Case based learning in spirometry

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American Thoracic Society/European Respiratory Society spirometry quality criteria

Acceptability

Free of artifacts

- **Cough**
- **Glottis closure**
- **Early termination**
- **Submaximal effort**
- **Leaks**
- **Obstructed mouthpieces**

Back extrapolated volume <5% of FVC or 0.15 L, whichever is greater

Expiratory time ≥ 6 s, 3 s for children or plateau in the volume-time curve or when the patient cannot or should not continue to exhale

Repeatability

A minimum of three acceptable tests should be obtained

The two largest FVC should be within .15 L of each other

The two largest FEV1 should be within .15 L of each other

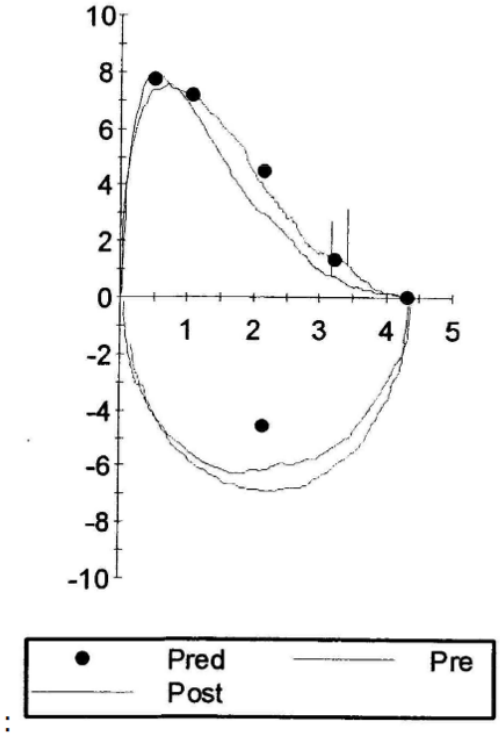
Case 1

A 65 year-old man undergoes pulmonary function testing as part of a routine health-screening test. He had no pulmonary complaints. He is a lifelong non-smoker and had a prior history of asbestos exposure while serving in the Navy. His pulmonary function test results are as follows:

	Pre-Bronchodilator (BD)			Post- BD
Test	**Actual**	**Predicted**	**% Predicted**	**% Change**
FVC (L)	4.39	4.32	102	-1
FEV_1 (L)	3.20	3.37	95	7
FEV_1/FVC (%)	73	78		8
FRC (L)	3.17	3.25	98	
ERV (L)	0.63	0.93	68	
RV (L)	2.54	2.32	109	
TLC (L)	6.86	6.09	113	
DLCO uncorr	25.69	31.28	82	
DLCO corr	26.14	31.28	84	

DLCO is measured in ml/min/mmHg

His flow volume loops is as follows:

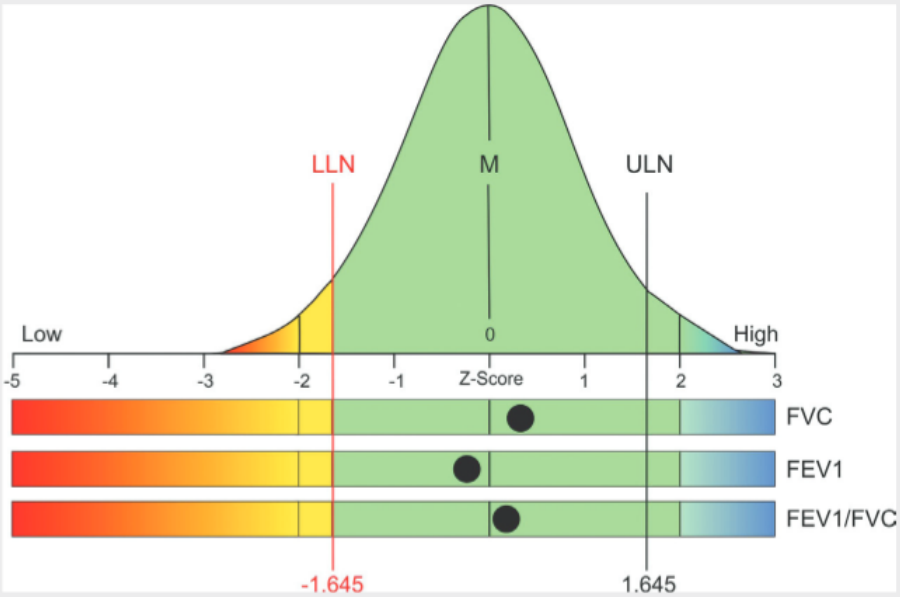


Case 1 interpretation

- This case demonstrates an example of normal pulmonary function tests. The FVC and the FEV1 are 102% and 95% of predicted, respectively, values well above the lower limit of normal and the FEV1/FVC ratio is greater than the predicted value minus 8. The flow-volume loop also corresponds quite nicely to the predicted values for this patient (darkened circles). Based on this normal spirometry pattern, you would conclude that there is no evidence of air-flow obstruction. The patient also has normal total lung capacity, indicating that there is no evidence of restriction, and a normal diffusing capacity for carbon monoxide, indicating that the alveolar-capillary surface area for gas exchange is normal. There is no bronchodilator response.

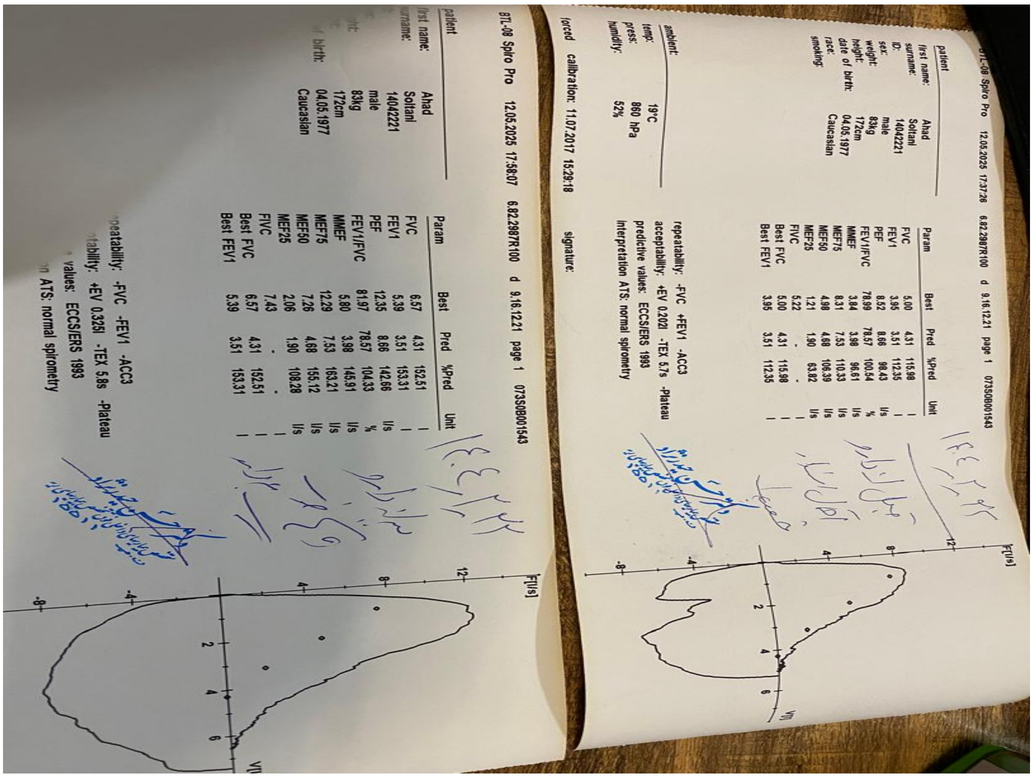
FIGURE 3

Spirometry data displayed on a bell curve. LLN, lower limit of normal; M, median; ULN, upper limit of normal; FVC, forced vital capacity; FEV_1, forced expiratory volume in the first second. (Courtesy of Morgan Scientific Inc., Haverhill, MA, USA)



Case 2

- 47 yo male 20 p/y smoker with hoarseness , cough, without dyspnea ,
- Wheezing and rhonchi in both chest with hoarseness

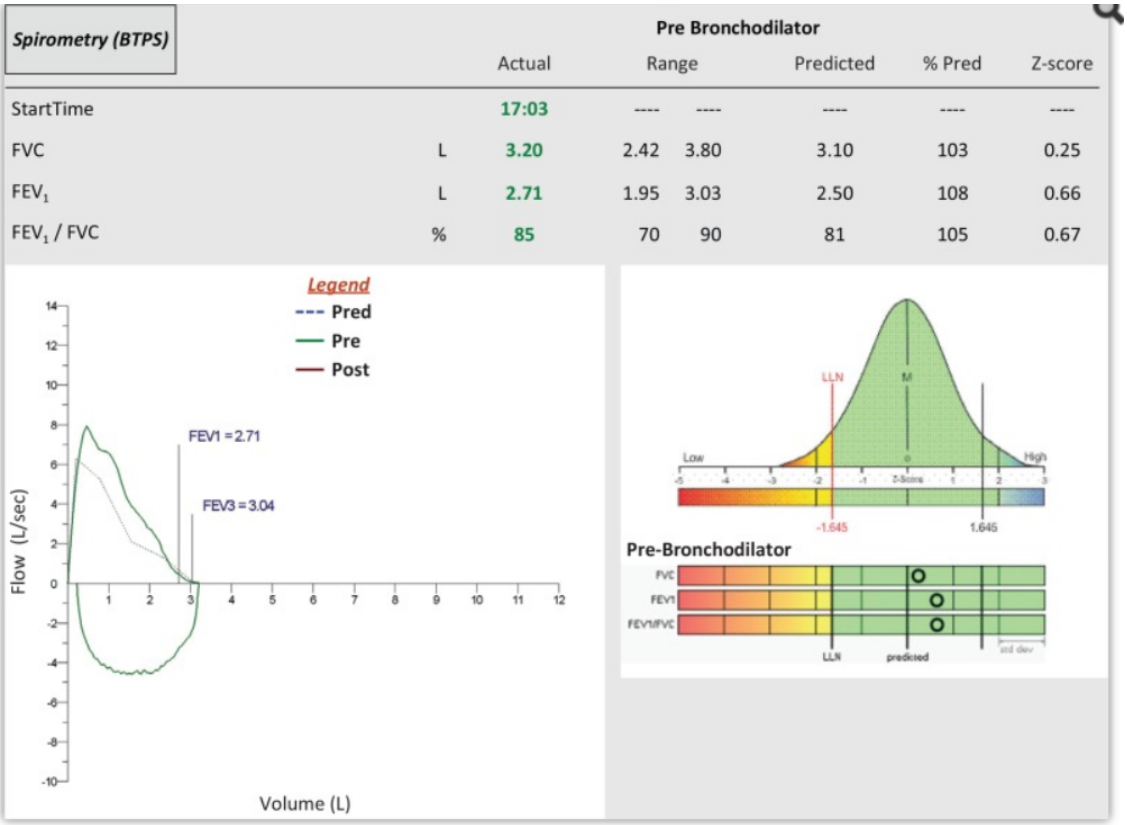


- 73 female COPD , referred for check up.
- Diagnosed as COPD 5 yrs ago , on daily tiotropium , salbutamol PRN
- In last yr increasing dyspnea with exertion, decreasing exercise activity
- No sputum , no cough , increased salbutamol use up to 5 times/day
- 3 infection /yr in past 2 yrs, treated with prednisone and antibiotics
- Good vaccination , quitted smoking 5 yrs
- Sat =96% on room air, decreased breath sounds , no other finding
- Cxr = hyperinflation with decreased vascularity
- ECG normal

• FVC = 2.29(70),
• FEV1 = 1.33(59),
FEV1/FVC = 58%,
TLC = 4.68 (86)
FRC = 2.95(99)
RV = 2.24(105)
DLCO = 10.4 (50)

What is your next step in management of this patient ?

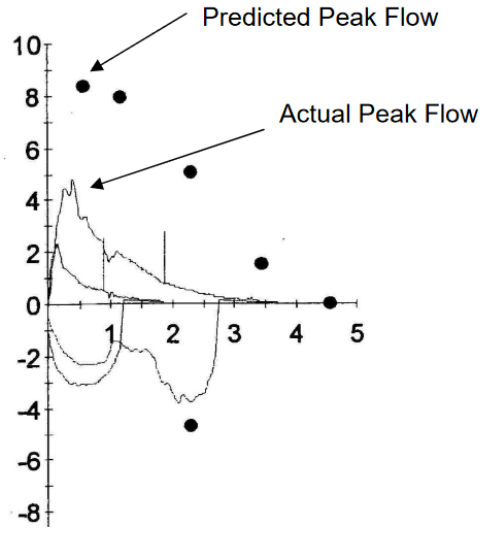
• D/C tiotropium and start long acting beta 2 agonist
• Continue tiotropium and add roflumilast
• Discontinue tiotropium and start inhaled steroid with LABA
• Change tiotropium to an inhaled combination LABA /LAMA



A 54 year-old man presents to his primary care provider with dyspnea and a cough. He is a non-smoker with no relevant occupational exposures.

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	3.19	4.22	76	4.00	25
FEV_1 (L)	2.18	3.39	64	2.83	30
FEV_1/FVC (%)	68	80		71	4

His flow volume loop is as follows:



- The FVC and FEV1 are both below the LLN (defined as 80% of the predicted value for the patient).
- The FEV1/FVC ratio is only 0.68, less than the LLN of the predicted value minus 8 (80-8 = 72) for this male patient.
- A low FEV1 and FVC with a decreased FEV1/FVC ratio is consistent with a diagnosis of air-flow obstruction.
- With an FEV1 of 64% predicted this would be classified as "moderate" airflow obstruction.
- The FVC improves by 0.81 L (25% increase) and the FEV1 improves by 0.65L (30% increase) after bronchodilator so this patient would qualify as having a bronchodilator response (defined as a 12% and 200 ml increase in Peak either the FEV1 or FVC).
- The flow volume loop also shows several abnormalities consistent with obstructive lung disease. The peak expiratory flow rate is lower than the predicted peak expiratory flow and the curve has the characteristic scooped

- Is pulmonary function test is diagnostic for any disease?
- Pattern recognition
- Severity assessment

Pattern recognition

- Normal
- Obstructive
- Restrictive
- Mixed obstructive-restrictive
- Bizare , poor cooperation ,
- Upper airway obstruction

Severity assessment criteria when fev1 is <LLN

Classification	% of predicted	z-score
Mild	≥70	≥−2
Moderate	60–69	−2 to −2.5
Moderately severe	50–59	<−2.5 to −3
Severe	35–49	<−3 to −4
Very severe	<35	<−4

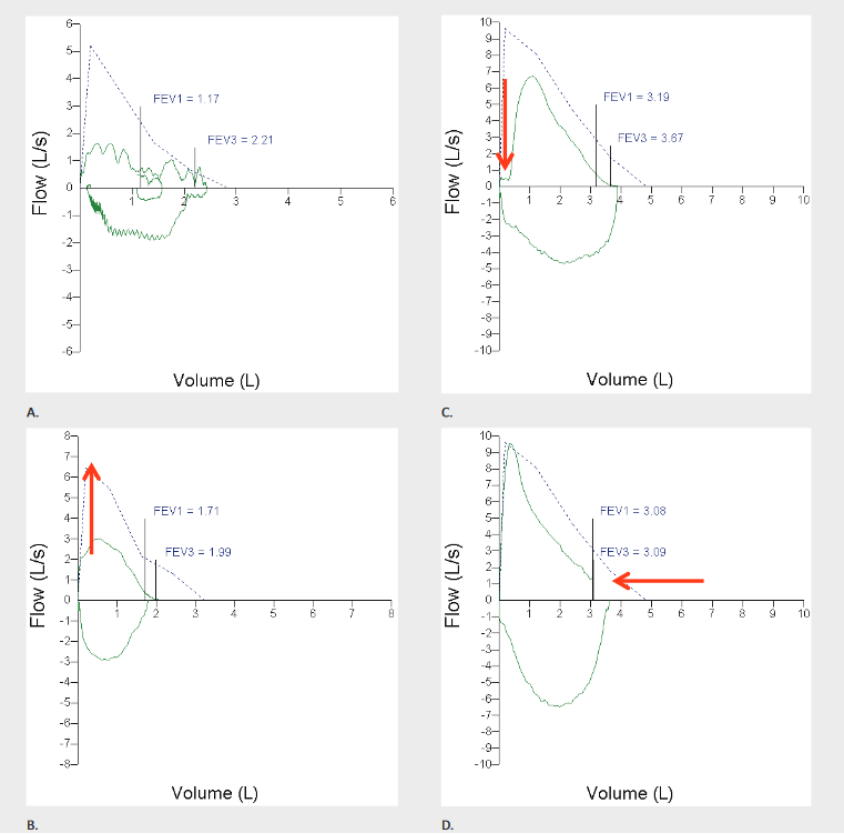
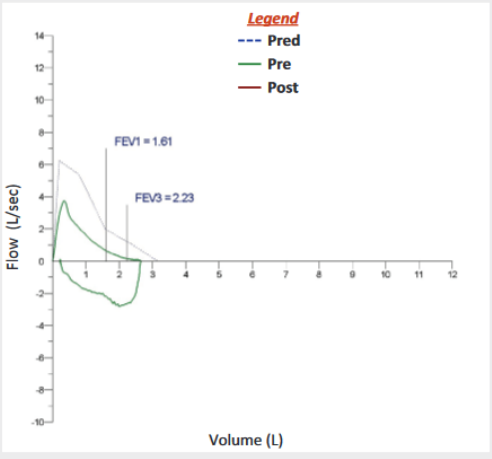


FIGURE 4

Obstructive spirometry pattern, the FEV_1 and FEV_1/FVC are < LLN. The flow–volume loop shows less than expected expiratory flows (dotted line), which create a concave contour. FVC, forced vital capacity; FEV_1, forced expiratory volume in the first second; FEV_3, forced expiratory volume in the third second; M, median; LLN, lower limit of normal.

Spirometry (BTPS)		Pre Bronchodilator Actual	Range		Predicted	% Pred	Z-score
StartTime		09:14	----	----	----	----	----
FVC	L	2.64	2.36	3.99	3.16	84	–1.07
FEV_1	L	1.61	1.84	3.08	2.47	65	–2.24
FEV_1 / FVC	%	61	66	89	79	77	–2.26



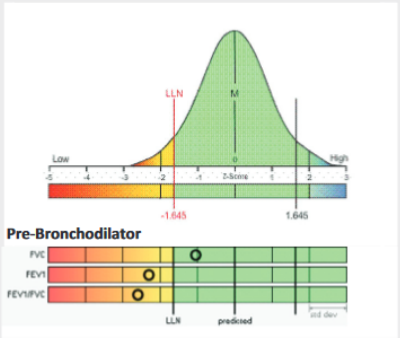
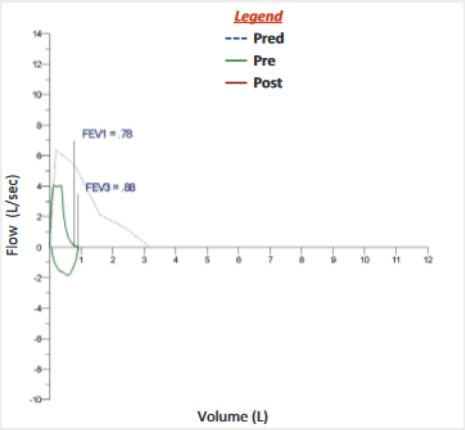


FIGURE 5

Restrictive spirometry pattern, the FVC and FEV_1 are <LLN but the FEV_1/FVC is >LLN. The flow–volume loop is narrow indicating low volumes. FVC, forced vital capacity; FEV_1, forced expiratory volume in the first second; FEV_3, forced expiratory volume in the third second; M, median; LLN, lower limit of normal.

Spirometry (BTPS)		Pre Bronchodilator Actual	Range		Predicted	% Pred	Z-score
StartTime		15:36	----	----	----	----	----
FVC	L	0.90	2.48	3.94	3.19	28	–5.68
FEV_1	L	0.78	1.98	3.11	2.56	30	–4.81
FEV_1 / FVC	%	87	69	90	80	109	1.10



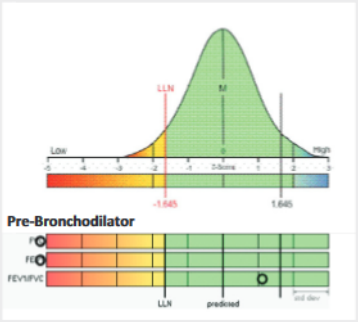
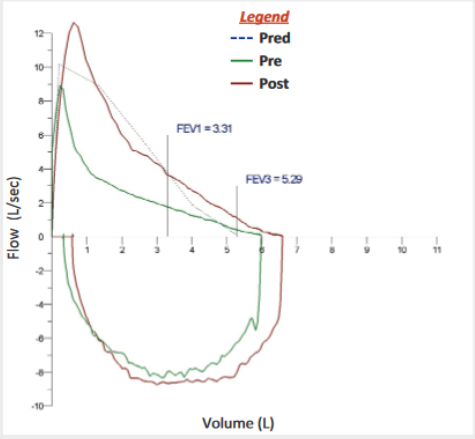
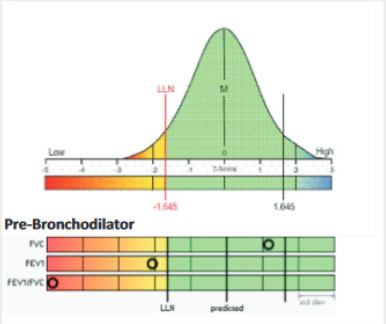


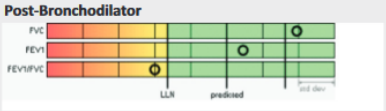
FIGURE 6

Significant bronchodilator response, the post-bronchodilator FEV_1 has increased more than 12% and 200 mL and is >LLN. The flow–volume loop overlay shows higher flows and volumes after bronchodilator (red tracing). FVC, forced vital capacity; FEV_1, forced expiratory volume in the first second; FEV_3, forced expiratory volume in the third second; M, median; LLN, lower limit of normal.

Spirometry (BTPS)		Pre Bronchodilator Actual	Range		Predicted	% Pred	Z-score	Post Bronchodilator Actual	% Pred	% Change	Z-score
StartTime		10:12	----	----	----	----	----	10:39	----	--	----
FVC	L	6.09	4.30	6.39	5.35	114	1.16	6.59	123	8	1.94
FEV_1	L	3.31	3.52	5.30	4.41	75	–2.02	4.65	105	40	0.46
FEV_1 / FVC	%	54	72	94	83	65	–3.61	71	86	31	–1.76





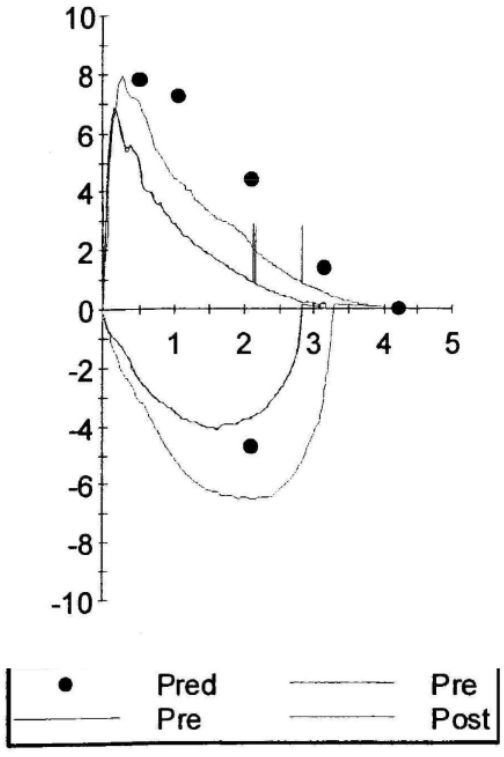


Case 3

A 60 year-old man presents to his primary care provider with complaints of increasing dyspnea on exertion. He has a 40 pack-year history of smoking and is retired following a career as a building contractor. His pulmonary function testing is as follows:

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	1.89	4.58	41	3.69	96
FEV_1 (L)	0.89	3.60	25	1.89	112
FEV_1/FVC (%)	47	79			
RV (L)	5.72	2.31	248		
TLC (L)	7.51	6.41	117		
RV/TLC (%)	76	37			
DLCO corr	20.73	33.43	62		

The units for DLCO are ml/min/mmHg



- The FVC is only 41% predicted while the FEV1 is only 25% predicted, well below the LLN of 80% predicted.
- The FEV1/FVC ratio is markedly reduced.
- The combination of the low FEV1, FVC and reduced FEV1/FVC ratio is consistent with a diagnosis of airflow obstruction.
- With an FEV1 of 25% predicted, this would be classified as "severe" airflow obstruction.
- The patient also meets criteria for reversible airflow obstruction as both the FEV1 and FVC improve by over 200 ml and 12% following administration of a bronchodilator.
- In addition to these abnormalities on spirometry, the patient has a markedly elevated residual volume (RV), a finding that is indicative of air-trapping.
- The total lung capacity (TLC) is somewhat elevated at 117% predicted but it is still shy of the 120% predicted level used to define

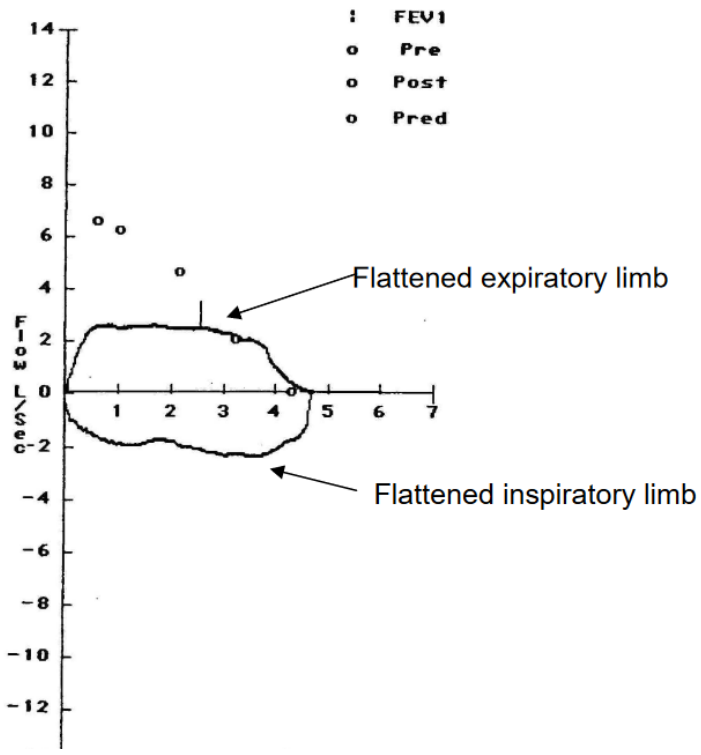
Case 4

A 25 year-old man presents to his physician with complaints of dyspnea and wheezing. He is a non-smoker. Two years ago, he was in a major motor vehicle accident and was hospitalized for 3 months. He had a tracheostomy placed because he remained on the ventilator for a total of 7 weeks. His tracheostomy was removed 2 months after his discharge from the hospital. His pulmonary tests are as follows:

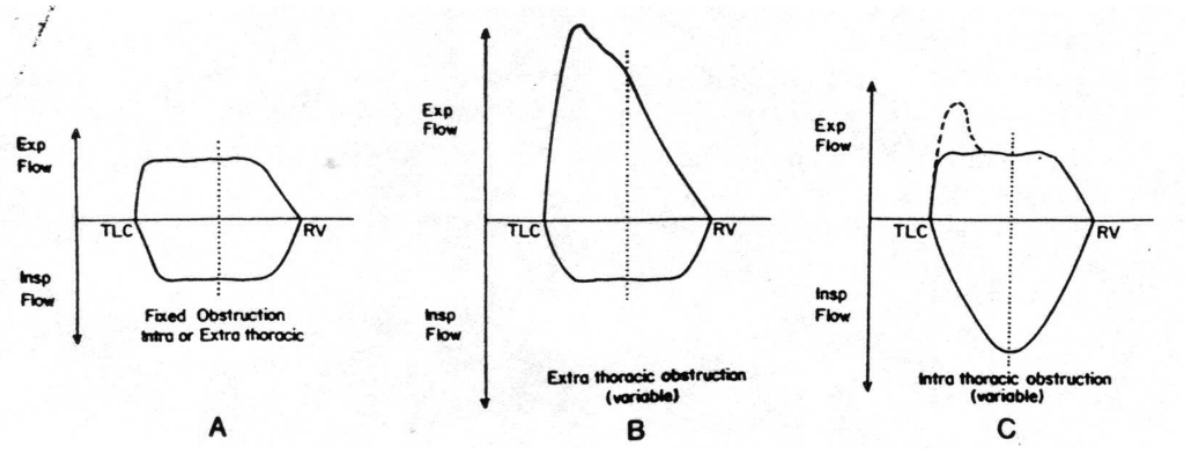
	Pre-Bronchodilator (BD)		
Test	**Actual**	**Predicted**	**% Predicted**
FVC (L)	4.73	4.35	109
FEV_1 (L)	2.56	3.69	69
FEV_1/FVC (%)	54	85	

- Simple test to assess upper airway obstruction?

His flow volume loops is as follows:



- This patient has evidence of airflow obstruction on spirometry as he has a low FEV1 and a reduced FEV1/FVC ratio of 0.54.
- Given that the FEV1 is 69% of predicted this patient would be labeled as having "mild airflow obstruction.
- In order to make a correct diagnosis in this patient, however, you cannot look simply at the numbers from his spirometry testing but must also look at the flow volume loops.
- A noteworthy feature of his flow volume loop is that there is flattening of both the inspiratory and expiratory limbs.
- This pattern is seen in patients who have a fixed upper airway obstruction.
- In a patient with a prior history of tracheostomy, you would be very suspicious that this patient has developed tracheal stenosis, a known long-term complication of tracheostomy tubes.
- Other forms of airway obstruction will also demonstrate characteristic patterns on the flow-volume loops.

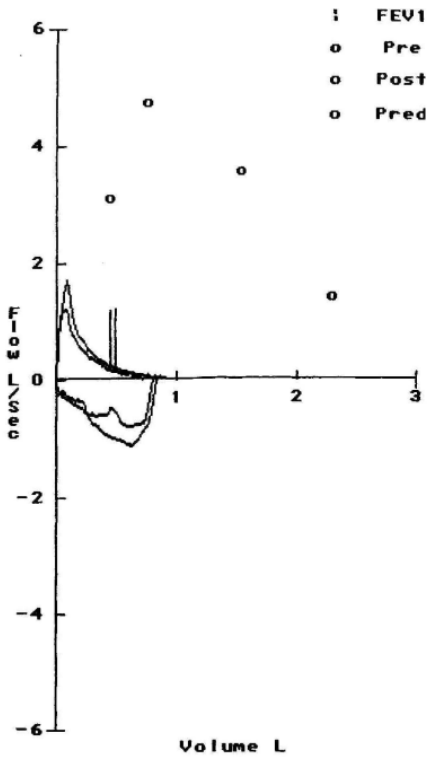


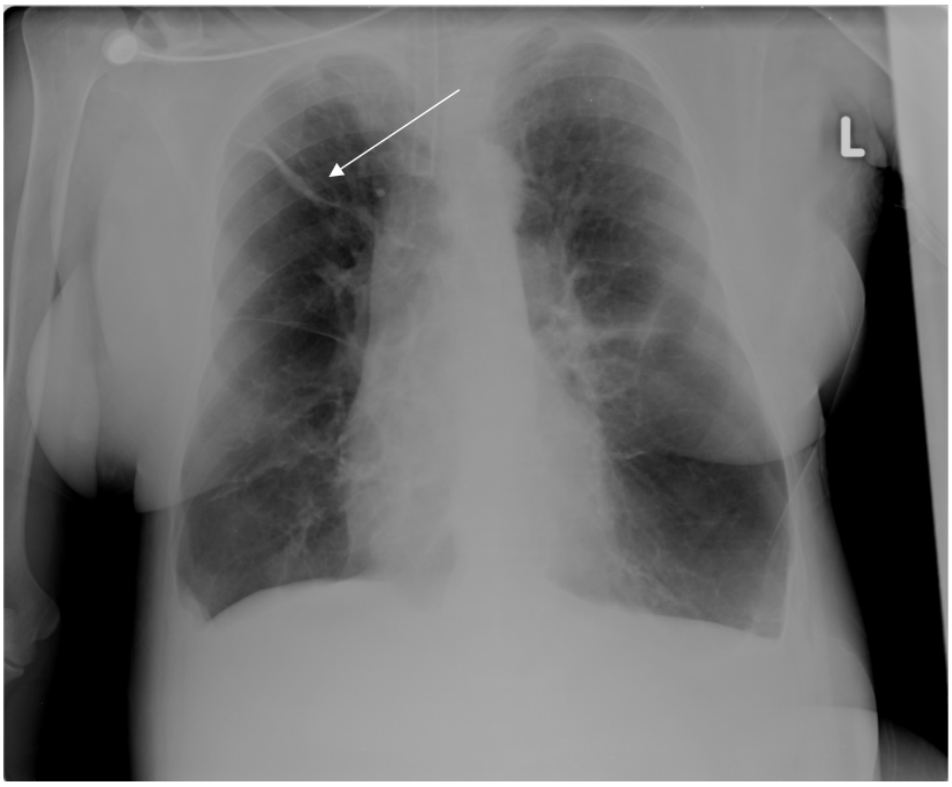
Case 5

A 41 year-old woman presents to the General Internal Medicine Clinic at Harborview Medical Center complaining of dyspnea with mild exertion. She has a 10 pack-year history of smoking and a history of using intravenous drugs including heroin and ritalin. Her pulmonary function tests are as follows:

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	0.90	3.09	29	0.74	- 17
FEV_1 (L)	0.49	2.57	19	0.44	-10
FEV_1/FVC (%)	54	83		59	8
RV (L)	3.83	1.49	257		
TLC (L)	4.78	4.44	108		
RV/TLC (%)	80	33			
DLCO corr	0.75	24.85	3		

Her flow volume loop is as follows:





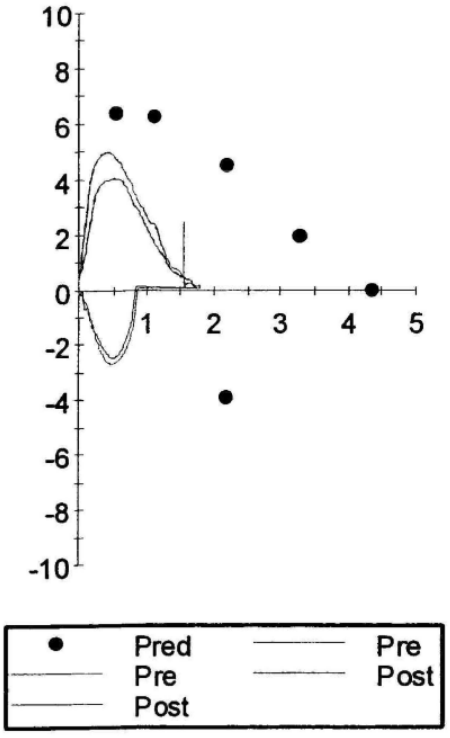
- This patient has evidence of air-flow obstruction, as her FEV1, FVC and her FEV1/FVC are all decreased.
- Her flow volume demonstrates the characteristic scooped-out appearance seen in obstructive lung disease and also demonstrates markedly reduced peak expiratory flows.
- Based on her FEV1 of 19% predicted this would be classified as “very severe” obstructive lung disease.
- The patient also has evidence of air-trapping, as her RV is 257% predicted.
- She would not be classified as being hyper-inflated because her TLC is only 108% predicted.
- There is no evidence of a bronchodilator response as her FVC and FEV1 both decline following bronchodilator administration.
- Her DLCO is also decreased, indicating a loss of alveolar-capillary surface area for gas exchange. It is highly unlikely for a 41 year-old person to have obstructive lung disease with only a 10-pack year history of smoking.
- Asthma is an unlikely diagnosis given the absence of reversibility with

Case 6

A 30 year-old woman presents for evaluation of dyspnea on exertion, which has been present for 2 months. She is a life-long non-smoker with no prior history of asthma or other pulmonary problems. She works as a receptionist at a publishing company. She has two cats and several parakeets at home. Her pulmonary function testing is as follows:

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	1.73	4.37	40	1.79	4
FEV_1 (L)	1.57	3.65	43	1.58	0
FEV_1/FVC (%)	91	84		88	-3
RV (L)	1.01	1.98	51		
TLC (L)	2.68	6.12	44		
RV/TLC (%)	38	30			
DLCO corr	5.13	32.19	16		

Her flow volume loop is as follows:

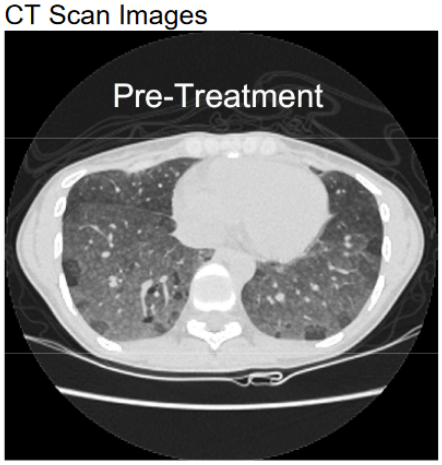


- This patient has a markedly reduced FEV1 and FVC. However, the FEV1/FVC ratio is normal (91%) and, therefore, she cannot be classified as having obstructive lung disease. The pattern of reduced FEV1 and FVC with preserved FEV1/FVC ratio is often seen in restrictive processes but in order to confirm the diagnosis of restriction, you must examine the total lung capacity. For this patient, the TLC is markedly reduced at 41% of predicted and confirms that she has a restrictive process. Based on her TLC of < 50% predicted, she would be classified as having a "severe" restrictive defect. Her DLCO is also reduced suggesting she has a loss of alveolar-capillary surface area for gas exchange and also suggesting that the cause of her restriction is intrinsic to the lungs (i.e. due to a problem in the pulmonary parenchyma). Further evaluation revealed that this patient had hypersensitivity pneumonitis, likely secondary to her exposure to parakeets. The parakeets were removed from her home and she was given a course of oral corticosteroids. Following treatment, her repeat pulmonary function tests were improved, as was the CT scan of her chest.

Pulmonary Function Tests Pre- and Post-Treatment

	Pre-Treatment			Post-Treatment		
Test	**Actual**	**Predicted**	**% Pred.**	**Actual**	**Predicted**	**% Pred.**
FVC (L)	1.73	4.37	40	3.00	4.35	69
FEV_1 (L)	1.57	3.65	43	2.40	3.63	66
FEV_1/FVC (%)	91	84		80	83	
RV (L)	1.01	1.98	51	0.70	1.99	35
TLC (L)	2.68	6.12	44	3.70	6.11	61
RV/TLC (%)	38	30		19	30	
DLCO corr	5.13	32.19	16	13.61	32.04	42

CT Scan Images

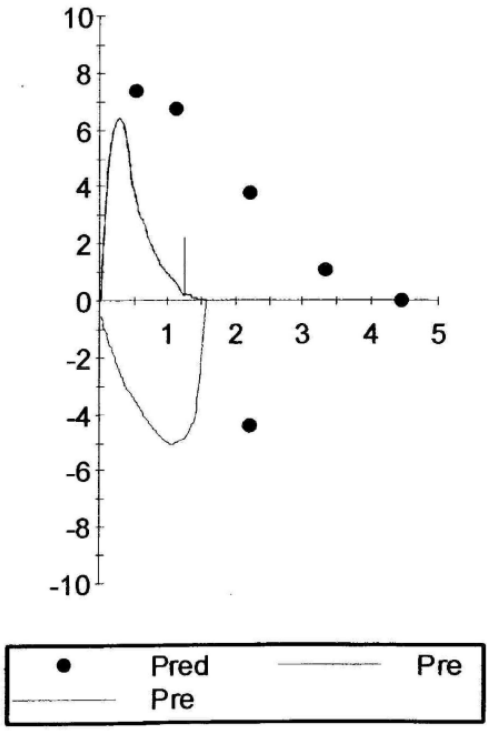


Case 7

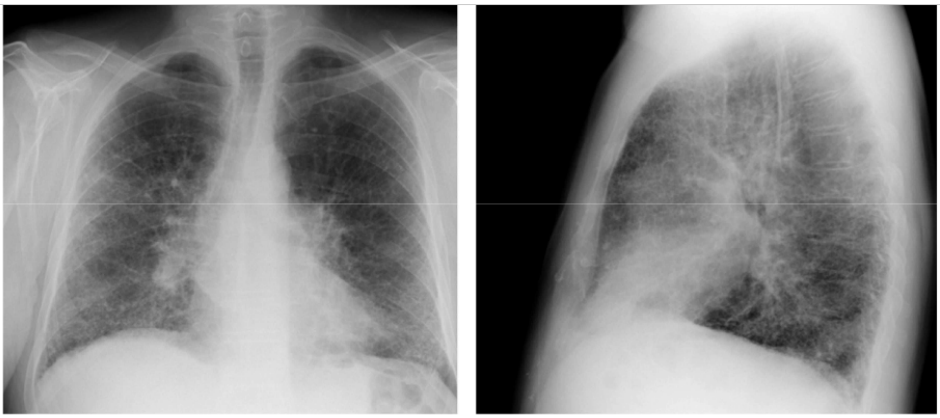
A 73 year-old man presents with progressive dyspnea on exertion over the past one year. He reports a dry cough but no wheezes, sputum production, fevers or hemoptysis. He is a life-long non-smoker and worked as a lawyer until retiring 3 years ago. He likes to hunt and fish in his leisure time. His pulmonary function testing is as follows:

	Pre-Bronchodilator (BD)		
Test	**Actual**	**Predicted**	**% Predicted**
FVC (L)	1.57	4.46	35
FEV_1 (L)	1.28	3.39	38
FEV_1/FVC (%)	82	76	
FRC	1.73	3.80	45
RV (L)	1.12	2.59	43
TLC (L)	2.70	6.45	42
RV/TLC (%)	41	42	
DLCO corr	5.06	31.64	16

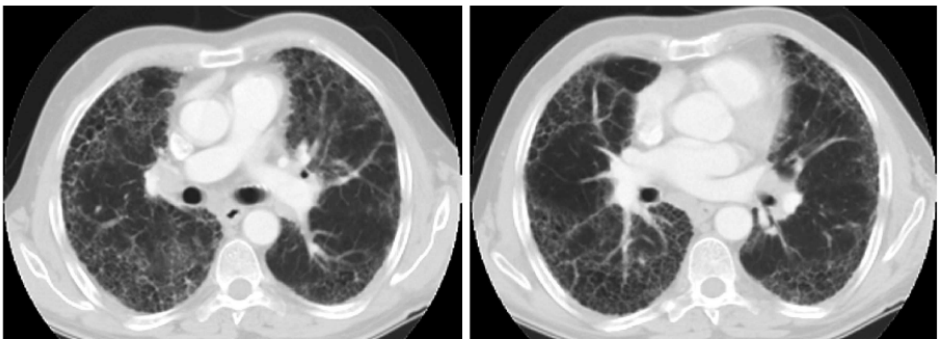
His flow-volume loop is as follows:



- This patient has a reduced FEV1 and FVC with a preserved FEV1/FVC ratio. The total lung capacity is reduced and the patient, therefore, has a restrictive defect. The flow-volume loop also has the characteristic appearance of a restrictive process – tall, narrow and a short expiratory phase. Based on the fact that his TLC is below 50% predicted, this would be classified as a "severe" restrictive defect. His DLCO is also markedly reduced indicating he has a reduced alveolarcapillary interface for gas exchange and suggesting that the cause of his restrictive process lies within the lung parenchyma. This patient was subsequent found to have idiopathic pulmonary fibrosis. His chest x-ray and CT images are shown below.



Chest CT Images



Case 8

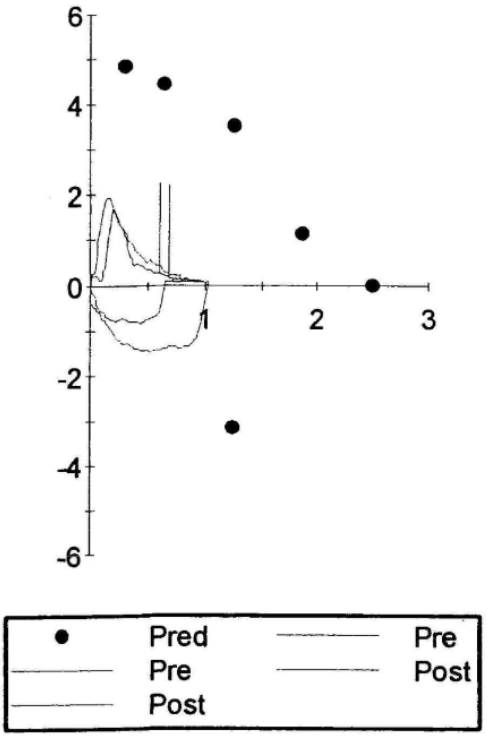
A 64 year-old woman presents with complaints of dyspnea and orthopnea. She is a life-long non-smoker. Her pulmonary function testing is as follows:

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	1.00	2.51	40	1.02	3
FEV_1 (L)	0.61	2.00	30	0.69	13
FEV_1/FVC (%)	61	80		67	10
RV (L)	1.15	1.55	74		
TLC (L)	2.08	4.04	52		
RV/TLC (%)	55	39			

Her spirometry is repeated with her in the upright and supine positions:

Test	**Upright**	**Supine**
FVC (L)	0.49	0.37
FEV_1 (L)	0.82	0.68
FEV_1/FVC (%)	0.60	0.54

Her flow volume loop is as follows:



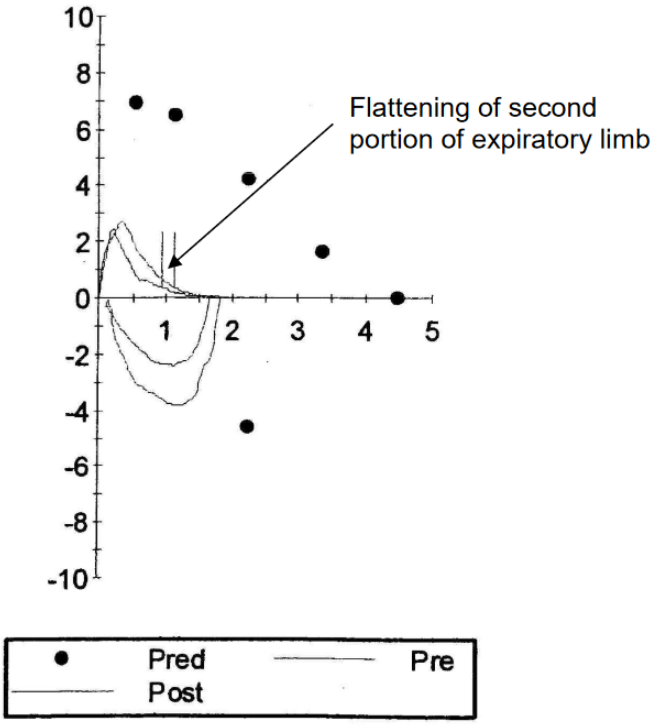
- This patient has a reduced FEV1 and FVC with a reduced FEV1/FVC ratio. She would, therefore, be classified as having an obstructive defect. However, she also has a low TLC (52% predicted).
- This is evidence of a restrictive defect and, therefore, this patient would be labeled as having a combined obstructiverestrictive defect.
- A DLCO is not provided which makes it difficult to determine if the cause of her restriction is due to a pulmonary parenchymal process or an extra-pulmonary process.
- An important clue comes from her history. The patient reports orthopnea. Although this is classically seen in patients with heart failure, it is not specific for this disease. Patients with diaphragmatic weakness can also present with this symptom. When they lie supine, gravity no longer exerts an effect on the diaphragm and abdominal contents and the patients have trouble getting their diaphragm to descend against the abdominal contents on inspiration. The presence of diaphragmatic weakness is confirmed by repeating her pulmonary function tests with her in the upright and supine positions. When she is supine, her FVC and FEV1 both fall by greater than

Case 9

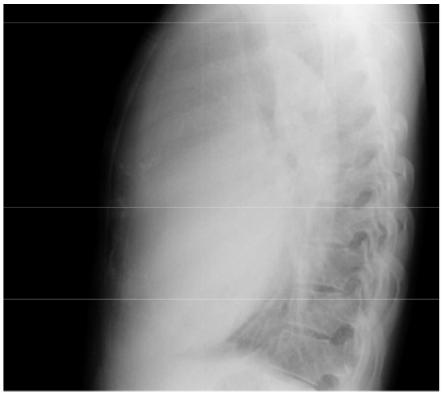
A 35 year-old previously healthy man presents with dyspnea, fevers, chills and night sweats for the past 2 months. He is a non-smoker with no concerning habits or occupational exposures. His pulmonary function tests are as follows:

	Pre-Bronchodilator (BD)		
Test	**Actual**	**Predicted**	**% Predicted**
FVC (L)	1.66	4.48	37
FEV_1 (L)	0.94	3.67	26
FEV_1/FVC (%)	57	82	
RV (L)	1.39	1.66	84
TLC (L)	3.06	5.96	51
RV/TLC (%)	45	29	

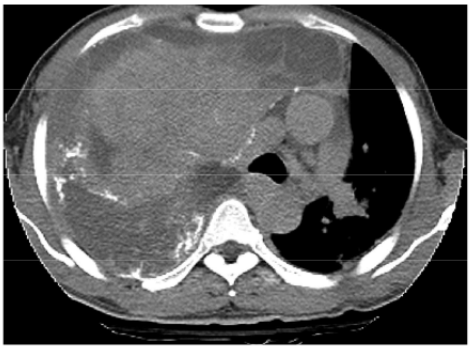
His flow volume loop is as follows:



- This patient has reduced FEV1 and FVC with a low FEV1/FVC ratio, consistent with an obstructive process. He also has a low TLC indicating he has a restrictive process as well. He would, therefore, be labeled as having a combined obstructive-restrictive defect. His obstructive defect would be classified as “very severe” based on his FEV1 of only 26% predicted while his restrictive process would be labeled as moderate given his TLC of 51% predicted. There is an interesting finding in his flow-volume loop as well. The expiratory limb appears to have two components. There is a steep component and then a second, flatter component over the latter half of exhalation. This pattern suggests that one lung may be emptying faster than the other and, therefore, that the slowly emptying lung might have an obstructing airway lesion. In fact, when the patient underwent chest x-ray imaging, he was found to have a dense opacity in the right chest. CT scanning revealed the presence of a large mass. This mass was so large it not only collapsed the right lung but also compressed the left lung causing lung restriction. It also compresses the airways (arrow in CT scan) on the right side leading to the obstruction to air-flow out of the viable right lung.

Chest CT



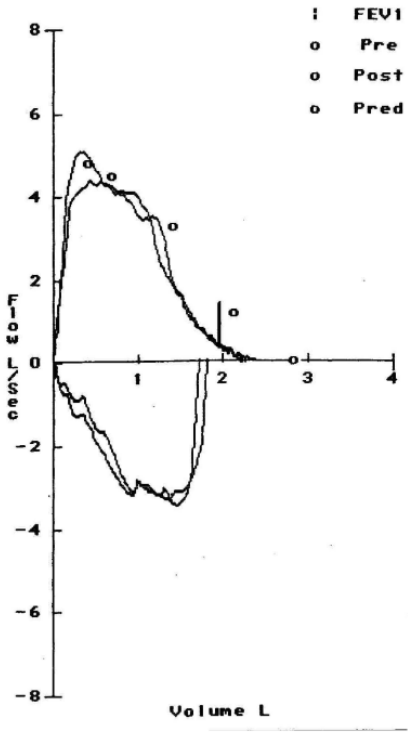

Case 10

A 53 year-old woman presents with increasing dyspnea on exertion. She denies cough, fevers, hemoptysis, weight loss or sweats. She was previously an active runner but has had to cut back significantly because of her symptoms with exercise. She does note occasional chest pain with exercise but has not had any syncope or palpitations. Her pulmonary function tests are as follows:

	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	2.38	2.87	83	2.23	-6
FEV_1 (L)	1.95	2.31	84	1.93	-1
FEV_1/FVC (%)	82	81		87	
RV (L)	1.69	1.58	107		
TLC (L)	4.26	4.36	98		
RV/TLC (%)	40	36			
DLCO corr	9.96	23.25	43		

DLCO is measured in ml/min/mmHg

Her flow volume loop is as follows:



- This patient has normal FEV1 and FVC and a preserved FEV1/FVC ratio. She also has a normal total lung capacity. As a result, there is no evidence of either obstructive or restrictive lung disease. The patient does have a reduced DLCO, however, indicating that she has a reduced alveolar-capillary interface for gas exchange. Based on her DLCO of 43% predicted, she would be labeled as having a “moderate” gas exchange abnormality. The finding of an isolated decreased in the DLCO (i.e. normal spirometry and lung volumes) is highly suggestive of a pulmonary vascular process such as pulmonary hypertension. This patient was, in fact, found to have pulmonary hypertension due to chronic thromboembolic disease.

Case 11

A 36 year-old woman presents with a several month history of worsening dyspnea on exertion and exercise limitation. She is a life-long non-smoker and has no history of asthma or other known pulmonary diseases. She has had to stop going out with her weekly running group because she can no longer keep up with her friends. Her pulmonary function testing is as follows:

	Pre-Bronchodilator (BD)		
Test	**Actual**	**Predicted**	**% Predicted**
FVC (L)	0.88	3.34	26
FEV_1 (L)	0.87	2.87	30
FEV_1/FVC (%)	99	86	
RV (L)	1.61	1.40	115
TLC (L)	2.49	4.73	53
RV/TLC (%)	65	29	
DLCO corr	21	26.6	78

- This patient has reduced FEV1 and FVC with a preserved FEV1/FVC ratio, a finding that is suggestive, but not diagnostic of a restrictive process.
- The presence of a reduced TLC confirms the presence of a restrictive defect.
- Based on the fact that her TLC is 53% of predicted, this would be labeled as a “moderate” restrictive defect.
- The patient has an essentially normal DLCO. Although the value is technically less than 80% of predicted, due to the inherent variability in this test, values in this range are considered normal.
- This suggests that her alveolar-capillary interface for gas exchange for normal and further suggests that her restrictive process is due to a

- This patient was sent for further pulmonary function testing.
- She had a 17% drop in her FVC from the sitting to supine position. Her maximum inspiratory pressures (– 35 cm H20), maximum expiratory pressure (- 50 cm H20) and peak cough flow (180 L/min) were all markedly reduced relative to normal values, findings that are indicative of muscle weakness.
- Upon further evaluation by a neurologist, the patient was found to have Limb Girdle Muscular Dystrophy.

Case 12

A 44 year-old woman with cirrhosis secondary to chronic alcohol abuse and Hepatitis C presents with complaints of increasing dyspnea. She reports that her dyspnea is worse when she is sitting upright or walking but improves when she is lying flat. She is an active cigarette smoker. On exam, she has a room air oxygen saturation of 88% in the sitting position and a room air oxygen saturation of 96% in the supine position. Her pulmonary function testing is as follows.

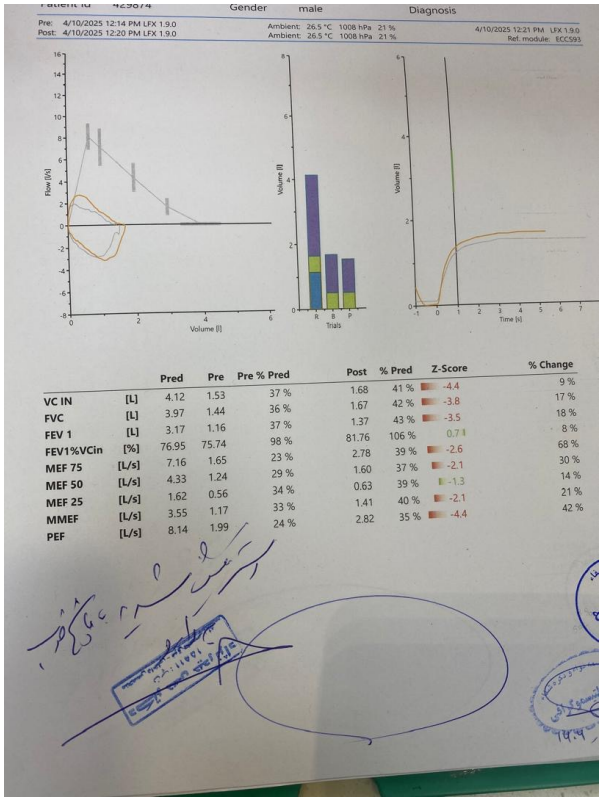
	Pre-Bronchodilator (BD)			Post- BD	
Test	**Actual**	**Predicted**	**% Predicted**	**Actual**	**% Change**
FVC (L)	3.94	3.69	107%	3.86	-2
FEV_1 (L)	2.76	3.03	91%	2.85	3
FEV_1/FVC (%)	70	82			
RV (L)	1.89	1.86	102		
TLC (L)	5.67	5.40	105		
RV/TLC (%)	33	33			
DLCO corr	10.22	28.22	36		

DLCO is measured in ml/min/mmHg

A flow-volume loop is not available for this case.

- The patient has normal FVC and FEV1 but a reduced FEV1/FVC ratio.
- Even though the FEV1 is within the normal range, she would, therefore, be classified as having mild obstructive lung disease because of the reduced FEV1/FVC ratio.
- There is no evidence of a bronchodilator response and the lung volumes are normal.
- Her DLCO, however, is markedly reduced and the reduction is far out of proportion to the abnormalities seen in her spirometry.
- This suggests that she may, in fact, have a pulmonary vascular problem.
- Patients with chronic liver disease are predisposed to several pulmonary vascular problems including portopulmonary hypertension and hepatopulmonary syndrome.
- The latter disorder is marked by the presence of intrapulmonary shunts, which occur predominantly at the bases of the lungs. Both of these problems can cause an isolated reduction in the DLCO on pulmonary function testing

- 57 yrs old farmer, non smoker ,referred with dyspnea on exertion , difficult breathing at rest , hx of diaphragm weak ness . Previous neurologic exam , possible ALS.
- PE decreased breath sound with decreased chest expansion . Otherwise normal
- Sonography decreased bilateral diaphragm motion .
- Spirometry , fvc=36% pred, fev1=37% pred , fev1/fvc%= 75, PEF= 24%
- After bronchodilator , FVC=42% (17% increase), FEV1=43%(18% increase), PEF=42%



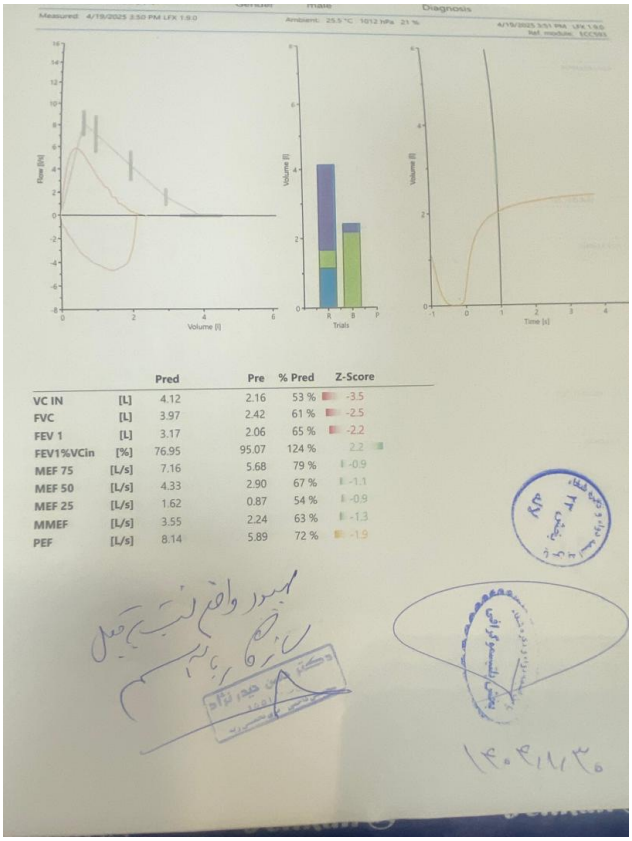
Gender male Diagnosis

Pre: 4/10/2025 12:14 PM LFX 1.9.0
Post: 4/10/2025 12:20 PM LFX 1.9.0

Ambient: 26.5 °C 1008 hPa 21 %
Ambient: 26.5 °C 1008 hPa 21 %

4/10/2025 12:21 PM LFX 1.9.0
Ref. module: ECC593

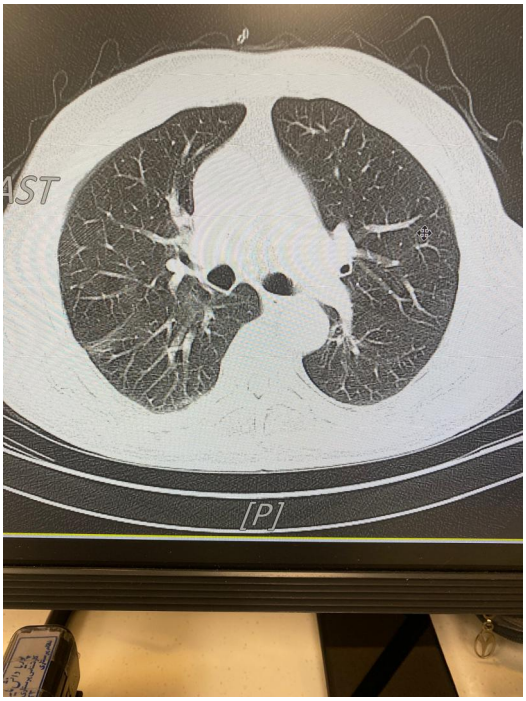
		Pred	Pre	Pre % Pred	Post	% Pred	Z-Score	% Change
VC IN	[L]	4.12	1.53	37 %	1.68	41 %	-4.4	9 %
FVC	[L]	3.97	1.44	36 %	1.67	42 %	-3.8	17 %
FEV 1	[L]	3.17	1.16	37 %	1.37	43 %	-3.5	18 %
FEV1%VCin	[%]	76.95	75.74	98 %	81.76	106 %	0.7	8 %
MEF 75	[L/s]	7.16	1.65	23 %	2.78	39 %	-2.6	68 %
MEF 50	[L/s]	4.33	1.24	29 %	1.60	37 %	-2.1	30 %
MEF 25	[L/s]	1.62	0.56	34 %	0.63	39 %	-1.3	14 %
MMEF	[L/s]	3.55	1.17	33 %	1.41	40 %	-2.1	21 %
PEF	[L/s]	8.14	1.99	24 %	2.82	35 %	-4.4	42 %

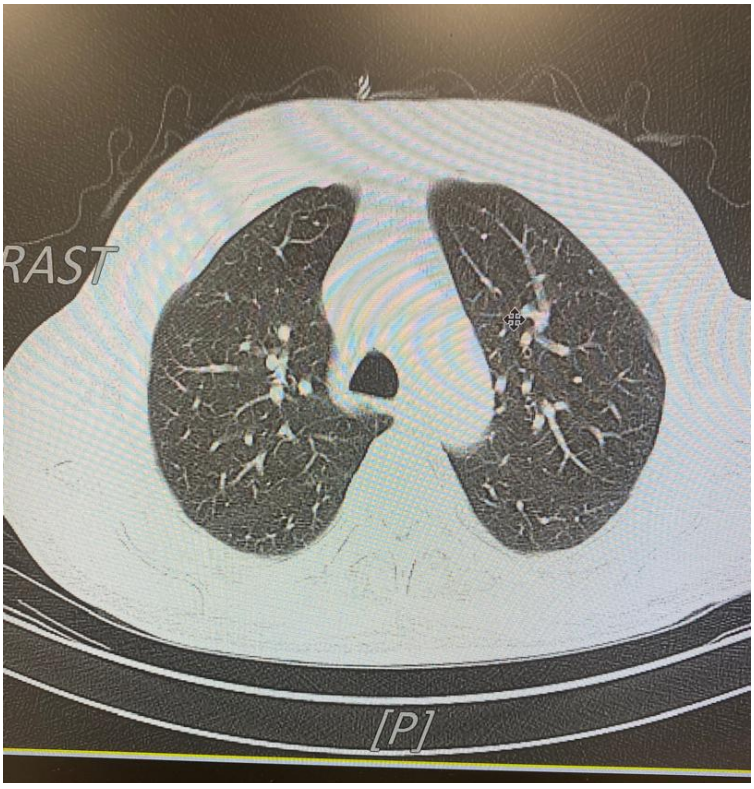


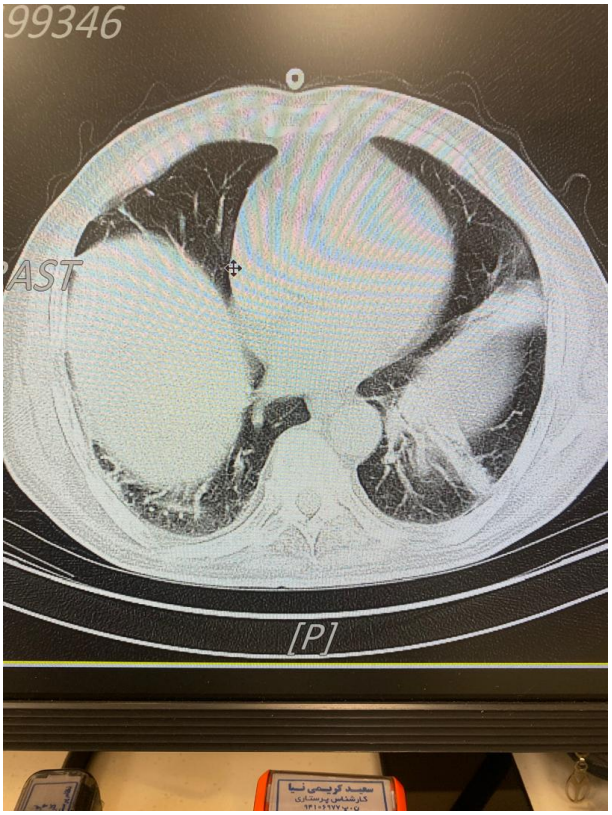
Diagnosis

Measured: 4/19/2025 3:50 PM LFX 1.9.0
Ambient: 25.5 °C 1012 hPa 21 %
Ref. module: ECC593

		Pred	Pre	% Pred	Z-Score
VC IN	[L]	4.12	2.16	53 %	-3.5
FVC	[L]	3.97	2.42	61 %	-2.5
FEV 1	[L]	3.17	2.06	65 %	-2.2
FEV1%VCin	[%]	76.95	95.07	124 %	2.2
MEF 75	[L/s]	7.16	5.68	79 %	-0.9
MEF 50	[L/s]	4.33	2.90	67 %	-1.1
MEF 25	[L/s]	1.62	0.87	54 %	-0.9
MMEF	[L/s]	3.55	2.24	63 %	-1.3
PEF	[L/s]	8.14	5.89	72 %	-1.9



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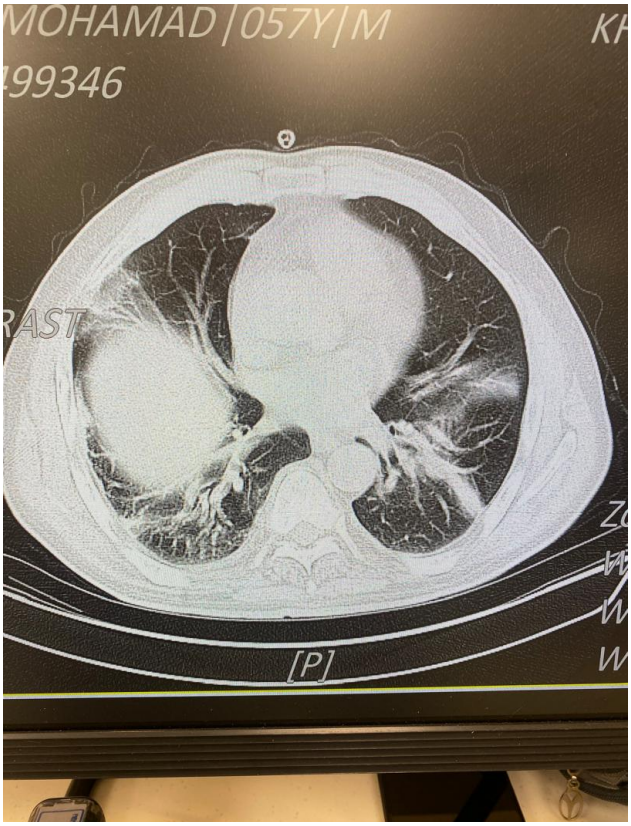
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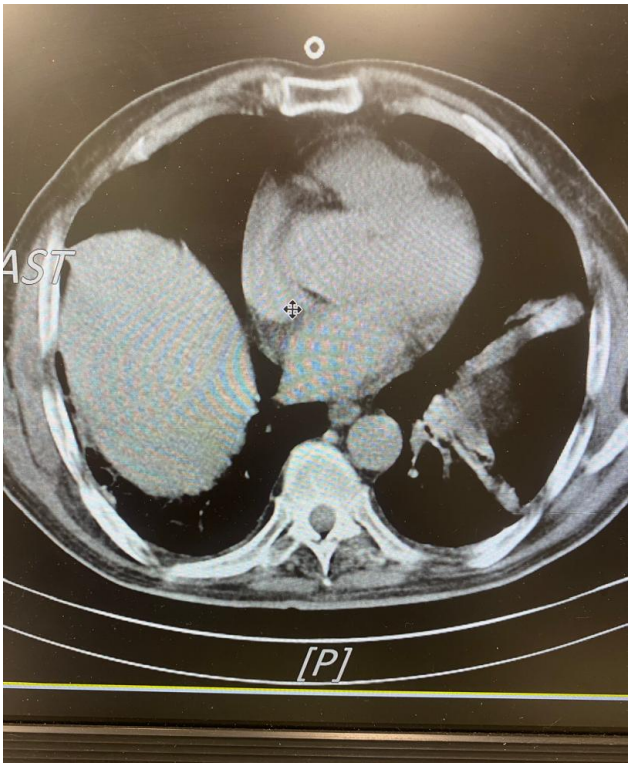
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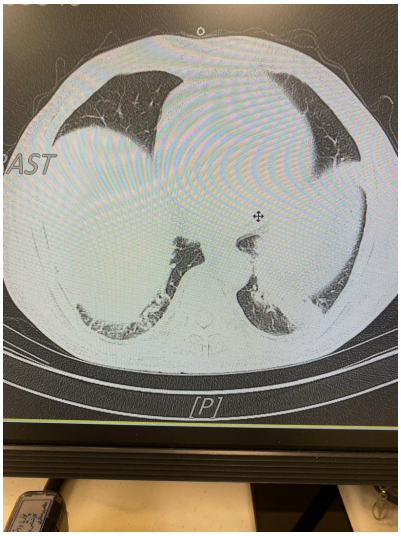
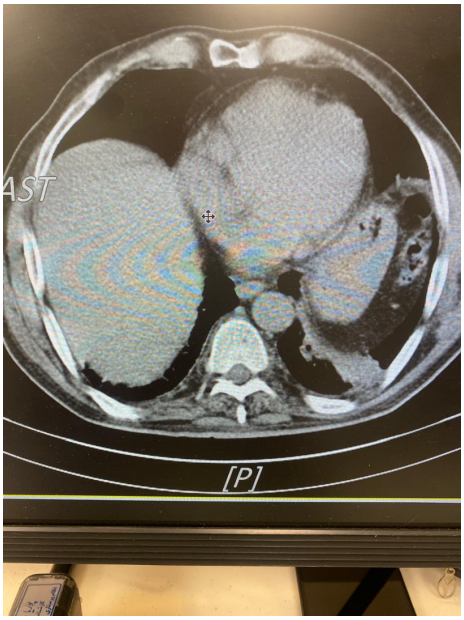




HR : 91 BPM

HX of palpitation

LV : small LV size, with normal systolic function, **GEF: 55-60 %** ,no LVH, base septum : 11mm(resulting in LVOT systolic turbulency) ,No RWMA,
[LVOT VTI:21 cm], normal LV diastolic function

RV: normal RV size [RVEDD: 3.2cm] with normal RV systolic function, TAPSE:16 mm, RVs: 11cm/sec

LA : top normal LA size, LAD: 3.8 cm , LA area : 20 cm2

RA: Normal RA size, RA area : 15 cm2

MV: trivial MR, no MS,

AV: **tricuspid AV** , No AI, no AS, Peak PG: 6 mmHg, Mean PG:3 mmHg

TV: **mild TR, no TS, TRG: 22 mmHg, PAPs: 30 mmHg, no PH**

PV: mild PI, no PS, Peak PG : 3 mmHg

AORTA: dilated aortic Root : 3.6 cm , ascending aorta : 3.6 cm , Descending thoracic aorta : cm

Pulmonary artery : size of MPA is normal , MPA: 2 cm

IAS: IAS is redundant.

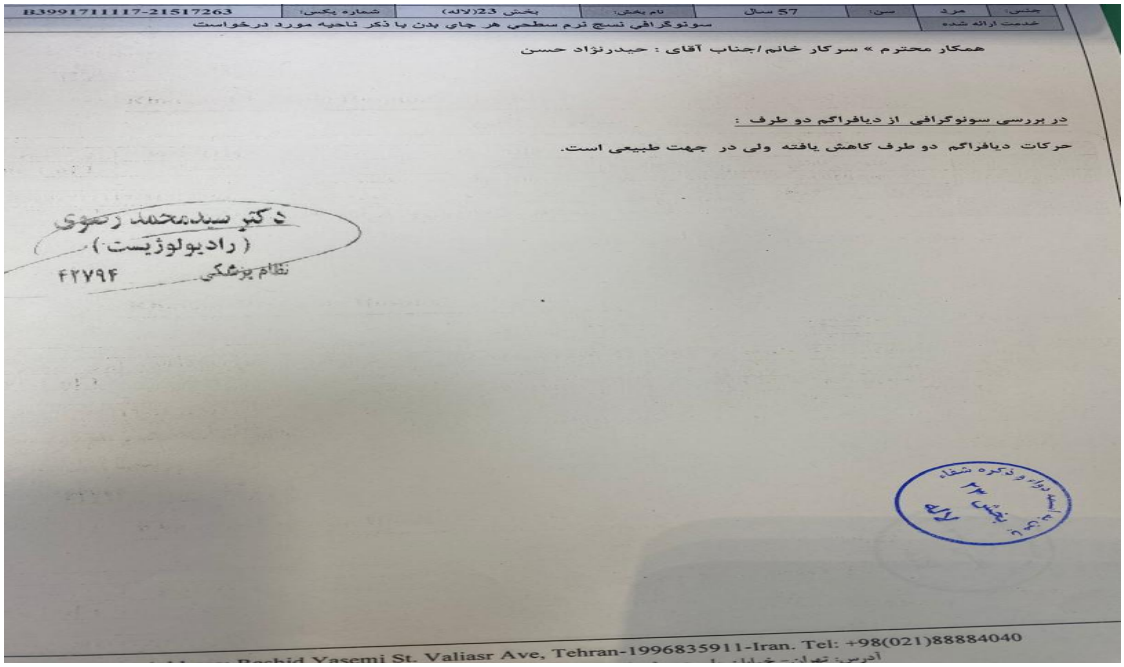
IVS: IVS is intact, no VSD.

IVC: size of IVC is normal with more than 50% collapse

Pericardium: no PE

TDI: Tissue Doppler Imaging showed: e' of septum:9 cm/s, e' of lateral : 11 cm/s .

Rec: HR control,ECG holter



جنس:	مرد	سن:	57 سال	نام بخش:	بخش 23(لاله)	شماره پکس:	B39917111I7-21517263
خدمت ارائه شده	سونوگرافی نسج نرم سطحی هر جای بدن یا ذکر ناحیه مورد درخواست						

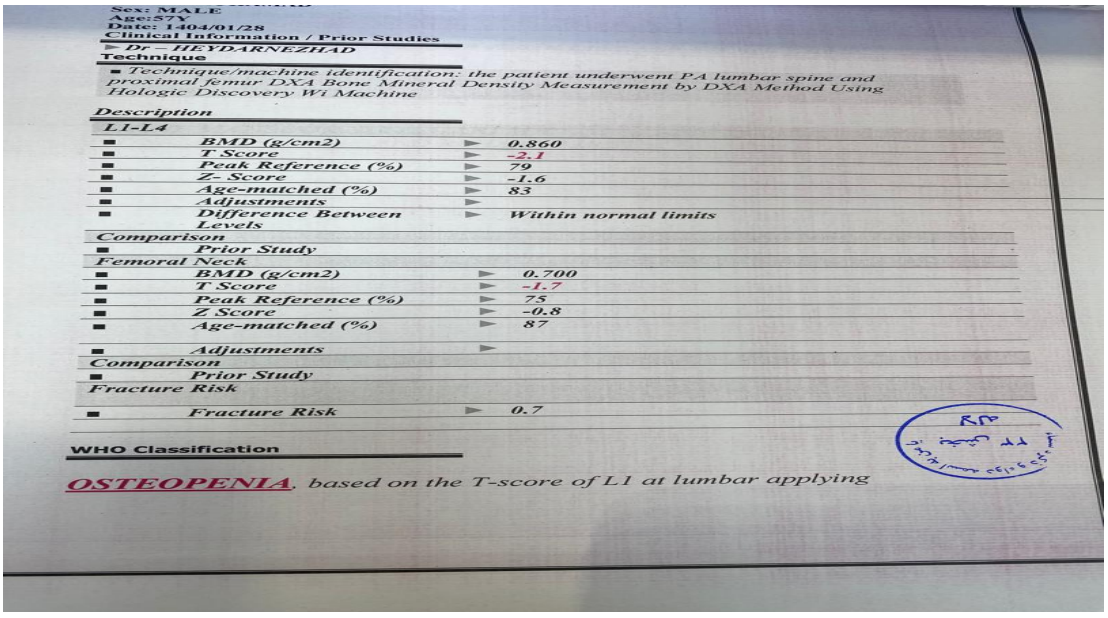
همکار محترم » سرکار خانم/جناب آقای : حیدرنژاد حسن

در بررسی سونوگرافی از دیافراگم دو طرف :

حرکات دیافراگم دو طرف کاهش یافته ولی در جهت طبیعی است.

دکتر سیدمحمد رضوی
(رادیولوژیست)
۴۲۷۹۴ نظام پزشکی

Rashid Yasemi St. Valiasr Ave, Tehran-1996835911-Iran. Tel: +98(021)88884040



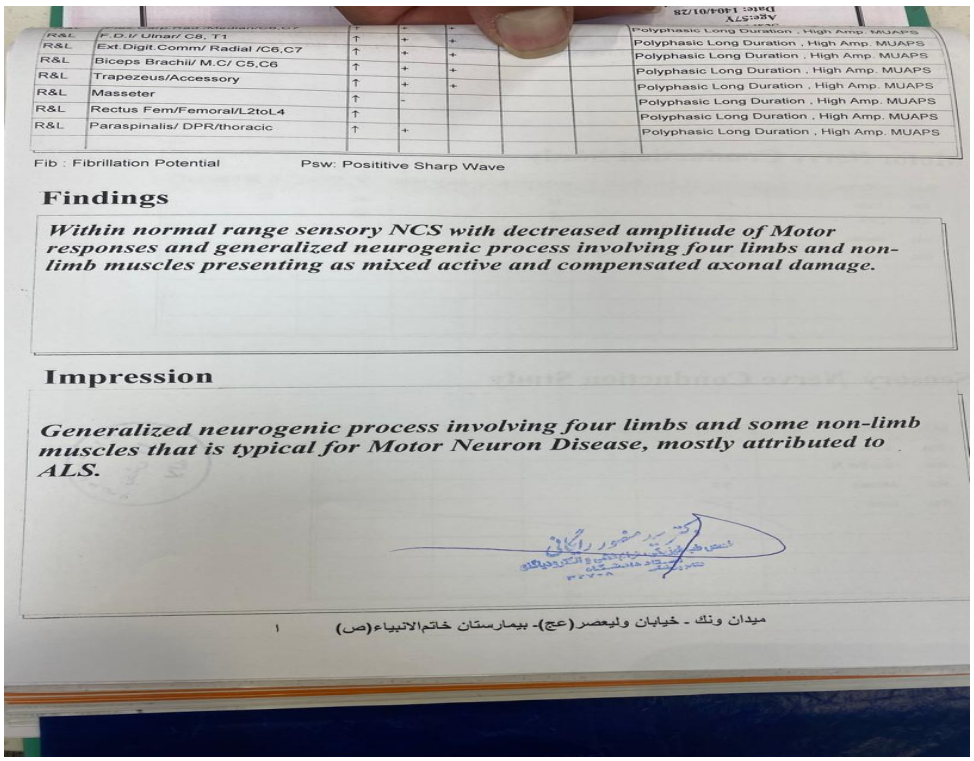
Sex: MALE
Age:57Y
Date: 1404/01/28
Clinical Information / Prior Studies
Dr HEYDARNEZHAD
Technique
- Technique/machine identification: the patient underwent PA lumbar spine and proximal femur DXA Bone Mineral Density Measurement by DXA Method Using Hologic Discovery Wi Machine

Description

L1-L4		
BMD (g/cm2)	►	0.860
T Score	►	-2.1
Peak Reference (%)	►	79
Z- Score	►	-1.6
Age-matched (%)	►	83
Adjustments	►	
Difference Between Levels	►	Within normal limits
Comparison		
Prior Study		
Femoral Neck		
BMD (g/cm2)	►	0.700
T Score	►	-1.7
Peak Reference (%)	►	75
Z Score	►	-0.8
Age-matched (%)	►	87
Adjustments	►	
Comparison		
Prior Study		
Fracture Risk		
Fracture Risk	►	0.7

WHO Classification

OSTEOPENIA, based on the T-score of L1 at lumbar applying



R&L	F.D.I/ Ulnar/ C8, T1	↑	+	+			Polyphasic Long Duration , High Amp. MUAPS
R&L	Ext.Digit.Comm/ Radial /C6,C7	↑	+	+			Polyphasic Long Duration , High Amp. MUAPS
R&L	Biceps Brachii/ M.C/ C5,C6	↑	+	+			Polyphasic Long Duration , High Amp. MUAPS
R&L	Trapezeus/Accessory	↑	+	+			Polyphasic Long Duration , High Amp. MUAPS
R&L	Masseter	↑	-				Polyphasic Long Duration , High Amp. MUAPS
R&L	Rectus Fem/Femoral/L2toL4	↑					Polyphasic Long Duration , High Amp. MUAPS
R&L	Paraspinalis/ DPR/thoracic	↑	+				Polyphasic Long Duration , High Amp. MUAPS

Fib : Fibrillation Potential Psw: Posititive Sharp Wave

Findings

Within normal range sensory NCS with dectreased amplitude of Motor responses and generalized neurogenic process involving four limbs and non-limb muscles presenting as mixed active and compensated axonal damage.

Impression

Generalized neurogenic process involving four limbs and some non-limb muscles that is typical for Motor Neuron Disease, mostly attributed to ALS.