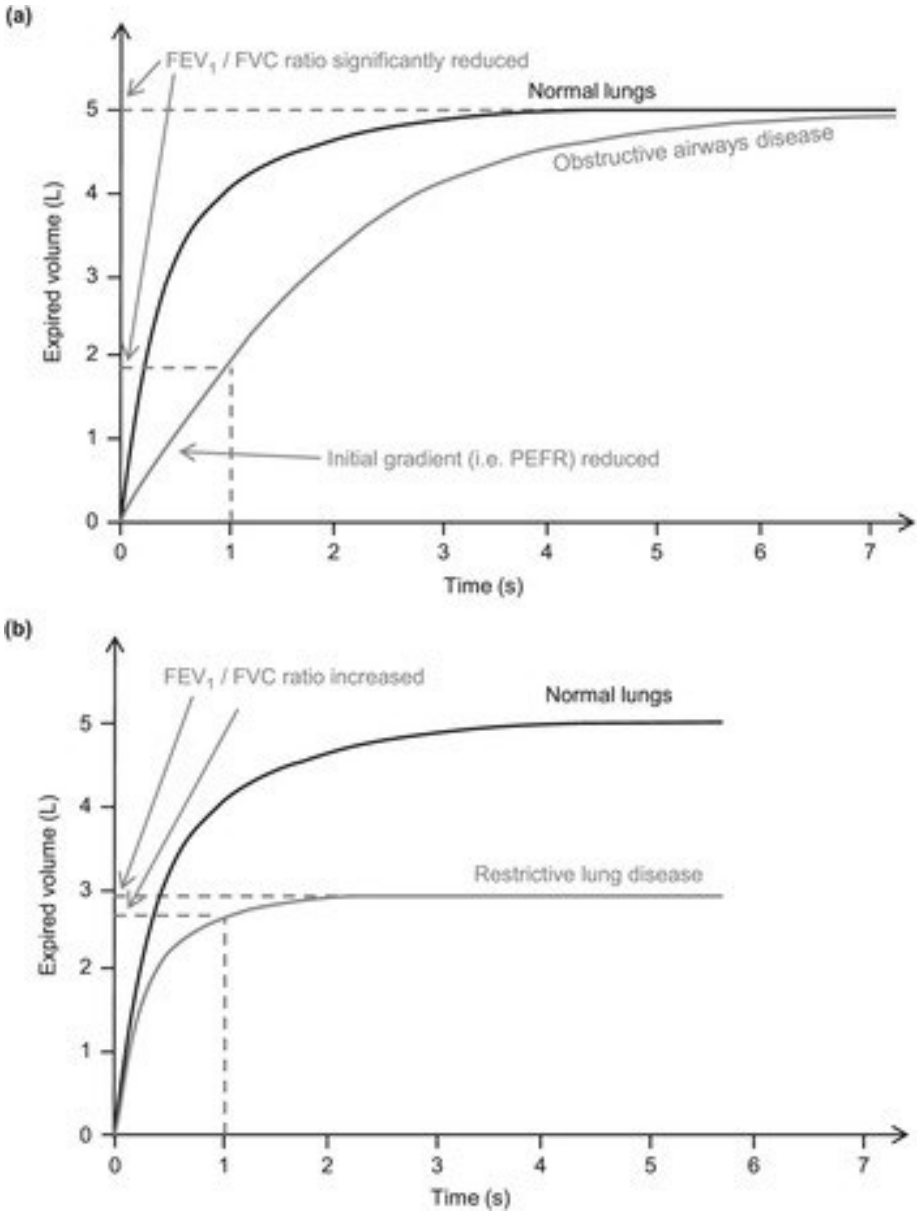


FIGURE 4: Time-Volume Curve – Obstructive vs Restrictive Patterns



According to the stepwise approach to interpretation of PFTs by Johnson and Theurer, *"if an obstructive defect is present, the physician should determine if the disease is reversible based on the increase in FEV_1 or FVC after bronchodilator treatment (i.e., increase of more than 12% and more than 200 mL in adults). Asthma is typically reversible, whereas chronic obstructive pulmonary disease is not".*

"A restrictive pattern is indicated by an FVC below the fifth percentile based on NHANES III data in adults". "If a restrictive pattern is present, ***full pulmonary function tests with diffusing capacity of the lung for carbon monoxide testing should be ordered to confirm restrictive lung disease and form a differential diagnosis****.* Full PFTs provide the patient's total lung capacity. A restrictive pattern is confirmed if the total lung capacity less than the lower limits of normal (LLN) in adults. The FVC can be used to infer a restrictive defect, BUT **FVC has a poor positive predictive value. Therefore, full PFTs with lung volumes should be obtained.**

A low Forced Expiratory Volume in 1 second (FEV1) is often associated with obstructive lung diseases like COPD or asthma, it's not the single most definitive factor in differentiating between obstructive and restrictive lung diseases. As part of the same review article, ***"If both the FEV_1 / FVC ratio and the FVC are low, the patient has a mixed defect"***

It is important that you as a DD are aware of the following. As per Stat Pearls on Pulmonary Function tests (Ponce), ***"the results of the PFTs are affected by the effort of the patient.*** *PFTs do not provide a specific diagnosis; the results should be combined with relevant history, physical exam, and laboratory data to help reach a diagnosis".*

While IR is assessed by quantifying the FVC, FEV1, FVC / FEV and the FEF25-75, these should not be the only parameters tested. This may result in you assigning an IR for invalid or suboptimal efforts. **As a DD, you must review the PFTs to assess if the testing is VALID. Look at the Flow-Volume Loops and the Time-Volume curves to assess for full effort by the examinee.**

1. These should be consistent and reproducible efforts.
2. During spirometry FEV1 and FVC measurements should within 0.2 L of each other during the two best efforts. Additionally, confirm validity.

Other elements of PFTs that are important to the overall interpretations of validity of testing and IF the results are consistent with the claimed condition, the PFTs should include the various measurements of lung volume.

TLC = Total lung capacity is the volume of air in the lungs at the end of maximal inspiration. **TLC is the gold standard for diagnosing restrictive lung disease.** A restrictive ventilatory defect is diagnosed when TLC less than 80% of predicted.
The sum of RV and VC or FRC and inspiratory capacity (IC) equals TLC. **[See figure on the next page.]**

FRC = Functional reserve capacity is the volume of the amount of gas in the lungs at the end of expiration during tidal breathing. FRC is also the sum of ERV and RV.

ERV = Expiratory Reserve Volume is the volume of gas maximally exhaled after end-inspiratory tidal breathing

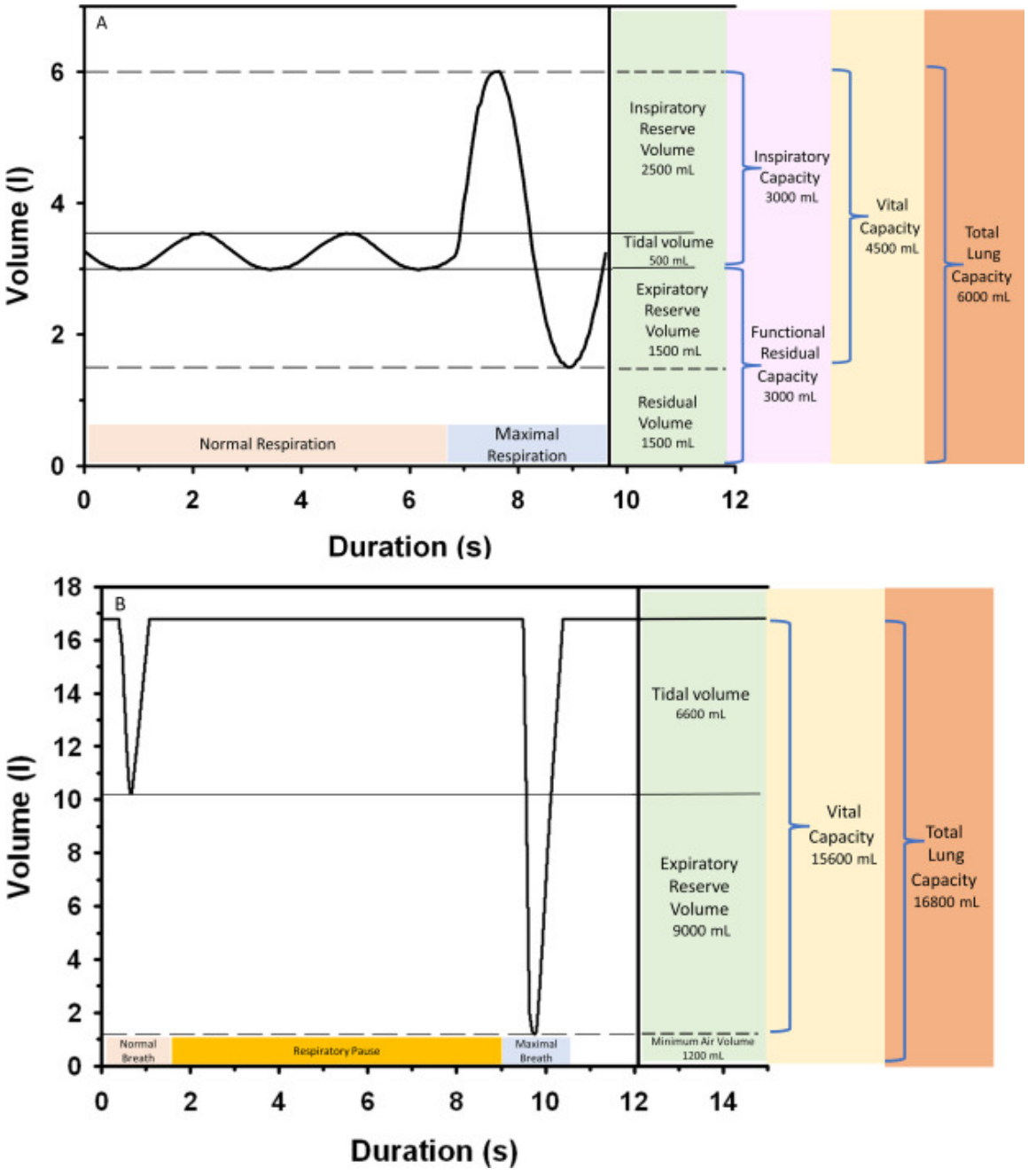
RV = Residual Volume is the volume of gas in the airways after a maximal exhalation.

VC = Vital Capacity is the volume of gas expelled from full inspiration to residual volume. FVC is similar to VC, but the patient exhales at maximal speed and effort.

SVC = Slow Vital Capacity can be measured as the maximal amount of air exhaled in a relaxed expiration from full inspiration to residual volume; exhalation should be terminated after 15 seconds. The SVC may be a useful measurement when the FVC is reduced, and airway obstruction is present.

These lung volume measurements are important to detect changes in lung volume independent of effort, especially when FVC is reduced on spirometry.

FIGURE 5: LUNG VOLUMES: TLC / FRC / RV / VC



Diffusion capacity (DLCO) measures diffusion of oxygen from the lungs into the bloodstream. DLCO represents the volume of the test gas, CO (in mL) transferred per minute for each unit of pressure difference (in mm Hg) across the total available functioning gas exchange surface in the lungs. It is important that the individual being tested not smoke within 8 hours of the test as this can lower the DLCO. A baseline hemoglobin level should be obtained before DLCO testing because results are adjusted for the hemoglobin level.

The DLCO helps evaluate patients with dyspnea, hypoxemia, emphysema, and interstitial lung disease (ILD) and serves as an early indicator for conditions like idiopathic pulmonary fibrosis (IPF) before spirometry changes are detectable. This measure of lung function:

1. Provides clinicians with information about parenchymal and nonparenchymal lung diseases,
2. Clarifies the underlying cause of hypoxemia (low blood oxygen) and dyspnea (shortness of breath),
3. Assesses the severity of obstructive and restrictive lung diseases,
4. Can evaluate pulmonary vascular disease.

A special consideration in first responders, especially firefighters (but can also be affected in smokers) is carbon monoxide (CO) exposure. **During acute CO exposure, the binding of the CO to hemoglobin directly affects the normal diffusion of gases (O2) across the alveolar-capillary membrane.** PFTs are incomplete if they do not measure **diffusion capacity** (DLCO), especially if CO poisoning (or other diseases conditions affecting DCO) is being considered as the cause of shortness of breath and dyspnea.

If the PFTs in the record do not consider ALL the appropriate parameters you need OR do not include flow loops or other information to consider validity of testing to make your determination, you may need to order independent PFTs.

KNOW HOW TO ORDER PFTs and what specific questions that need to be addressed.

1. **Minimum Attempts:** Three acceptable maneuvers with consistent (repeatable) results are required to provide valid Pulmonary Function Tests (PFTs), specifically in the context of spirometry.

2. **Maximal Attempts:** *While* three acceptable and repeatable maneuvers are the goal, additional attempts can be made, up to a maximum of eight, to meet these criteria.

3. **Repeatability:** This refers to the consistency between acceptable maneuvers. For adults and older children, the difference between the two largest Forced Vital Capacity (FVC) and Forced Expiratory Volume in the first second (FEV1) values must be within 0.150 liters (150 ml) during the two best efforts.

4. **Quality Grading:** Some systems use a grading system (A-F) based on acceptability and repeatability to assess the quality of spirometry test sessions. Grades A-C are generally considered clinically useful.

5. **Request Time-Volume Curves and Flow Volume Loops** - consistent, reproducible effort and flow loops should confirm validity.

6. Request that IF an obstructive defect is present, determine if the disease is reversible based on the increase in FEV_1 or FVC **after** bronchodilator treatment.

7. Request that parameters of lung volume be tested as these do NOT have a volitional component.

8. IF the occupational condition includes silicosis, asbestosis, post-Covid lung injury, occupational smoke exposure or chronic Carbon Monoxide (CO) exposure, you will need DCO.

9. If the IE is a smoker, inform them that they should not snoke within 8 hours of testing as this can affect DCO. Note that IF they are a current smoker, this is a potent etiology for symptoms of respiratory impairment.

RATING PULMONARY FUNCTION TESTS (PFTs)

Be aware of how to read and use TABLE 8 on page 162 of Chapter 5 of the AMA Guides, 4th

Table 8. Classes of Respiratory Impairment.*

	Class 1: 0%, no impairment of the whole person	Class 2: 10-25%, mild impairment of the whole person	Class 3: 26-50%, moderate impairment of the whole person	Class 4: 51-100%, severe impairment of the whole person
FVC FEV_1 FEV_1/FVC (%) D_{CO}	FVC ≥ 80% of predicted; *and* FEV_1 ≥ 80% of predicted; *and* FEV_1/FVC ≥ 70%; *and* D_{CO} ≥ 70% of predicted.	FVC between 60% and 79% of predicted; *or* FEV_1 between 60% and 79% of predicted; *or* D_{CO} between 60% and 69% of predicted.	FVC between 51% and 59% of predicted; *or* FEV_1 between 41% and 59% of predicted; *or* D_{CO} between 41% and 59% of predicted.	FVC ≤ 50% of predicted; *or* FEV_1 ≤ 40% of predicted; *or* D_{CO} ≤ 40% of predicted.
	or	**or**	**or**	**or**
$\dot{V}O_2$ Max	> 25 mL/(kg • min); *or* > 7.1 METS	Between 20 and 25 mL/(kg • min); *or* 5.7-7.1 METS	Between 15 and 20 mL/(kg • min); *or* 4.3-5.7 METS	< 15 mL/(kg • min); or < 1.05 L/min; *or* < 4.3 METS

*FVC = forced vital capacity, FEV_1 = forced expiratory volume in the first second, D_{CO} = diffusing capacity of carbon monoxide. The D_{CO} is primarily of value for persons with restrictive lung disease. In classes 2 and 3, if the FVC, FEV_1 and FEV_1/FVC ratio are normal and the D_{CO} is between 41% and 79%, then an exercise test is required.

$\dot{V}O_2$ Max, or measured exercise capacity, is useful in assessing whether a person's complaint of dyspnea (see Table 1) is a result of respiratory or other conditions. A person's cardiac and conditioning status must be considered in performing the test and in interpreting the results.

THESE ARE BEST PRACTICES for DETERMINING IMPAIRMENT:

1. **Use Table 8.** This is one of the Non-MSK tables that does NOT depend on ADLs,

2. The condition MUST REACH A THRESHOLD of ONE of the PARAMETERS to ACCRUE IR. To RATE for IR, must be a Class 2.

3. Of the PFTS, RATE THE WORST. If FVC, FEV1, the FEV1/FVC ratio and the DCO are in different classes, rate as per the higher class.

4. Do not rate EACH of the components of the PFTs and then combine. Rate the worst of the system.

5. Changes in DCO are commonly associated with COVID-19 infections, but changes in DCO can also be seen in cases of silicosis / asbestosis and other non-occupational diseases and lifestyle habits.

6. REMIND the IE that if they ARE a smoker, no smoking within 8 hours of testing or can skew DCO results.
7. Look at FOOTNOTE: If FVC, FEV1, FEV1/FVC are normal AND DCO is between 41 % and 79 %, THEN an EXERCISE TEST is required.

8. You may use either the PFT results OR the VO2 Max. **As per page 163 of Chapter 5, *"the VO, max will be performed rarely and is not often necessary for identifying classes of impairment".***

9. If the patient is to be considered to have no impairment, all of the listed criteria except for V02 max must be met. For all other classes, at least one of the listed criteria must be fulfilled.

10. VO2 Max is the maximum amount of oxygen your body can utilize during exercise and is influenced by several factors.

11. For a VO2 MAX to be VALID, the IE must reach 85 % of their age-related heart rate (roughly 220 – their age).

12. VO2 Max is very difficult to find a lab to perform. It is less specific than PFTs. Even IF they are performed with VALIDITY, the results of testing are affected by factors other than the Respiratory System:
    a. Age (declines with age)
    b. Gender (typically higher in males)
    c. Body composition (BMI) – the higher the BMI, affects pulmonary status through restrictive changes to the pulmonary system and the abdominal obesity affects performance on the bicycle ergometer.
    d. Hip and knee joint arthritis – can affect ability to perform on a bicycle ergometer
    e. Genetics
    f. Training status (improved through consistent training, particularly high-intensity workouts)

13. If the other PFT parameters are more affected than DCO, consider that there may be other explanations for the changes on PFTs.

14. You might coach the IE to give maximal effort. IF there are indicators that full effort was not given, then the results are not valid for determining the IR.

15. As per Prior discussion, pulmonary conditions are common in those without occupational exposures. Asthma, COPD, Pulmonary Hypertension, Respiratory effects of obesity (OSA and hypoventilation syndrome) are NOT uncommon and have NOTHING to do with OCCUPATIONAL DISEASE.

16. PLEASE ASK:

    a. Childhood asthma and allergy history
    b. Smoking and second hand smoking history as well as other lifestyle choices

c. Occupational factors such as silicosis and asbestosis exposure.

d. Other occupational and non-occupational exposures

SPECIAL CONSIDERATIONS:

Section 5.3 SLEEP DISORDERS, ASTHMA, LUNG CANCER, AND OTHER IMPAIRMENT:.

Section 5.3 deals with Criteria for Evaluating Permanent Impairment and is on pages 163 – 164. Under that section, there is discussion of "*Sleep Disorders, Asthma, Lung Cancer, and Other Impairments".* The text in this section has more details but is also presented in Table 10.

Table 10 for page 164 of the AMA Guides 4th Edition discusses impairments not directly related to LUNG function. There may not be a permanent alteration of lung function by PFTs, but can affect the respiratory system.

5/164 Guides to the Evaluation of Permanent Impairment

Table 10. Impairments Not Directly Related to Lung Functions.

Asthma	Asthma presents a difficult problem in impairment evaluation because results of pulmonary function studies may be normal or near normal between attacks. Despite the intermittent nature of the disease, severe impairment may be diagnosed when the individual is receiving optimum medical therapy and has physiologic test results in the severely impaired range on three successive tests performed at least 1 week apart. The frequency of attacks also should be taken into consideration when deciding on the level of impairment. Persons whose asthma causes less than severe impairment, or whose asthma appears to be related to a class of chemicals or to a specific substance, such as toluene diisocyanate, may need to be evaluated for employability or the presence of an employment-related disability. In such a case the person should have spirometric testing before and immediately after work to determine whether an impairment related to workplace exposure occurs. The testing should be performed on at least three occasions. The physician's thorough documentation of the nature of the asthmatic condition and the compilation of the nonmedical evidence, such as that relating to occupation activities, specific chemicals that may be involved, and other circumstances of work, are crucial to the determination of work-related disability (see Glossary).
Hypersensitivity pneumonitis	A person with this condition may need to be removed from exposure to the causative agent or to other agents with similar sensitizing properties. This would help the person avoid future attacks and chronic sequelae.
Pneumoconiosis	Although a pneumoconiosis may cause no physiologic impairment, its presence usually requires the patient's removal from exposure to the dust causing the condition.
Lung cancers	All persons with lung cancers are considered to be severely impaired at the time of diagnosis. At a reevaluation 1 year after the diagnosis is established, if the person is found to be free of all evidence of tumor recurrence, then he or she should be rated according to the physiologic measures in Table 8 (p. 162). If there is evidence of tumor, the person remains "severely impaired." If the tumor recurs at a later date, the person immediately is considered to be severely impaired. Table 11 (p. 165) may be used to describe further the capabilities of a patient with lung cancer.

Although sleep disorders are listed in this section, they will infrequently be caused by an occupational disease. One exception is CENTRAL Sleep Apnea. This can be seen in those with moderate or usually more severe TBIs, especially if there is damage to the brainstem. If present, this may be considered for impairments in Chapter 4 for the Nervous System.

Lung cancers may be caused by occupational exposures, but will be dependent on type and degree of occupational exposure relative to non- occupational exposures.

COVID-19:

DON'T JUST ASSUME THAT THE PFT FINDINGS ARE DUE TO A COVID EXPOSURE.

It would be very helpful to obtain, and understand the contents of the following article:

Joseph Hirsch, PhD, PsyD; Steven Mandel, MD; Les Kertay, PhD; James B. Talmage, MD; Greg Vanichkachorn, MD; Kurt Hegmann, MD; James Underhill, PhD; John Meyers, PhD; Christopher R. Brigham, MD. **Long Covid-19 Neurological And Psychological Claims: Assessment Guidelines.** AMA Guides Newsletter (2022) 27 (3): 1–27.1 doi.org/10.1001/amaguidesnewsletters.2022.MayJune

[DWC cannot republish this article, but we recommend it as a resource.]

From the Abstract AMA Guides May - June 2022

1. Post–severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (coronavirus disease 2019 [COVID-19]) conditions are referred to by a wide range of names, including long COVID, post-acute COVID-19, long-term effects of COVID, post-acute COVID syndrome, chronic COVID, long-haul COVID, late sequelae, and others, as well as the research term, post-acute sequelae of SARS-CoV-2 infection (PASC).

2. Symptoms may include *"difficulty thinking or concentrating, fatigue, depression, anxiety, and other complaints".*
    - Many of the conditions attributed to Covid-19 infection, are often vague, symptom based and often non-verifiable.
    - Do many of the symptoms of post-Covid infection sound familiar? Consider Post Concussion Syndrome or other mental and behavioral diagnoses that often have vague symptoms that are difficult to objectify.
    - Use the same forensic scrutiny that you would for CRPS, post-concussion syndrome or PTSD.

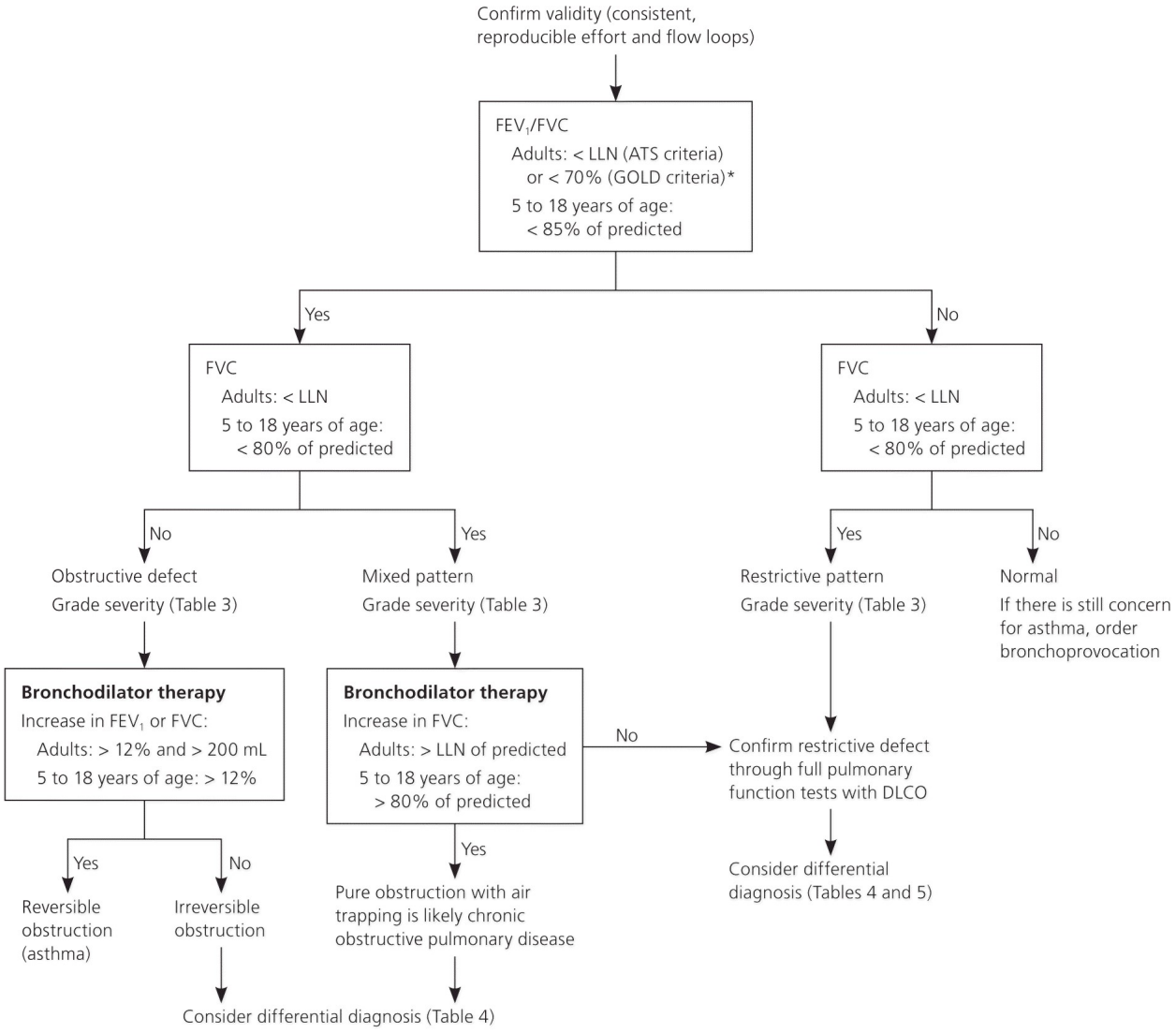
3. ***"The results of studies are clouded by self-reports, lack of objective cognitive data, misattribution, and ill-defined psychological issues".***

4. The authors surmised, ***"While we do not dismiss the presence of long COVID or chronic COVID-19 symptoms lasting beyond a typically expected viral respiratory transmitted syndrome, neither do we uncritically accept such a syndrome in all those who were diagnosed as having COVID-19, especially in those whose initial presentation was asymptomatic or mild.***

5. Also, ***"Evaluators must be astute and perform unbiased, thorough assessments and focus on objective findings while carefully assessing the potential for confounding or alternate conditions"***
    - What does this mean? DO NOT take symptoms at face value as being caused by a Covid-19 exposure or infection.
    - Provide a forensic analysis and look for alternate explanations that may be more medically probable.

Lori B Wasserburger, MD

INTERPRETING PULMONARY FUNCTION TESTS (Johnson and Theurer 2014)



NOTE: *A tool to calculate the LLN in adults up to 75 years of age is available at http://hankconsulting.com/RefCal.html.*

**—The 70% criteria should be used only for patients 65 years and older who have respiratory symptoms and are at risk of chronic obstructive pulmonary disease (i.e., current or previous smoker).*

American Lung Association.
Implementation and Interpretation of Spirometry

SPIROMETRY IMPLEMENTATION QUICK GLANCE GUIDE

Spirometry: A measure of airflow (how fast) and volume (how much)

Forced Vital Capacity (FVC): The volume delivered during an expiration made as forcefully and completely as possible starting from full inspiration.

Forced Expiratory Volume in the first second (FEV^1): The volume delivered in the first second of a FVC maneuver.

Obstruction is defined as FEV_1/FVC ratio below the lower limits of normal. The rule of thumb is if FEV_1/FVC is down 10 or more from the predicted value.

Restriction: Spirometry with a low FVC (less than the LLN) suggests restriction. Further testing is needed to confirm.

Spirometry must establish a solid baseline meeting the American Thoracic Society (ATS) criteria for acceptability and repeatability. Use Global Lung Initiative (GLI-2012) predictive ranges when available. GLI-2012 has a grading system range of A-F, spectrometry tests with grades of A-C are clinically useful.

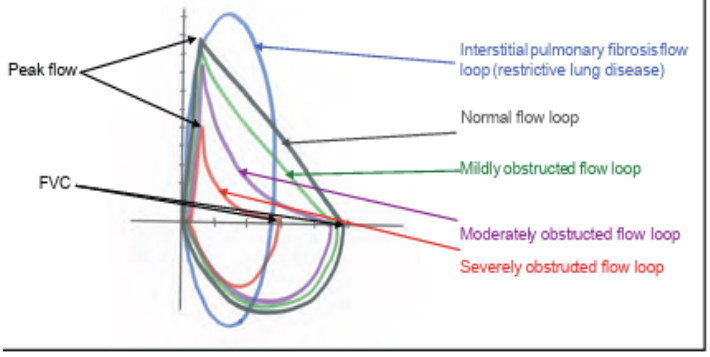
Contraindications of spirometry:

- ✓ Recent surgery
- ✓ Within one month of myocardial infarction
- ✓ Recent pneumothorax
- ✓ Unable to understand directions
- ✓ Inability to seal mouthpiece

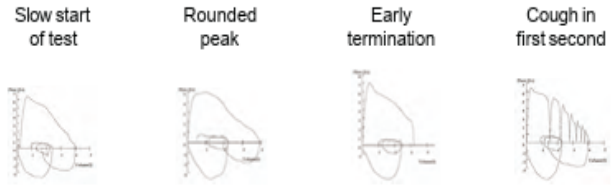
Refer to a specialist, if patient:

1. Has **severe** obstruction
2. Shows a **restrictive pattern**
3. Does **not respond to medications**

Examples of obstructed and restricted flow loops



Examples of Unacceptable Spirometry Tests:



Repeatability Criteria from ATS: ATS requires three acceptable maneuvers where the difference between the two largest FVC and FEV_1 values must be within 150 ml of each other for patients over 6 years old and 100ml for patients 6 years old and under.

Coaching Patients through Spirometry:
Instruct patient to breathe normally. When the patient is ready, have them take their deepest breath and blow as hard as they can, for as long as they can. There is a learning curve for spirometry. Use positive reinforcement to build on the patient's successes. For example, "that was good. This time, take an even deeper breath." Demonstrating the maneuver can be helpful.

Testing for Bronchodilator Responsiveness (Formerly Reversibility): Give patient 4 puffs of bronchodilator with a valved-holding chamber or a standard nebulized dose. Wait 10-15 minutes after last dose to perform post-bronchodilator maneuver. If the patient cannot perform acceptable baseline maneuvers or there is no evidence of airflow obstruction, do NOT give a bronchodilator.

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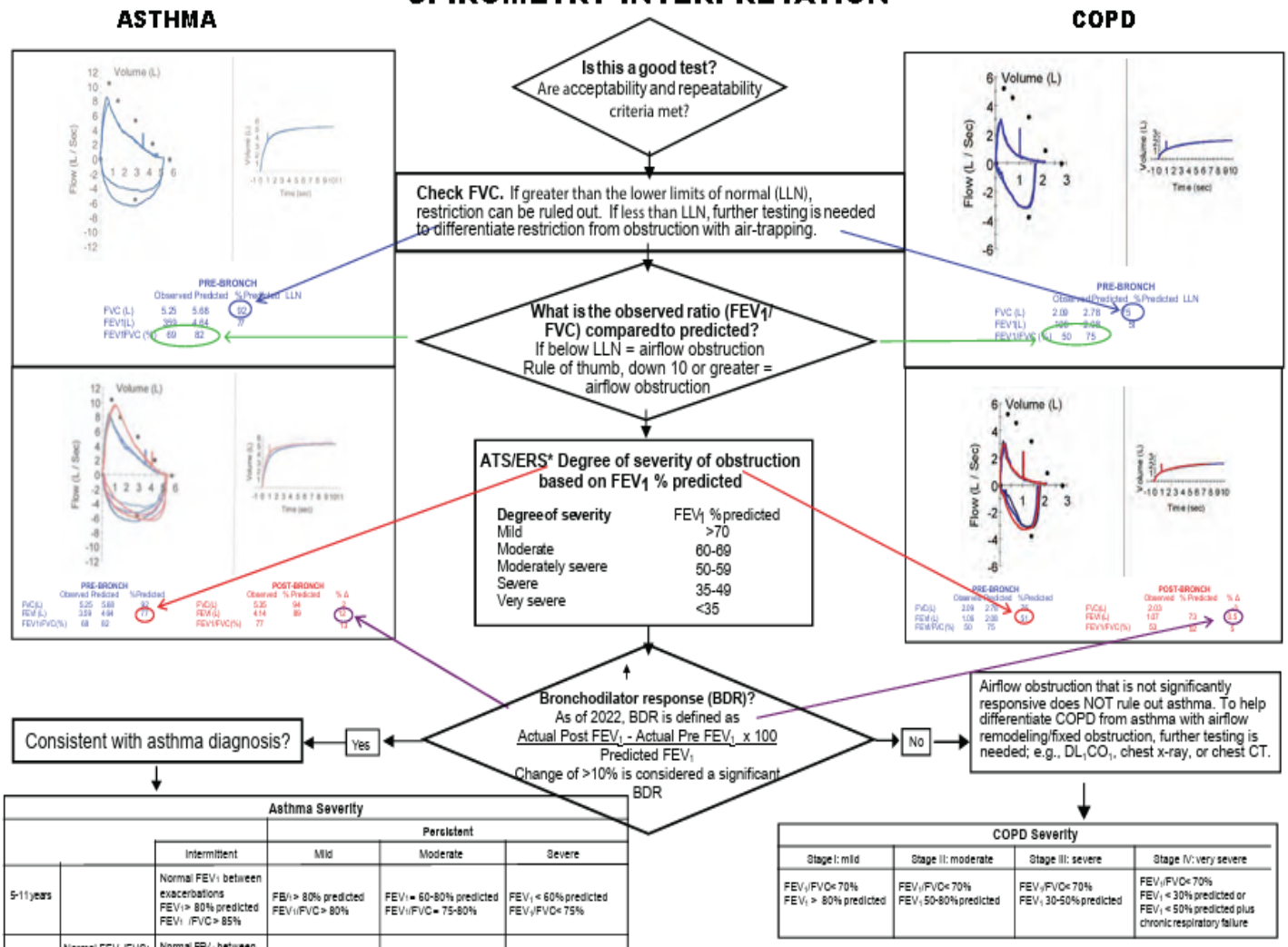
updated September 2024

SPIROMETRY INTERPRETATION



Asthma Severity					
			Persistent		
		Intermittent	Mild	Moderate	Severe
5-11 years		Normal FEV_1 between exacerbations FEV_1 > 80% predicted FEV_1 /FVC > 85%	FEV_1 > 80% predicted FEV_1/FVC > 80%	FEV_1 = 60-80% predicted FEV_1/FVC = 75-80%	FEV_1 < 60% predicted FEV_1/FVC < 75%
12+ years	Normal FEV_1/FVC: 8-19 yr 85% 20-39 yr 80% 40-59 yr 75% 60-80 yr 70%	Normal FEV_1 between exacerbations FEV_1 > 80% predicted FEV_1/FVC normal	FEV_1 > 80% predicted FEV_1/FVC normal	FEV_1 60-80% predicted FEV_1/FVC reduced 5%	FEV_1 < 60% predicted FEV_1/FVC reduced > 5%

COPD Severity			
Stage I: mild	Stage II: moderate	Stage III: severe	Stage IV: very severe
FEV_1/FVC < 70% FEV_1 > 80% predicted	FEV_1/FVC < 70% FEV_1 50-80% predicted	FEV_1/FVC < 70% FEV_1 30-50% predicted	FEV_1/FVC < 70% FEV_1 < 30% predicted or FEV_1 < 50% predicted plus chronic respiratory failure

Sample asthma interpretation: The FEV_1/FVC ratio below the lower limits of normal is consistent with airflow obstruction. The FEV1 being 77% of predicted suggests a mild airflow obstruction based on the 2005 ATS/ERS guide for severity of obstruction. The post bronchodilator study reveals a significant BDR with a change of 12%. This finding is consistent with a diagnosis of asthma although clinical correlation is needed to confirm. Based on the 2020 Focused Guidelines Update for asthma severity, this 28 year old male with a baseline FEV_1 of 77% of predicted has moderate persistent asthma. Treatment should begin with Step 3 or 4 therapy.

Sample COPD Interpretation: The FEV1/FVC ratio being below the lower limits of normal is consistent with airflow obstruction. A post bronchodilator FEV1/FVC ratio below 70% is consistent with COPD. The FEV_1 of 51% of predicted suggests a moderately-severe airflow obstruction based on the 2024 GOLD guidelines for severity of obstruction. There was no significant BDR to albuterol. Further testing revealed a diffusion capacity of 50% of predicted. The lateral chest x-ray showed signs of hyperinflation and flattened diaphragm and the chest CT had classic changes seen in emphysema. Based on GOLD, this 74 year old female has Stage II moderate COPD. Treatment should be based on the CAT score, mMRC score and exacerbation history.

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Obesity / Obstructive Sleep Apnea / Obesity-Hypoventilation Syndrome

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