Interpretation of

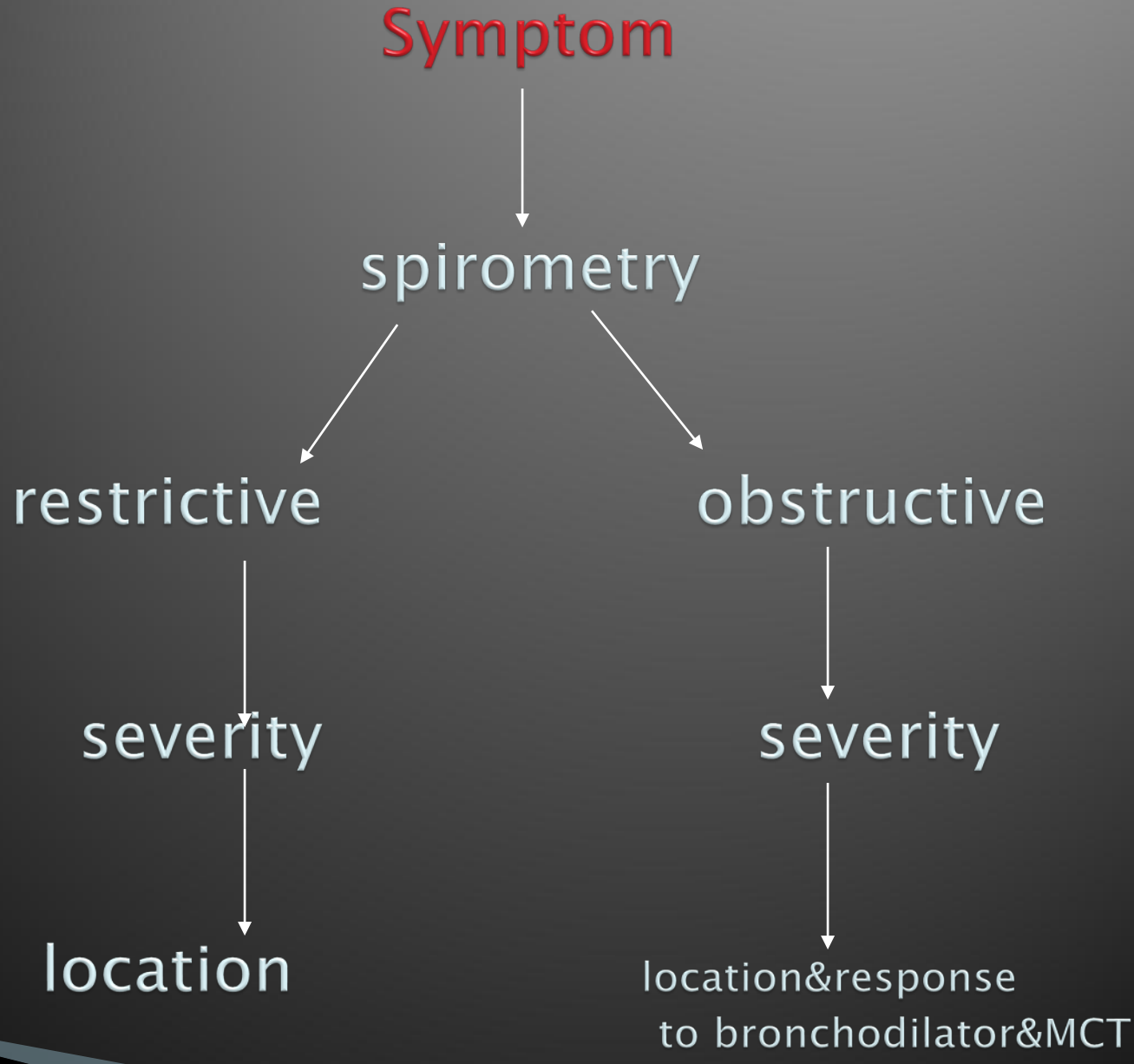
SPIROMETRY

ABOLFAZL MOZAFARI
PULMONOLOGIST- INTENSIVIST
ASSOCIATED PROFESSOR OF ISLAMIC AZAD UNIVERSITY OF QOM

Pulmonary function test:

1. **Spirometry**
2. Lung volumes
3. Gas transfer
4. Bronchial challenge
5. CPET

SPIROMETRY


Symptom
spirometry
restrictive
obstructive
severity
severity
location
location&response
to bronchodilator&MCT

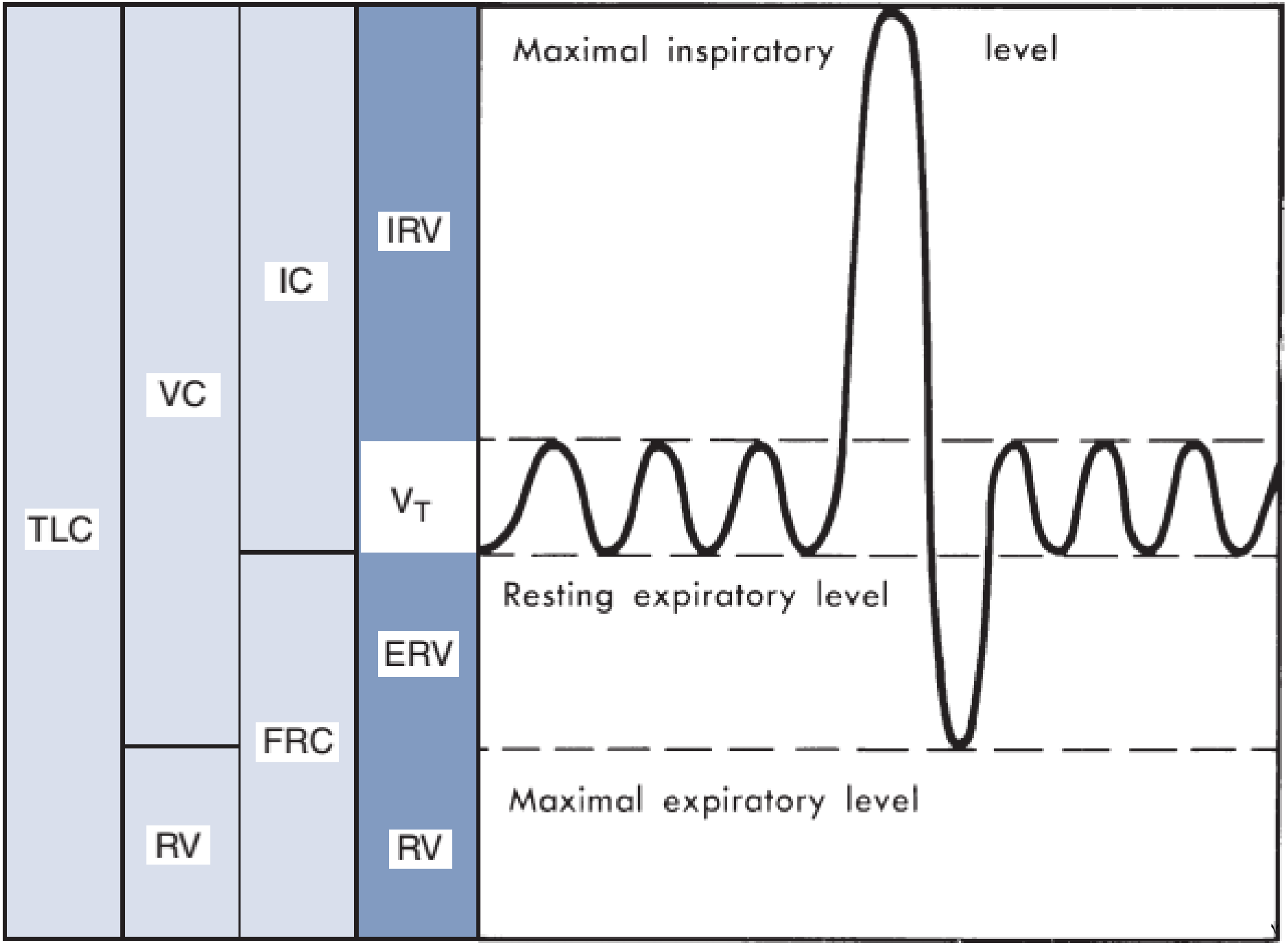
➢ *Indications.*

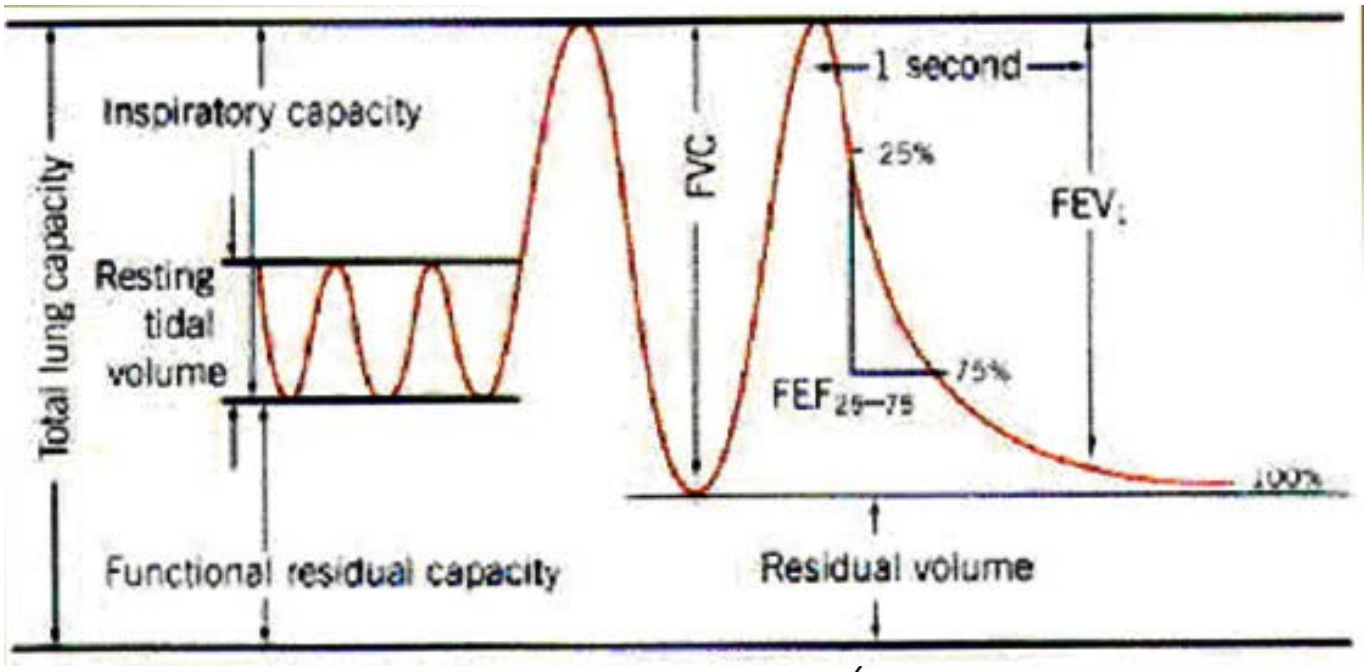
Dyspnea
wheeze
chronic cough
Identifying High-Risk Smokers.
Occupational Surveys
Preoperative Assessment
Evaluation of Impairment
Evaluation of Treatment
Evaluation of the Natural History of Disease
Baseline Function
severity of disease
prognosis

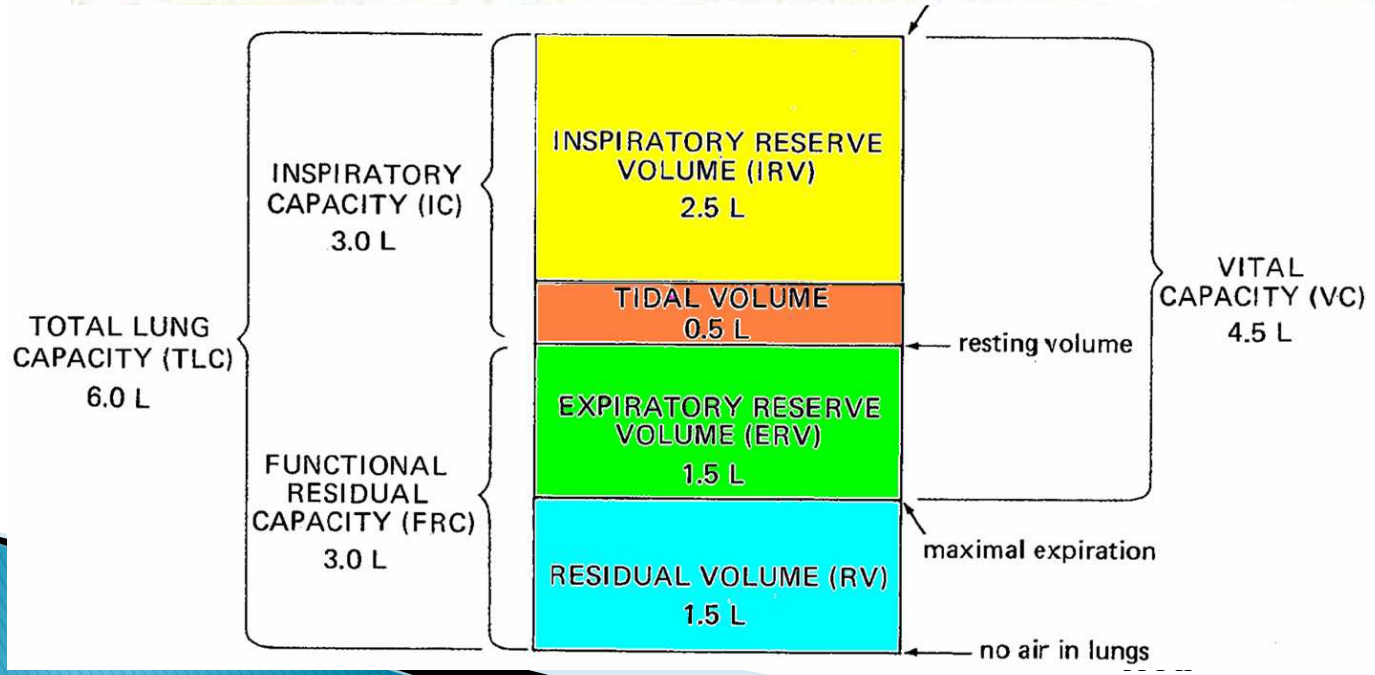
Contraindication of spirometry

recent stroke, eye surgery, thoracic/
abdominal surgery or pneumothorax, uncontrolled hypertension or hypotension,and known thoracic, aortic, or cerebral aneurysm.
Myocardial infarction within the last month

Conditions that can lead to a suboptimal test:
Chest, abdominal, facial, oral pain
Stress incontinence
Dementia, confusion


TLC
VC
IC
IRV
V_T
ERV
FRC
RV
RV
Maximal inspiratory level
Resting expiratory level
Maximal expiratory level


Inspiratory capacity
Total lung capacity
Resting tidal volume
Functional residual capacity
FVC
1 second
25%
75%
FEV1
FEF25–75
100%
Residual volume


INSPIRATORY RESERVE VOLUME (IRV)
2.5 L
INSPIRATORY CAPACITY (IC)
3.0 L
TIDAL VOLUME
0.5 L
resting volume
TOTAL LUNG CAPACITY (TLC)
6.0 L
EXPIRATORY RESERVE VOLUME (ERV)
1.5 L
VITAL CAPACITY (VC)
4.5 L
FUNCTIONAL RESIDUAL CAPACITY (FRC)
3.0 L
maximal expiration
RESIDUAL VOLUME (RV)
1.5 L
no air in lungs

Perform an FVC Maneuver

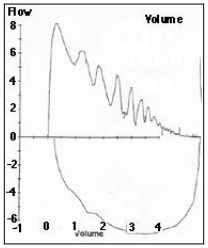
1. Tasks common to all procedures
   a. Calibrate and prepare equipment
   b. Review order
   c. Introduce yourself and identify patient according to institutional policies
   d. Describe and demonstrate procedure.
2. Have the subject sit upright with feet flat on the floor.
3. Subject's chin should be upright with the neck slightly extended.
4. The mouthpiece should rest on top of the tongue, gently biting down with their teeth, and sealing their lips firmly around the mouthpiece. Noseclips are recommended, but the maneuver can often be performed without.
5. With the spirometer hose or flow sensor in their hand, have them breathe quietly for several breaths on the mouthpiece (closed-circuit technique) and then take a maximal inspiration or alternatively have them take a maximal inspiration (open-circuit technique) and immediately place the mouthpiece in their mouth once they reach TLC. Some type of active encouragement (be a good coach/cheerleader) by the technologist may be helpful in conveying the necessity of the subject to take their deepest breath (e.g., "in, in, in"/"up, up, up"; raising their arms)
6. Instruct them to blast their air out forcefully. The technologist may wish to choose an action (e.g., clap their hands, snap their fingers, or stomp their foot) or a word (e.g., "blast," "snap,") to convey the urgency of the maneuver.
7. Encourage them to continue to blow (verbal cues, "keep blowing"/"blow, blow, blow") until empty.
8. If the subject gets lightheaded or complains of dizziness or shortness of breath, make sure to allow extra time between maneuvers.
9. Perform until acceptability and repeatability criteria are achieved (see Criteria for Acceptability 2-2).
10. Note comments related to test quality.

CRITERIA FOR ACCEPTABILITY 2-2

FVC Maneuver

1. Maximal effort; no cough or glottic closure during the first second; no leaks or obstruction of the mouthpiece.
2. Good start-of-test; back-extrapolated volume less than 5% of FVC or 150 mL, whichever is greater.
3. Tracing shows 6 seconds of exhalation (3 seconds for children) or an obvious plateau; no early termination or cutoff; or subject cannot or should not continue to exhale.
4. Three acceptable spirograms obtained; two largest FVC values within 150 mL; two largest FEV_1 values within 150 mL.
5. Report the highest FVC and highest FEV_1, even if they come from separate maneuvers. The FEV_1/FVC ratio is derived from these values.

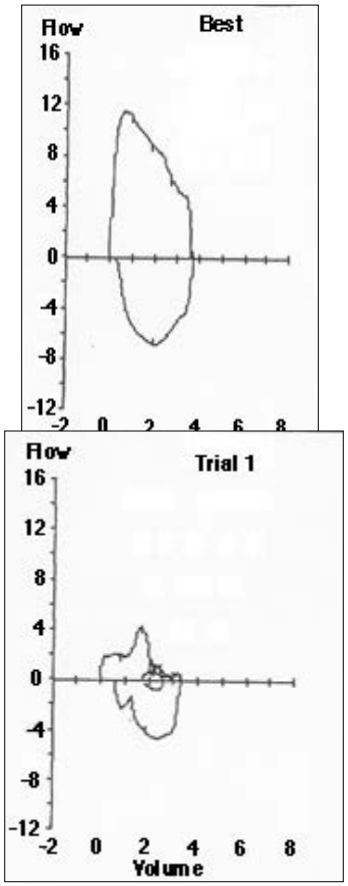
From ATS-ERS Task Force, 2005.

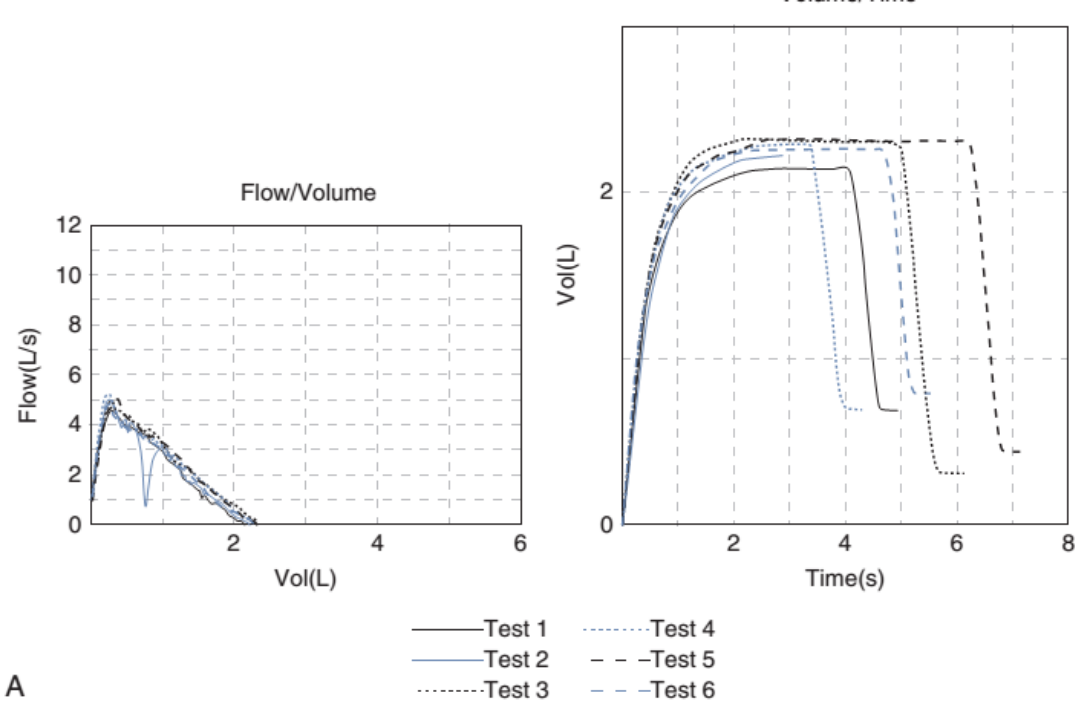


Acceptability Criteria

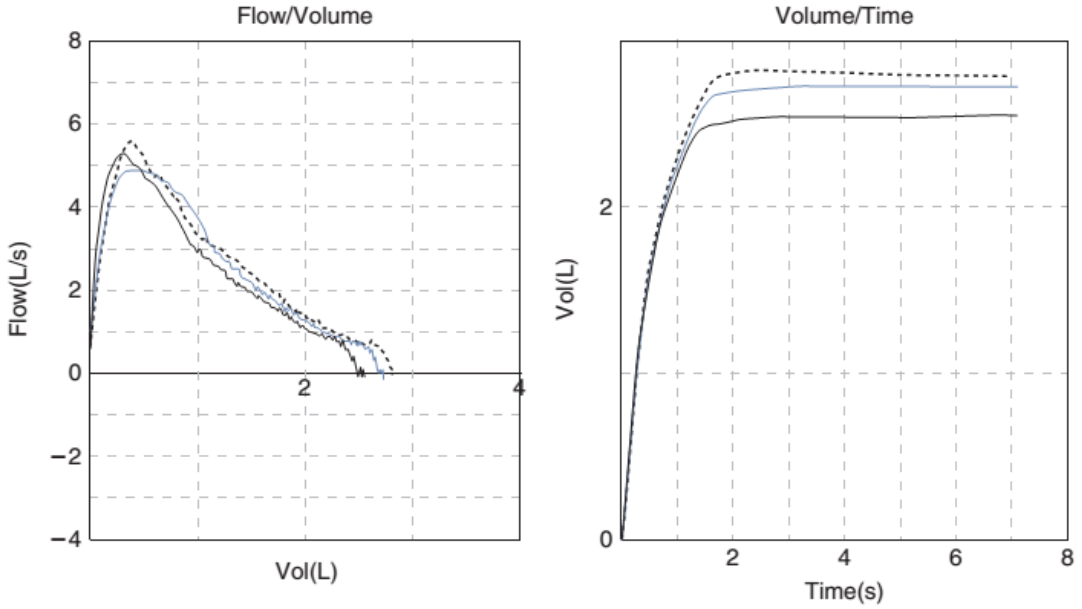
free from artifacts:

- Cough or glottis closure during the first second of exhalation
- Eary termination or cutoff
- Variable effort
- Leak
- Obstructed mouthpiece
- Have good starts
- Have a satisfactory exhalation 6 s of exhalation

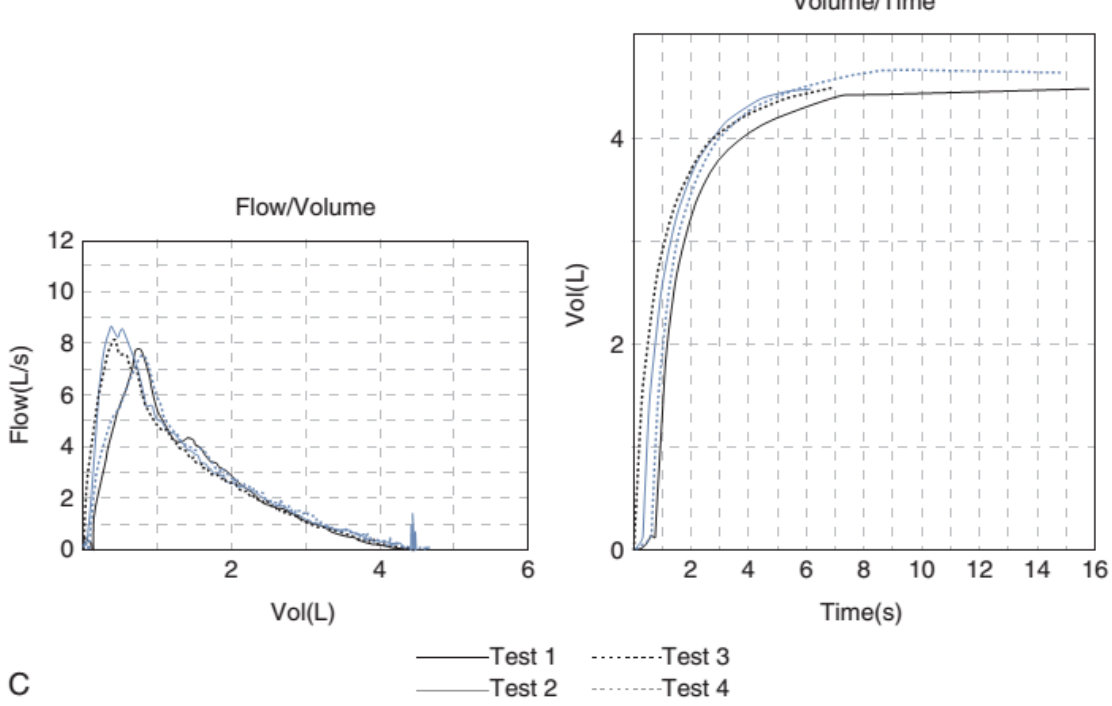



Flow/Volume
Flow(L/s)
Vol(L)
Vol(L)
Time(s)
Test 1
Test 2
Test 3
Test 4
Test 5
Test 6

A

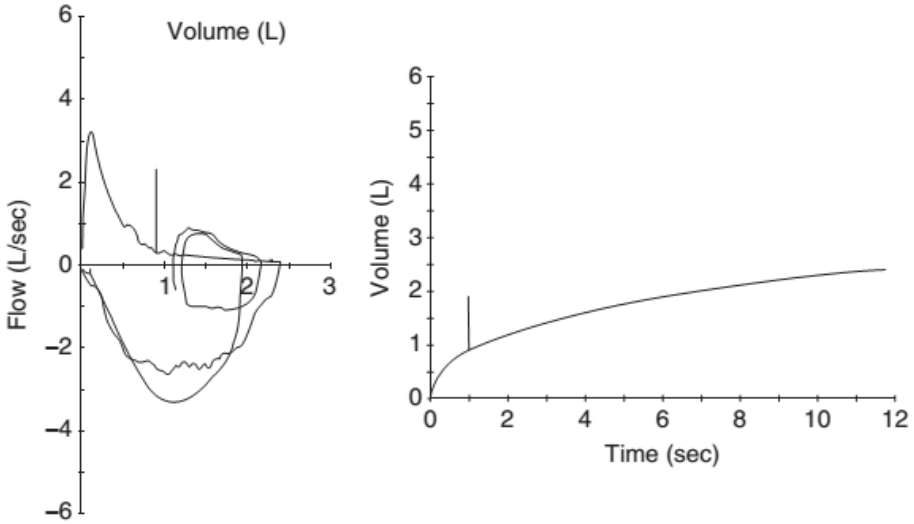

Flow/Volume
Volume/Time
Flow(L/s)
Vol(L)
Vol(L)
Time(s)
Test 1
Test 2
Test 3

B



C

GURE 2-11 cont'd **(C)** Test 1 demonstrates excessive back extrapolation volume secondary to a slow start. This will cause an erestimation of the FEV_1.



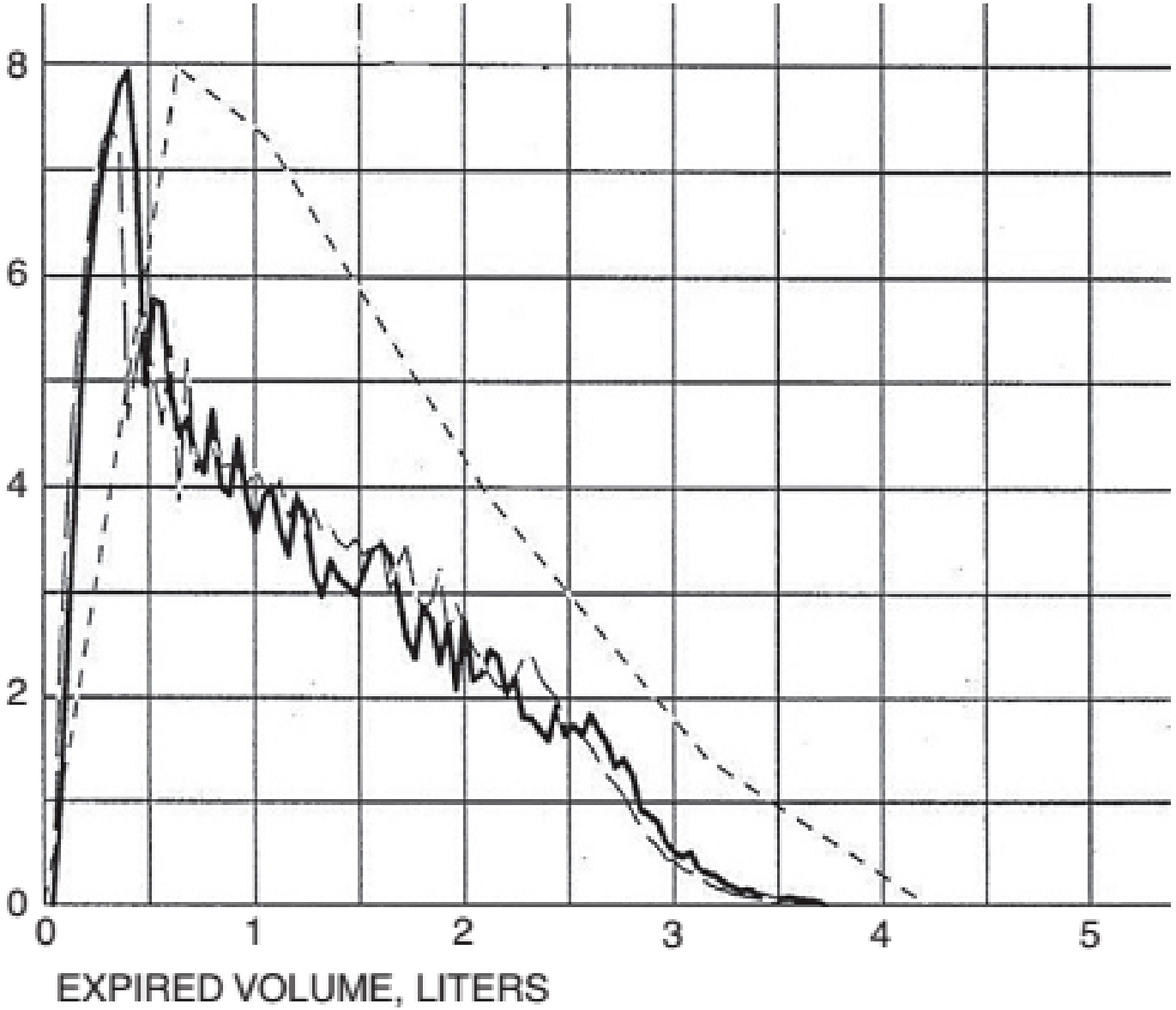


FIGURE 2-14 The "saw tooth" pattern, sometimes termed "redundant tissue of the airway," is sometimes seen in subjects with obstructive sleep apnea.

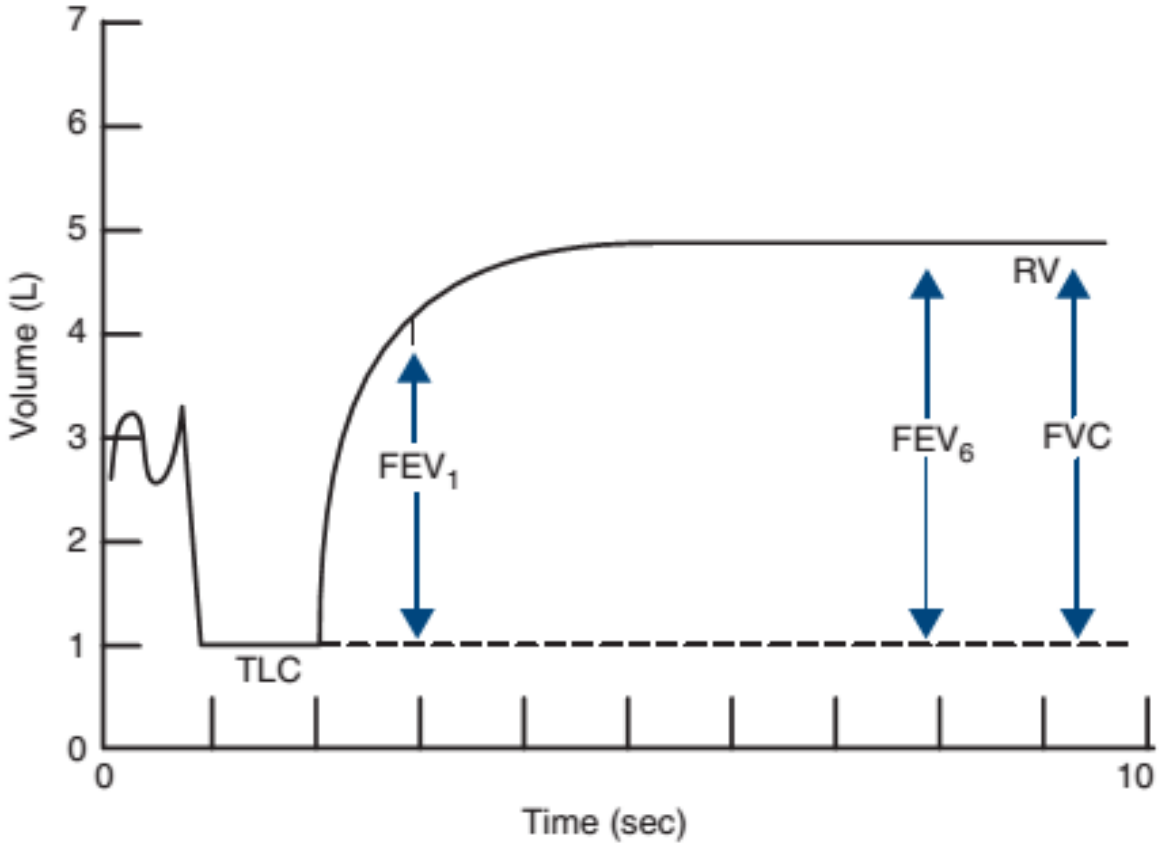


FIGURE 2-4 Determination of FEV_T values from an FVC maneuver. Various FEV_T values can be measured from the volume-time display of an FVC effort. FEV at intervals of 1 and 6 seconds, along with the FVC, are shown (*arrows*). FEV_1 is the most commonly used index of airflow. FEV_6 is sometimes used as a surrogate for FVC in patients with airway obstruction. Precise timing and acceptable start-of-test are required to determine FEV_T values accurately (Criteria for Acceptability 2-2).

The ATS-ERS recommends that spirometers measure FVC for at least 15 seconds

An alternative to measuring FVC in severely obstructed patients is to use FEV6 and allows the FEV1/FEV6 to be used as an index of obstruction

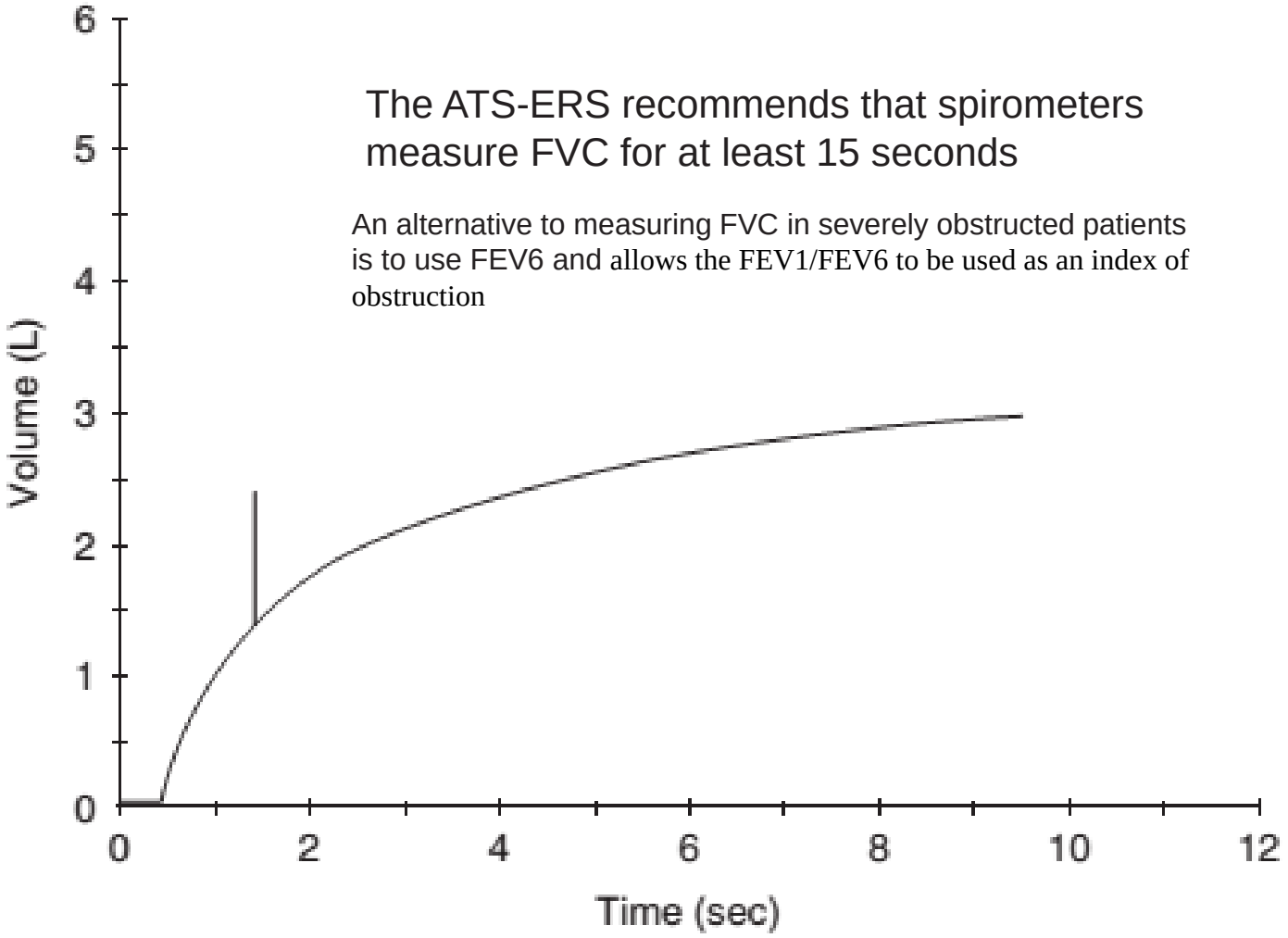


FIGURE 2-7 Volume-time FVC tracing from a patient with severe airway obstruction. A tick mark notes the point at which the patient exhaled his FEV_1. A significant volume is exhaled after the first second, and the tracing does not show an obvious plateau.

the severity of obstruction in a combined restrictive and obstructive defect is typically overestimated when basing severity solely on the reduction in FEV1.

Some patients with moderate or severe restriction have an FEV1 nearly equal to the VC.

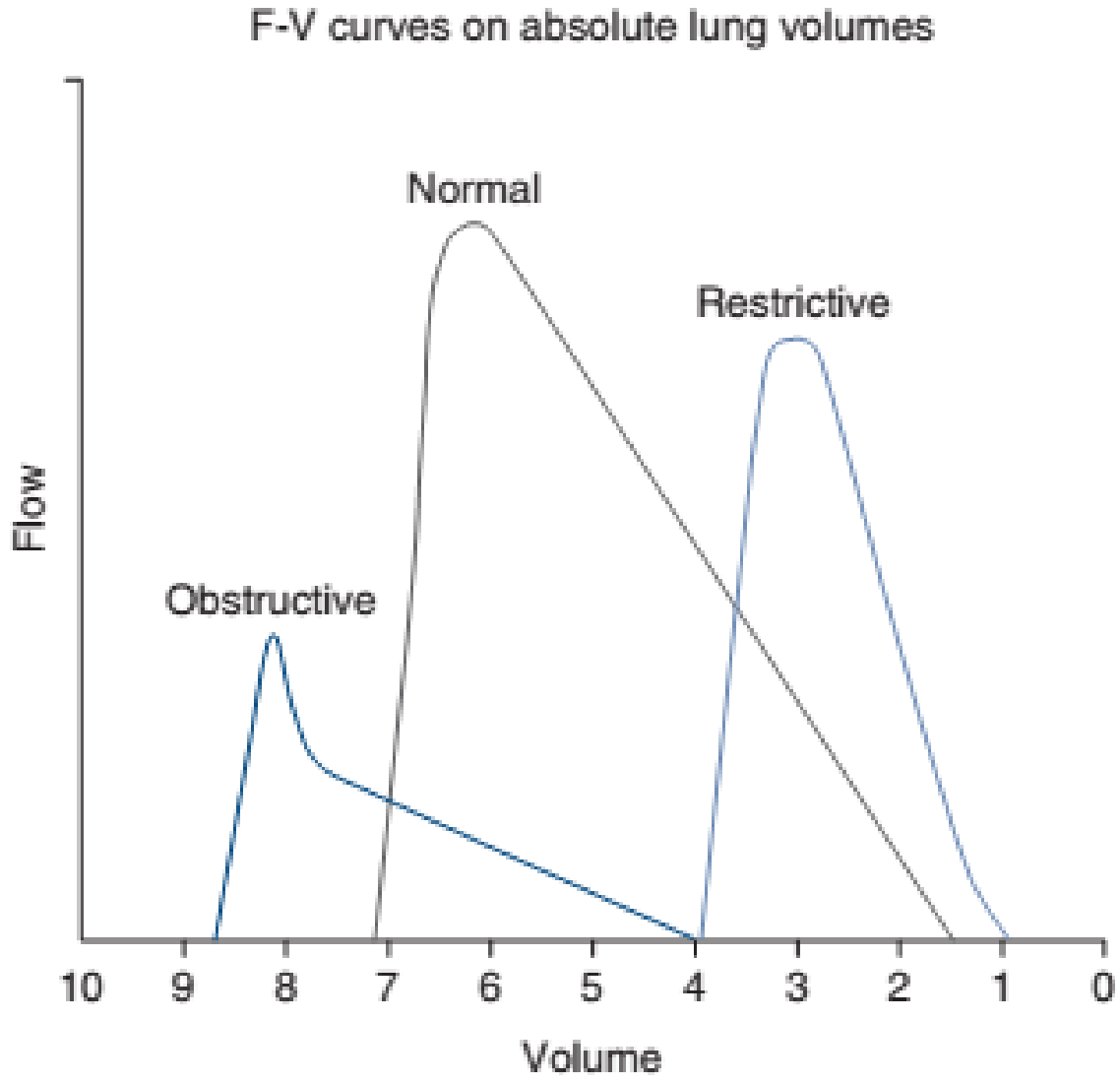
when the FVC and FEV1/VC ratio are both normal, restriction, as defined by a low TLC, is very unlikely.

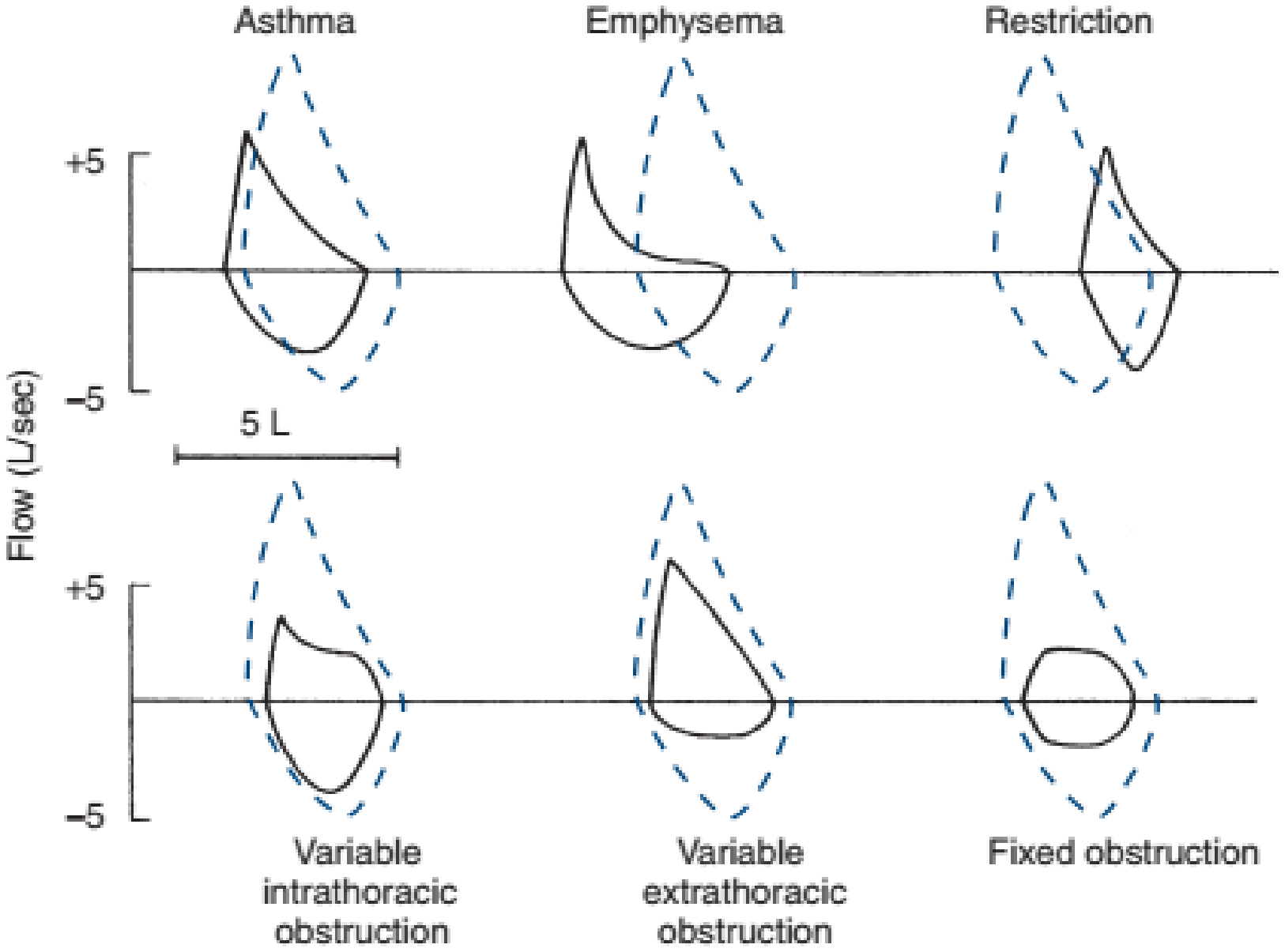
- If FEV1, FEV1/FVC, and FEF25-75% all are normal, the patient has a normal PFT.

- If both FEV1 and FEV1/FVC are normal, but FEF25-75% is ≤ 60% ,then think about early obstruction or small airways obstruction.

- If FEV1 ≤ 80% and FEV1/FVC ≤ 70%, there is obstructive defect, if FVC is normal, it is pure obstruction. If FVC ≤ 80% , possibility of additional restriction is there, get lung volume to confirm.

- If FEV1 ≤ 80% , FVC ≤ 80% and FEV1/FVC ≥ 70% , there is restrictive defect, get lung volumes to confirm.


F-V curves on absolute lung volumes
Normal
Restrictive
Obstructive
Flow
10
9
8
7
6
5
4
3
2
1
0
Volume


Asthma
Emphysema
Restriction
+5
−5
5 L
Flow (L/sec)
+5
−5
Variable intrathoracic obstruction
Variable extrathoracic obstruction
Fixed obstruction

Use an MDI

1. Shake the MDI; activate once to prime and check contents. If empty, replace.
2. Hold the MDI mouthpiece slightly away from the patient's open mouth or if a spacer is used (preferred method).
3. Place the spacer mouthpiece between the lips, per the manufacturer's instructions.
4. As the patient inspires slowly from the resting expiratory level, activate the MDI.
5. Have the patient continue slowly inhaling to maximal inspiration.
6. Have patient hold the breath for 5 to 10 seconds, followed by a slow exhalation.
7. Repeat inhalations as indicated (see text). Inhalations can be repeated at 30-second intervals.

Bronchodilator Studies

1. Are the prebronchodilator and postbronchodilator measurements acceptable? Repeatable within 150 mL? If not, postbronchodilator changes may be erroneous.
2. Is there a 12% or greater improvement in FEV_1 or FVC? Is there also a 200-mL increase? If so, there is a significant improvement.
3. No significant improvement observed? Trial of bronchodilator therapy still may be recommended, if clinically indicated.

Illustration of Bronchodilator Response

Test	Prebronchodilator	Postbronchodilator	Absolute (%) Change
FVC (L)	2.80	3.25	+0.45 (16)
FEV_1 (L)	1.82	2.07	+0.25 (14)

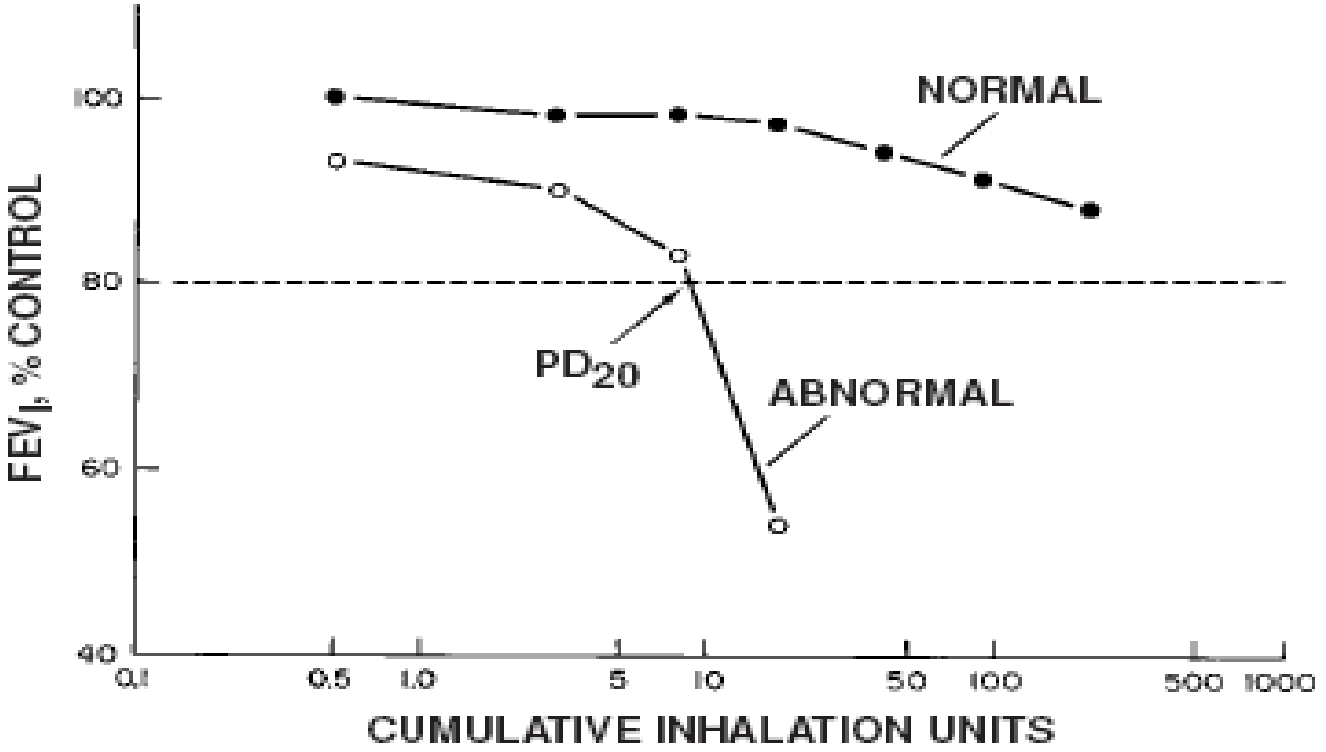
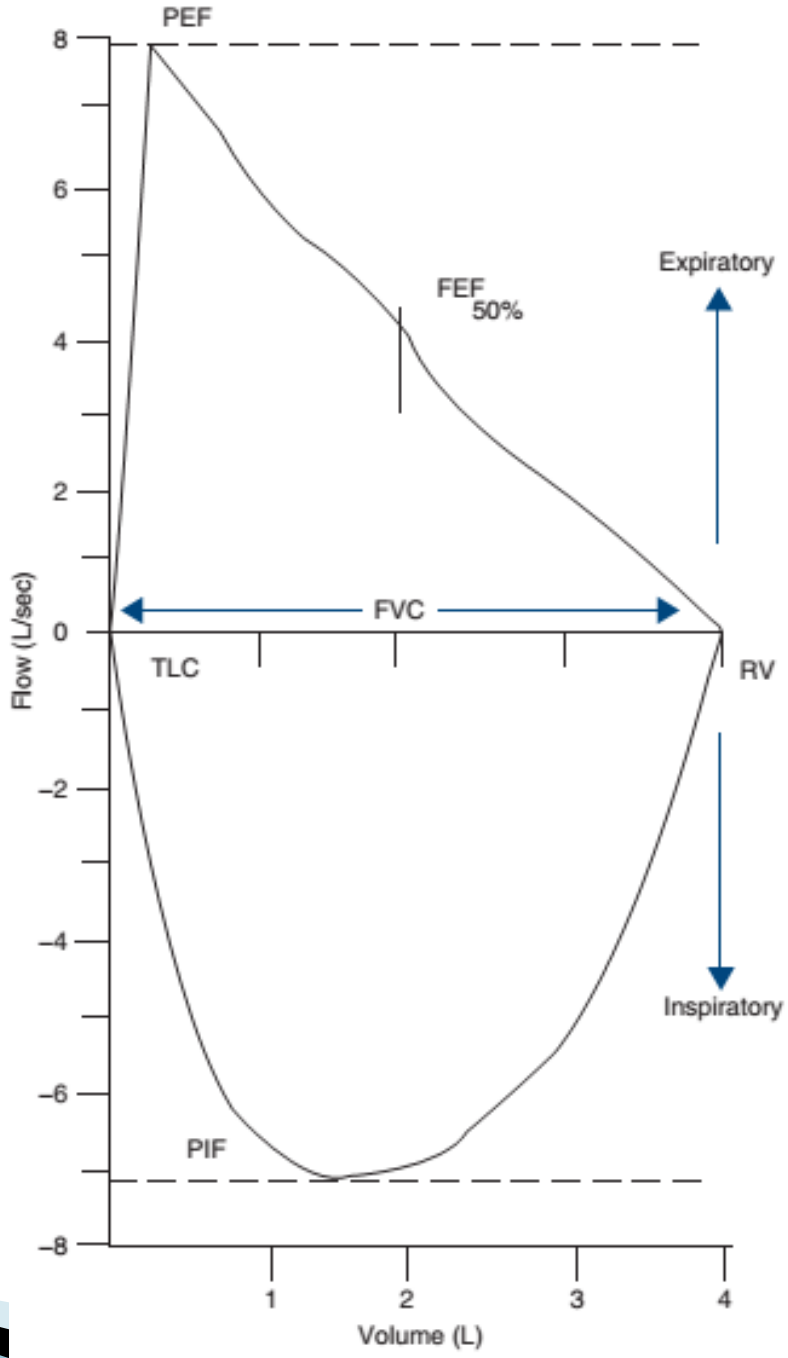


Figure 34-25 Plot of FEV_1, percent control vs. cumulative dose of methacholine administered by inhalation (logarithmic scale), to a normal subject and a subject with hyperreactive airways. The PD_{20} is the cumulative dose, which results in a 20 percent drop in the FEV_1 from the baseline measurement (after inhalation of diluent alone). In the subject with normal airway reactivity, the maximal cumulative dose of methacholine administered fails to elicit a 20 percent drop in FEV_1.


PEF
8
6
4
2
0
−2
−4
−6
−8
Flow (L/sec)
Expiratory
FEF
50%
FVC
TLC
RV
Inspiratory
PIF
1
2
3
4
Volume (L)

CRITERIA FOR ACCEPTABILITY 2-4

Peak Flow

1. Patient was standing or sitting up straight.
2. Patient inhaled maximally (rapid, but not forced) and exhaled maximally without holding his or her breath.
3. At least three efforts were performed and recorded in order.
4. The largest two out of three efforts were repeatable within 0.67 L/s (40 L/min).
5. Largest PEF obtained is reported.

From ATS-ERS Task Force, 2005.

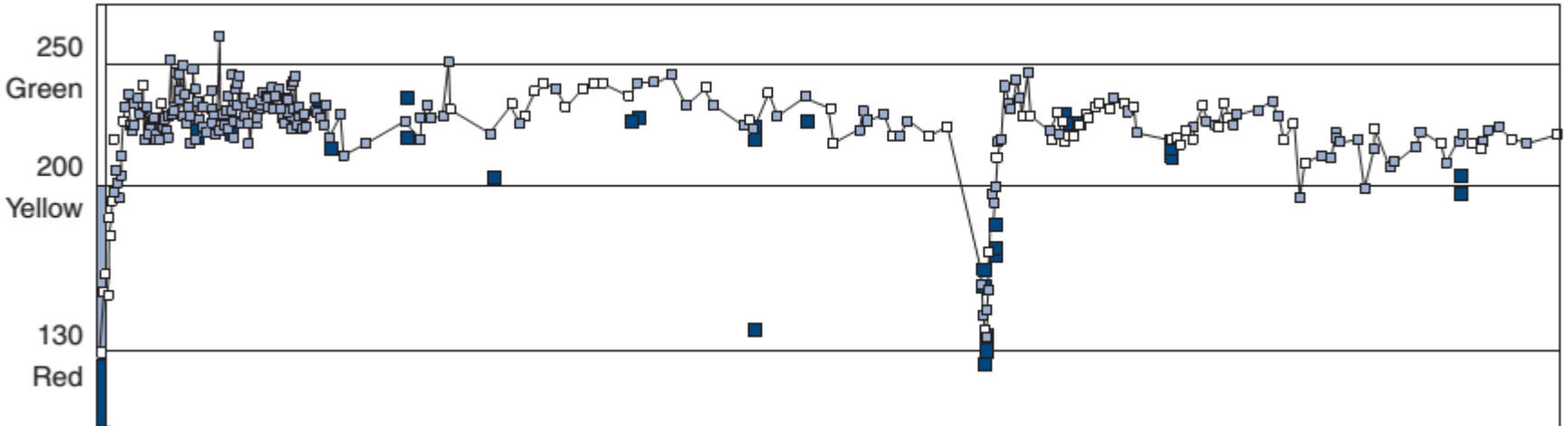
INTERPRETIVE STRATEGIES 2-4

Peak Flow

1. What is the patient's personal best PEF?
2. Is the current PEF the best of three trials? Was it obtained in the morning or evening? Was it obtained before or after inhaled bronchodilator therapy?
3. Zone system*:

Green	80%-100% of personal best Signals good control. Take your medications as usual.
Yellow	50%-80% of personal best Signals caution. Your asthma may not be under good control. Take your medicine as directed by your physician and follow your asthma plan and/or ask your doctor whether you need to change or increase your daily medicines.
Red	<50% of personal best Signals a medical alert. You must take an inhaled short-acting β_2 agonist right away. Call your doctor or emergency room (ER) and ask what to do, or go directly to the ER.

*National Asthma Education and Prevention Program, EPR-3, 2007.



CRITERIA FOR ACCEPTABILITY 2-5

MVV

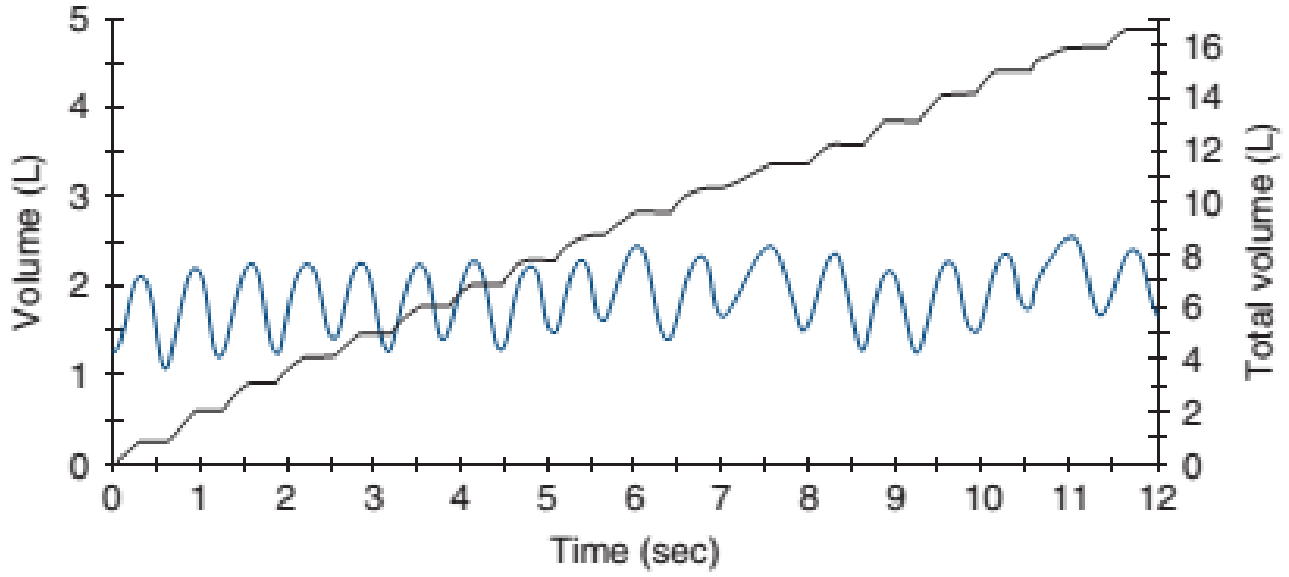
1. Volume-time tracing shows continuous, rhythmic effort for at least 12 seconds.
2. Volume is approximately 50% of VC, and the rate is 90-110 breaths per minute.
3. Two acceptable maneuvers are obtained; MVV values are within 20%.
4. Report the highest acceptable MVV and breathing rate.

From ATS-ERS Task Force, 2005.

INTERPRETIVE STRATEGIES 2-5

MVV

1. Was MVV test performed acceptably? At least 12 seconds?
2. Does MVV approximate $FEV_1 \times 40$? If not, suspect suboptimal effort or neuromuscular weakness, variable extrathoracic obstruction.
3. Is MVV less than 75% of predicted? If so, correlate with obstruction ($FEV_{1\%}$).
4. If no obstruction, look for clinical correlation for reduced MVV. Consider testing maximal respiratory pressures.



Pul.meas	BEST	PRE	Pred%		%pred after bronchodilator
SVC			80-120		
FVC			80-120		
FEV1			80-120		
FEV1/FVC			80-120		
Airway Resistance			70-170		
FEF25%			50-150		
FEF50%			50-150		
RV			80-120		
TLC			80-120		
FRC			80-120		
DLCO			75-125		

NORMAL

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC					
FVC	4.28	4.10	98		
FEV1	3.21	2.99	89		
FEV1/FVC	75	78			
FEF25-75%	3.37	3.31	95		
FEF25%					
FEF5O%					
RV					
TLC					
FRC					
DLCO					

NORMAL PFT

Pul.meas	BEST	PRE	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC					
FVC	2.16	3.13	69		
FEV1	1.68	2.55	66		
FEV1/FVC	78	81			
FEF25-75%	1.48	2.68	55		
FEF25%	5	5.8	87		
FEF5O%	2.62	3	86		
RV					
TLC					
FRC					
DLCO					

MODERATE RESTRICTION

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC					
FVC	4.5O	2.44	54		
FEV1	3.3O	O.69	21		
FEV1/FVC	73	**28**			
FEF25-75%	3.32	28	8		
FEF25%	4.24	1.01	25		
FEF5O%	4.33	0.3O	7		
RV	2.12	4.56	216		
TLC	6.2O	7.24	115		
FRC	3.36	6.10	181		
DLCO					

VERY SEVERE OBSTRUCTION

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.' £}7¢# 9*®5}ƒ*28§¥}¥7¥ x ¥&1¥8£}.$f}$8088$ƒ$цx $ 66'1 xxц4 ¶ц"*8 0]6 7 1 9¥v28 xцц ƒ*28§3¥1.' £}7¢# ©8x1' £}ƒ' 2£

FEVI:33% FVC:66% FEVI/FVC:50 FEF25%:45% FEF25-75%: 34% TLC:49% DLCO:45%

:¢86 ¥8¥6'}ƒ ¥7¥ x *9 x ¥&1¥8£}-ц

FEVI: 33% FVC: 66% FEVI/FVC: 50 FEF25%:45% FEF25-75%: 34% TLC:126% DLCO:105%

After bronchodilator: FEVI:47%

:¢86 ¥8¥6'}ƒ ¥7¥ x *9 x ¥&1¥8£}-ц

FEVI: 81% FVC: 86% FEVI/FVC: 80 FEF25%:85% FEF25-75%: 90% TLC: 87% DLCO: 45%

:¢86 ¥8¥6'}ƒ ¥7¥ x *9 x ¥&1¥8£}-љ

FEVI: 60% FVC: 77% FEVI/FVC:84 FEF25%:77% FEF25-75%: 80%

TLC:60% RV:68% RV/TLC: NL

۵- What's your interpretation in this spirometry?

FEVI: 67% FVC:85% FEVI/FVC:69 FEF25%:50% FEF25-75%: 85% DLCO:NL

A. Moderate restriction intrapulmonary lesion

B. moderate obstruction probably asthma

C. moderate obstruction suspect to emphysema

D. moderate restriction maybe kyphoscoliosis

۶- Please describe following PFT:

FEVI: 55% FVC: 90% FEVI/FVC:61 FEF25%:45% FEF25-75%: 34% TLC:155% DLCO:45%

A. Moderate restriction intrapulmonary lesion

B. moderate obstruction probably asthma

C. moderate obstruction suspect to emphysema

D. moderate restriction maybe kyphoscoliosis

۷- What's your diagnosis?

FEVI: 45% FVC:77% FEVI/FVC:61 FEF25%:34% FEF25-75%: 32%

After bronchodilator: FEVI:47%

DLCO:45%

HISTORY

A 21-year-old male in good health who plays college football. His chief complaint is shortness of breath after wind sprints and similar vigorous exercises. He denies any other symptoms, including cough or sputum production. He has never smoked. His grandfather had lung problems, but there is no other history of pulmonary disease involving the family. He states that his brothers and sisters have hay fever. There is no history of exposure to environmental pollutants.

PULMONARY FUNCTION TESTING

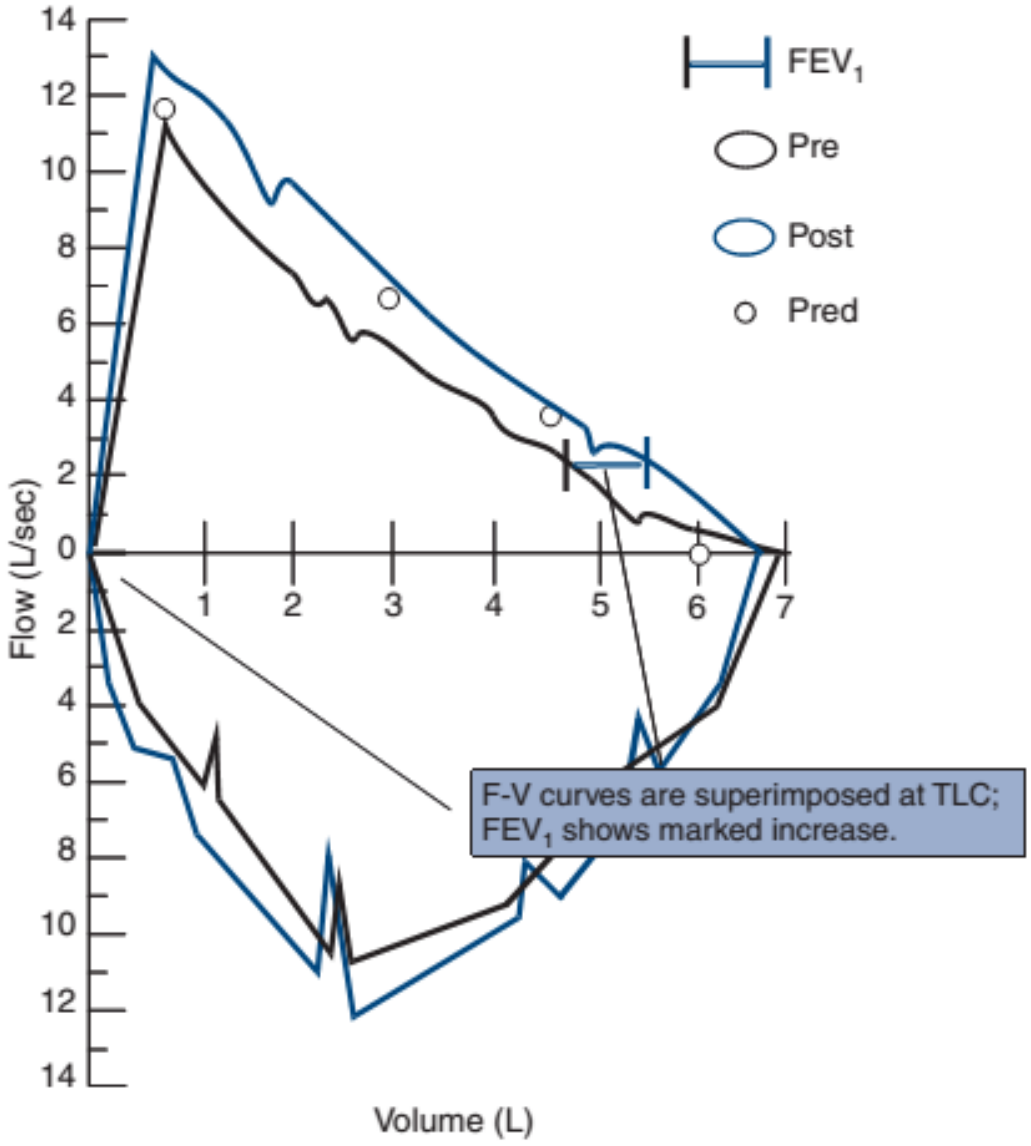
Personal Data

Sex:	Male
Age:	21 yr
Height:	73 in. (185 cm)
Weight:	180 lb (81.6 kg)

Spirometry

	Pre-drug	Pred*	LLN†	% Pred	Post-drug	%Pred	%Change
FVC (L)	6.85	6.04	5.07	111	6.73	111	−2
FEV_1(L)	4.65	4.78	4.18	97	5.45	114	17
$FEV_{1\%}$(%)	70	79	74	—	81	—	
$FEF_{25\%-75\%}$(L/sec)	3.9	5	3.46	78	4.88	97	25
MVV (L/min)	218	166		131	215	130	−1

*Pred = predicted value, based on NHANES III, Chapter 13
†LLN = lower limit of normal, based on NHANES III



CASE STUDY 2-1 **Flow-volume loops superimposed at TLC.**

HISTORY

A 47-year-old carpenter whose chief complaint is shortness of breath on exertion. His dyspnea, although worse recently, has been present for several years. He smoked 1½ packs of cigarettes per day for 32 years (48 pack years). He has a cough in the morning. He says that he produces a "small amount of grayish sputum." The subject's father had tuberculosis. A sister had asthma as a child and now as an adult. He denies any extraordinary exposure to environmental dusts or fumes.

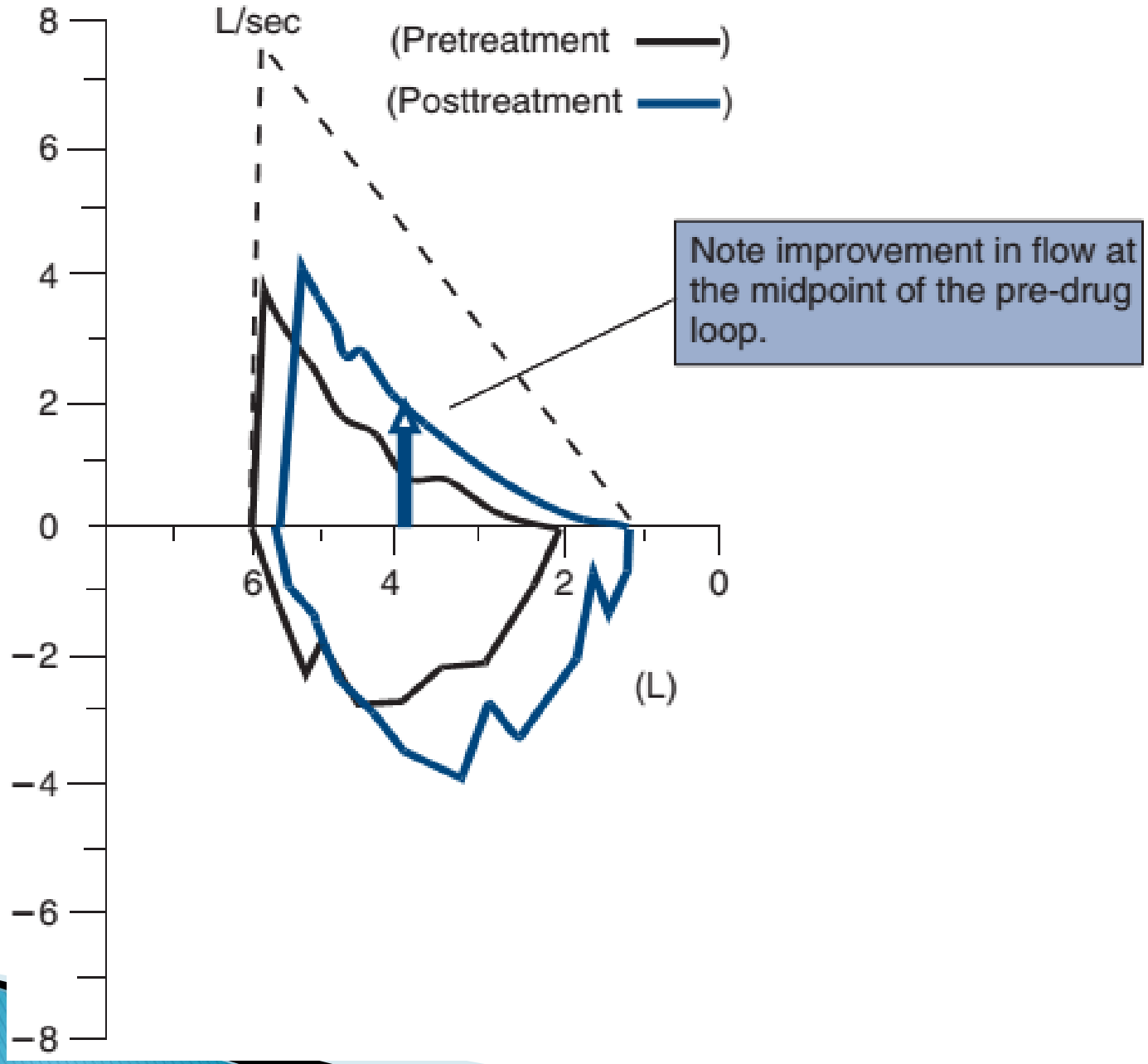
PULMONARY FUNCTION TESTING

Personal Data

Sex:	Male
Age:	47 yr
Height:	70 in. (178 cm)
Weight:	190 lb (86.4 kg)

Spirometry

	Pre-drug	Pred	LLN	% Pred	Post-drug	% Pred	% Change
FVC (L)	4.01	4.97	4.22	81	4.49	90	12%
FEV_1 (L)	2.05	3.67	3.26	56	2.20	6	7%
$FEV_{1\%}$ (%)	51	74	69	—	49	—	– 4%
$FEF_{25\%-75\%}$ (L/sec)	1.2	3.69	2.03	33	1.3	35	8%
$\dot{V}max_{50}$ (L/sec)	1.35	5.54		24	2.67	30	98%
$\dot{V}max_{25}$ (L/sec)	0.55	2.58		21	1.02	40	85%
MVV (L/min)	81	146		55	97	67	20%


L/sec
(Pretreatment ——)
(Posttreatment ——)
8
6
4
2
0
−2
−4
−6
−8
6
4
2
0
(L)
Note improvement in flow at the midpoint of the pre-drug loop.

HISTORY

A 27-year-old auto mechanic referred to the pulmonary function laboratory by his private physician. His chief complaint is "breathing problems." He describes breathlessness that occurs suddenly and then subsides. He has no other symptoms and no history of lung disease. None of his immediate family has any lung disease. He has smoked one pack of cigarettes per day for the past 10 years (10 pack years). He has no unusual environmental exposure. He claims that gasoline fumes sometimes bring on the episodes of shortness of breath.

PULMONARY FUNCTION TESTS

Personal Data

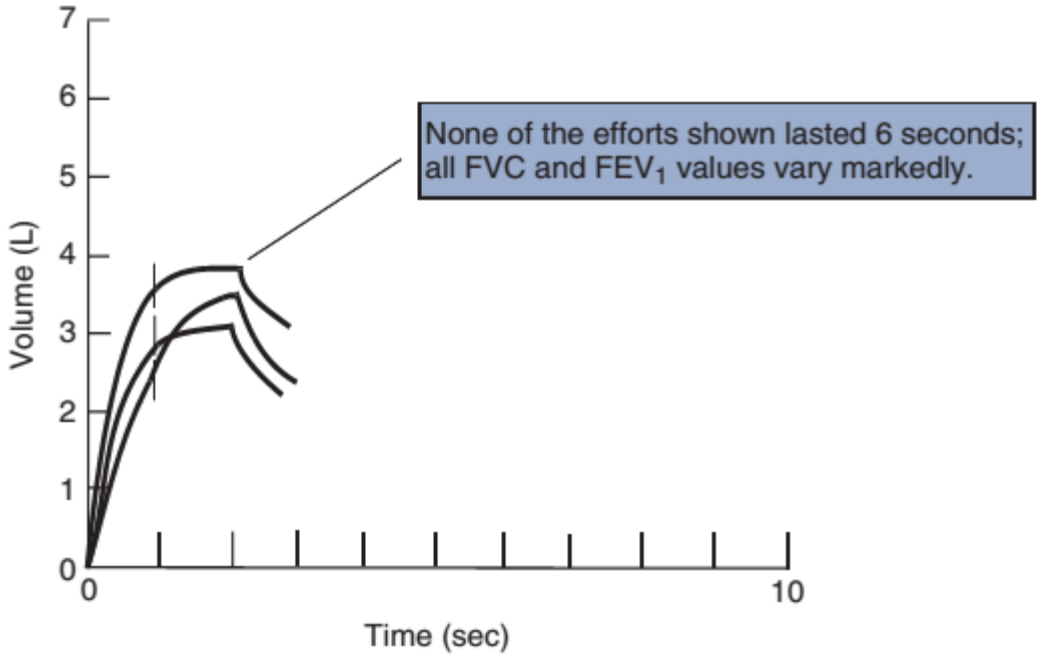
Sex:	Male
Age:	27 yr
Height:	68 in. (173 cm)
Weight:	150 lb (68.2 kg)

Spirometry

	Before Drug	Predicted	LLN	% Predicted
FVC (L)	3.80	5.15	4.32	74
FEV_1 (L)	3.70	4.13	3.55	90
$FEV_{1\%}$ (%)	97	80	73	—
$FEF_{25\%-75\%}$ (L/sec)	4.62	4.49	2.94	103
$FEF_{50\%}$ (L/sec)	4.81	6.01	—	80
$FEF_{75\%}$ (L/sec)	3.12	3.33	—	94
MVV (L/min)	77	146	—	53

TECHNOLOGIST'S COMMENTS

None of the FVC maneuvers were acceptable; they did not last 6 seconds or show an obvious plateau. Best FVC values were not within 150 mL. A total of eight maneuvers were attempted. The subject had difficulty completing all maneuvers.



CASE STUDY 2-3 Multiple FVC maneuvers are superimposed. None of the recorded efforts are acceptable.

SELF-ASSESSMENT QUESTIONS

Entry-level

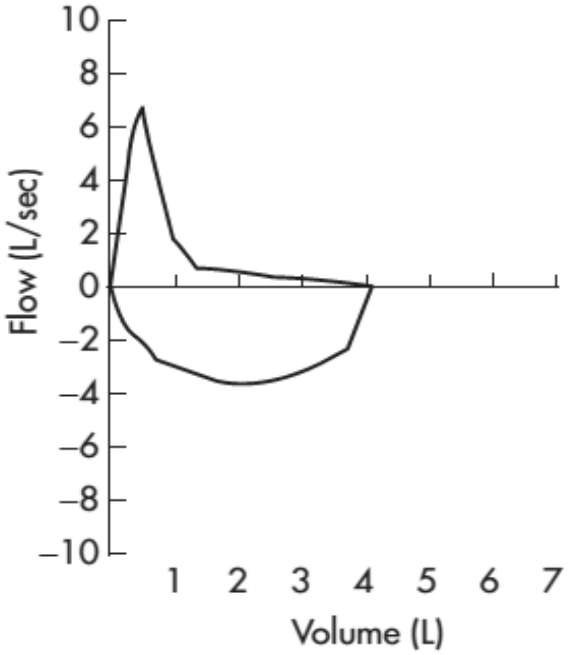
1. A patient performs three FVC maneuvers using a computerized spirometer. The spirometer reports that all maneuvers had a back-extrapolated volume of less than 5% and 150 mL. The maneuvers met all other criteria for acceptability and repeatability. The technologist should:
   a. Repeat all maneuvers
   b. Correct the FEV_1 and all other flows by the amount of the back-extrapolated volume
   c. Perform at least one more maneuver
   d. Report the average of the three FVC values
2. A 58-year-old man who complains of increased shortness of breath with exercise has the following spirometry results:

	Measured	Predicted	LLN	% Predicted
FVC (L)	5.11	4.93	4.19	104
FEV_1 (L)	2.57	3.95	3.38	65

These results are consistent with which of the following?
   a. Normal lung function
   b. Restrictive lung disease
   c. Obstructive lung disease
   d. Incorrect predicted values
3. An 81-year-old man performs three acceptable spirometry efforts and records these results:

	Measured	Predicted	LLN	% Predicted
FVC (L)	2.17	3.82	3.25	57
FEV_1 (L)	1.71	2.41	2.05	71

Which of the following do these values suggest?
   a. Normal spirometry for an elderly man
   b. Obstructive lung disease
   c. Restrictive lung disease
   d. Erroneously measured FEV_1
4. Which of the following best describes the flow-volume curve shown?



   a. Normal forced expiratory flow pattern
   b. Variable intrathoracic obstruction
   c. Variable extrathoracic obstruction
   d. Fixed large airway obstruction

5. A 20-year-old man complains of shortness of breath with exercise. The following results of spirometry are obtained:

	Measured	Predicted	LLN	% Predicted	After Bronchodilator	% Change
FVC (L BTPS)	4.98	5.83	4.96	85	5.98	20
FEV_1 (L BTPS)	3.18	4.68	3.98	68	3.50	10

Which of the following statements best describes these findings?

a. Results are of normal spirometry.
b. There is moderate obstruction with significant response to bronchodilators.
c. There is moderate obstruction without significant response to bronchodilators.
d. Results are inconsistent and must be repeated.

6. A 33-year-old woman complains of increasing shortness of breath with exertion. Her spirometry results are as follows:

	Measured	Predicted	LLN	% Predicted
FVC (L)	2.25	3.09	2.62	73
FEV_1 (L)	1.84	2.62	2.23	70
PEF (L/s)	2.77	6.17	5.24	45
MVV (L/min)	45	104	—	43

Which of the following is most consistent with these results?

a. Moderate obstructive lung disease
b. Normal spirometry
c. Severe lung volume restriction
d. Muscle weakness or poor effort

7. How long should the pulmonary function technologist wait after giving inhaled β_2 agonist before conducting postbronchodilator testing?

a. 5 min
b. 15 min
c. 30 min
d. 45 min

Which of the following is most consistent with these results?

a. Three acceptable and two repeatable maneuvers
b. Perform another maneuver
c. Moderate obstructive disease
d. Severe obstructive lung disease

Advanced

9. A 14-year-old male with cystic fibrosis performs three spirometry trials:

	Trial 1	Trial 2	Trial 3
FVC (L)	3.01	2.99	3.12
FEV_1 (L)	1.99	2.01	1.95

The reported flow-volume loop should come from which data?

a. Trial 1
b. Trial 2
c. Trial 3
d. Average of all three trials

10. A healthy, physically fit patient performs spirometry, and the following values are recorded:

	Trial 1	Trial 2	Trial 3	Trial 4
FVC (L)	6.52	6.23	6.17	6.37
FEV_1 (L)	5.01	5.22	5.13	5.19

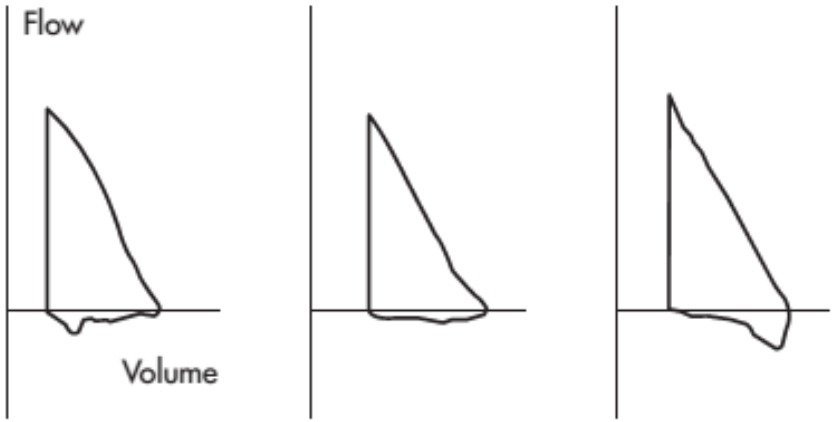
Which values of FVC, FEV_1, and $FEV_{1\%}$ should be reported for this patient?

a. FVC = 6.52 L, FEV_1 = 5.22 L, $FEV_{1\%}$ = 80%
b. FVC = 6.23 L, FEV_1 = 5.22 L, $FEV_{1\%}$ = 84%
c. FVC = 6.52 L, FEV_1 = 5.01 L, $FEV_{1\%}$ = 77%
d. FVC = 6.52 L, FEV_1 = 5.22 L, $FEV_{1\%}$ = 82%

8. A 60-year-old woman complains of increasing shortness of breath with exertion. Her spirometry results are as follows:

	Trial 1	Trial 2	Trial 3	Best	Predicted	LLN	% Predicted
FVC (L)	2.25	2.30	2.28	2.30	2.96	2.23	78
FEV_1 (L)	1.14	1.06	1.12	1.14	2.41	1.86	47
BE Vol (L)	0.230	0.145	0.09				

11. A patient, whose chief complaints are cough and hoarseness, performs a series of FVC efforts, and flow-volume curves are recorded as shown. Which of the following diagnoses seems most likely?



a. Fixed airway obstruction
b. Variable intrathoracic obstruction
c. Variable extrathoracic obstruction
d. The patient was malingering

12. A patient performs the following test:

	Trial 1	Trial 2	Trial 3	Trial 4
FVC (L)	4.50	4.22	4.13	4.30
FEV_1 (L)	3.45	3.15	3.02	2.95

The data is consistent with which of the following?

a. Acceptable and repeatable spirometry
b. FVC-induced bronchospasm
c. Poor repeatability
d. Consistent with muscle weakness

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC					
FVC			66		
FEV1			33		
FEV1/FVC	75	5O			
FEF25-75%					
FEF25%					
FEF5O%					
RV					
TLC			49		
FRC					
DLCO			45		

MIXED OBS & RES

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC					
FVC	2.6O	2.26	87		
FEV1	2.13	1.86	86		
FEV1/FVC	82	67			
FEF25-75%	4.20	3.90	91		
FEF25%	4.08	2.04	48		
FEF5O%	4.12	2.90	60		
MVV	87	27	31		
TLC					
FRC					
DLCO			9O		

UPPER AIRWAY OBSTRUCTION

SEVERE PULMONARY FIBROSIS

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC	3.1	1.3	42		
FVC	3.1	1.3	42		
FEV1	2.4	1.2	38		
FEV1/FVC	77	91			
Airway Resistance	2	1.2	6o		
FEF25%	1.6	4.8	3OO		
FEF5O%	3.1	6.7	216		
RV	2.2	1.5	68		
TLC	5.3	2.8	53		
FRC	3.2	2.1	66		
DLCO	1O	6	59		

Pul.meas	Pred	Best	Pred %	Meas after bronchodilator	%pred after bronchodilator
SVC	3.3	2.90	90	2.90	90
FVC	3.3	2.90	90	2.90	90
FEV1	2.6	1.56	60	1.60	62
FEV1/FVC	79	53			
Airway Resistance			180		
FEF25%	1.6	O.7	44		
FEF5O%	3.3	1.38	42		
RV	2.1	2.3	11O		
TLC	5.4	6.3	117		
FRC	3.2	4.2	131		
DLCO	3O	15	5O		

EMPHYSEMA

Patient 4C: age 60, male, European, height 1.83 m, weight 89 kg

History: Gradual onset of dyspnoea and cough. Ex-smoker.

Technician's comments: good patient technique, results acceptable and reproducible.

		Predicted	Measured	% predicted
Spirometry	FEV_1 litres	3.44	(1.18)	(34)
	FVC litres	4.91	(3.29)	(67)
	FEV_1/FVC %	70	36	
Lung volumes (plethysmograph)	TLC litres	7.14	(12.44)	(174)
	RV litres	2.51	(9.12)	(364)
	RV/TLC %	37	(73)	
	FRC litres	3.94	(9.76)	(248)
	VC litres	4.91	(3.31)	(67)

The tests were repeated 15 minutes after administration of nebulised bronchodilator.

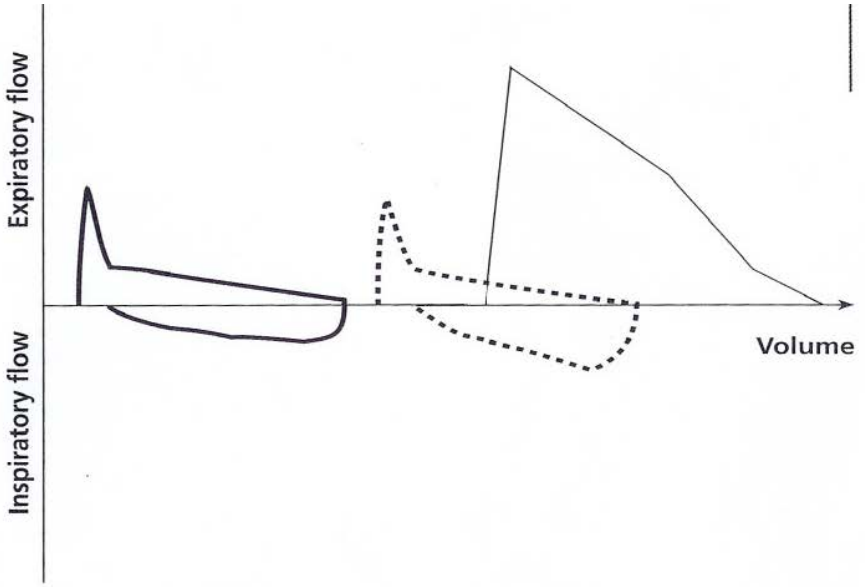


Figure 4.8 The flow-volume loop after bronchodilator is indicated by the broken line

		Measured	% predicted	% change
Spirometry	FEV_1 litres	(1.16)	(34)	−2
	FVC litres	(3.38)	(69)	3
	FEV_1/FVC %	34		
Lung volumes (plethysmograph)	TLC litres	(8.56)	(120)	−31
	RV litres	(5.18)	(206)	−43
	RV/TLC %	(61)		
	FRC litres	(5.96)	(151)	−39
	VC litres	(3.38)	(69)	2

SEC

PULMONARY FUNCTION TEST REPORT

(23)

DATE: 81-8-16
25°C 47% 680torr

NAME:
ID.#: 741000000003
SEX: MALE AGE: 64 YRS
RACE: WHITE 100% HEIGHT: 170 Cm
WEIGHT: 79 Kg

[FVC DATA]

FUNCTION		MEAS	PR	%PR
FVC	[L]	3.14	3.79	82
FEV.5	[L]	1.72		
FEV1	[L]	2.18	2.96	73
FEV3	[L]	2.92		
FEV1/FVC%	[%]	69.43		
FEV1/SVC%	[%]		75.69	
FEV3/FVC%	[%]	92.99		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	4.00		
FEF25-75%	[L/S]	1.34	3.25	41
FEF75-85%	[L/S]	0.41		
EX Time	[S]	6.20		
FIVC	[L]			
FIV.5	[L]			
FEV.5/FIV.5				
PE	[L/S]	4.77	7.84	60
PEF	[L/S]	4.60	6.96	66
FEF50%	[L/S]	2.07	4.11	50
FEF75%	[L/S]	0.51	1.43	35
FIF50%	[L/S]			
FEF50%/FIF50%				

2 Data, 3Accepted, 5Try

INTERPRETATION < Ellis >

NOTES: This report is not to be used until signed by a physician.

Reviewed by: _____

DATE: _____

NAME: 25°C 47% 680torr
ID.#: 748500000012
SEX : MALE AGE: 84 YRS
RACE: WHITE 100% HEIGHT: 171 Cm
WEIGHT: 44 Kg

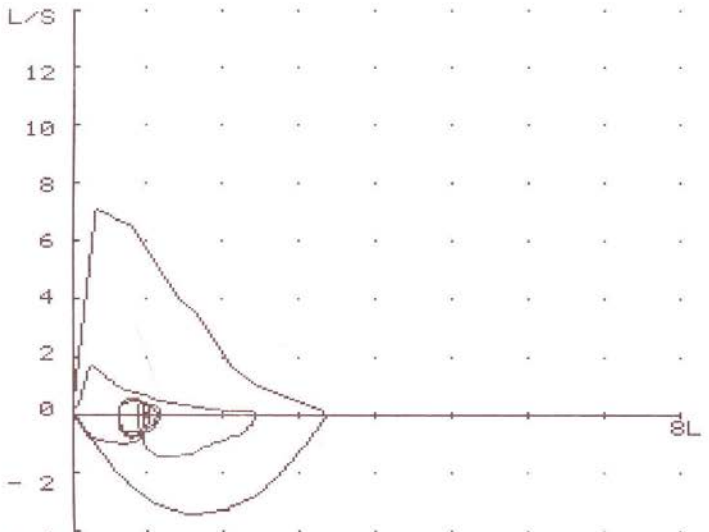
[FVC DATA]

FUNCTION		MEAS	PR	%PR
FVC	[L]	2.41	3.33	72
FEV.5	[L]	0.68		
FEV1	[L]	1.03	2.43	42
FEV3	[L]	1.74		
FEV1/FVC%	[%]	42.74		
FEV1/SVC%	[%]		72.09	
FEV3/FVC%	[%]	72.20		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	0.85		
FEF25-75%	[L/S]	0.42	2.41	17
FEF75-85%	[L/S]	0.16		
EX Time	[S]	8.83		
FIVC	[L]	1.55		
FIV.5	[L]	0.24		
FEV.5/FIV.5		2.83		
PEF	[L/S]	1.67	7.04	23
FEF25%	[L/S]	0.99	6.43	15
FEF50%	[L/S]	0.46	3.53	13
FEF75%	[L/S]	0.18	0.94	19
FIF50%	[L/S]	1.37		
FEF50%/FIF50%		0.34		

1 Data, 2Accepted, 1Try

INTERPRETATION < Ellis >

NOTES: This report is not to be used until signed by a physician.
Reviewed by: _____
DATE: _____



FUNCTION		MEAS	PR	%PR
FVC	[L]	3.56	3.45	103
FEV.5	[L]	2.54		
FEV1	[L]	3.36	3.01	111
FEV3	[L]	3.56		
FEV1/FVC%	[%]	94.38		
FEV1/SVC%	[%]		83.97	
FEV3/FVC%	[%]	100.00		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	5.88		
FEF25-75%	[L/S]	4.34	3.99	108
FEF75-85%	[L/S]	1.98		
EX Time	[S]	1.88		
FIVC	[L]			
FIV.5	[L]			
FEV.5/FIV.5				
PEF	[L/S]	6.08	6.83	89
FEF25%	[L/S]	6.08	6.04	100
FEF50%	[L/S]	4.76	4.38	108
FEF75%	[L/S]	2.56	2.10	121
FIF50%	[L/S]			
FEF50%/FIF50%				

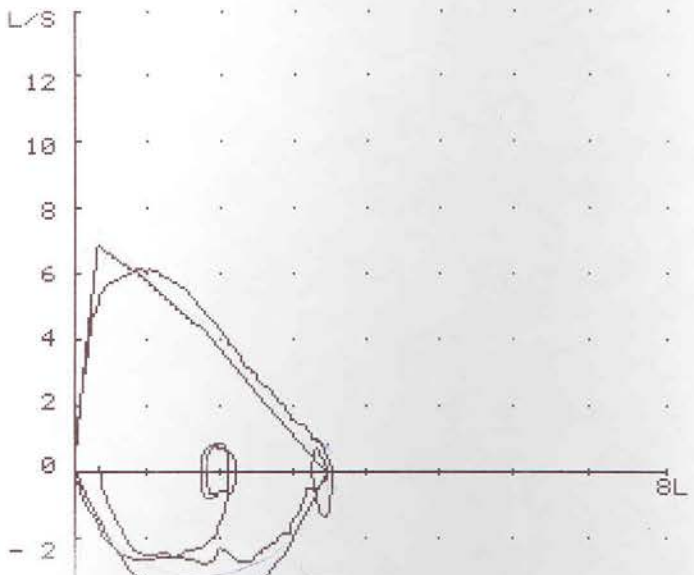
1 Data, 3Accepted, 4Try

INTERPRETATION < Ellis >

NOTES: This report is not to be used until signed by a physician.

Reviewed by: _____

DATE: _____



DATE: 81-8-18
25°C 47% 680torr

NAME:
ID.#: 896000000004
SEX : MALE
RACE: WHITE 100%

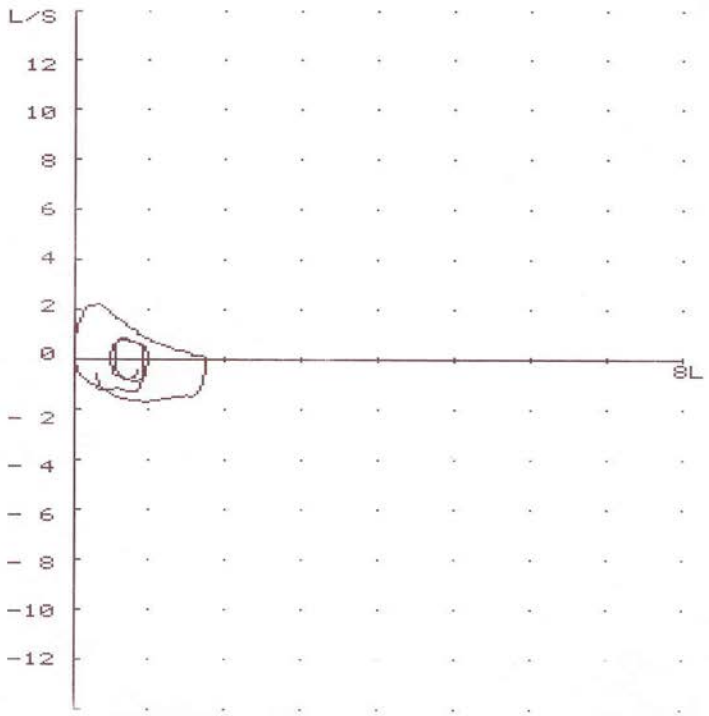
AGE: 15 YRS
HEIGHT: 154 Cm
WEIGHT: 33 Kg

40

[FVC DATA]

FUNCTION		MEAS	PR	%PR
FVC	[L]	1.78	3.21	55
FEV.5	[L]	0.87		
FEV1	[L]	1.23	2.70	45
FEV3	[L]	1.69		
FEV1/FVC%	[%]	69.10	84.00	82
FEV1/SVC%	[%]			
FEV3/FVC%	[%]	94.94		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	1.18		
FEF25-75%	[L/S]	0.87		
FEF75-85%	[L/S]	0.33		
EX Time	[S]	4.04		
FIVC	[L]	1.53		
FIV.5	[L]	0.55		
FEV.5/FIV.5		1.58		
PEF	[L/S]	2.21	5.83	37
FEF25%	[L/S]	2.01		
FEF50%	[L/S]	1.00	4.22	23
FEF75%	[L/S]	0.42		
FIF50%	[L/S]	1.78		
FEF50%/FIF50%		0.56		

1 Data, 2Accepted, 1Try



FUNCTION		MEAS	PR	%PR
FVC	[L]	1.95	3.78	51
FEV.5	[L]	1.56		
FEV1	[L]	1.75	2.99	58
FEV3	[L]	1.92		
FEV1/FVC%	[%]	89.74		
FEV1/SVC%	[%]		76.41	
FEV3/FVC%	[%]	98.46		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	4.35		
FEF25-75%	[L/S]	3.24	3.38	95
FEF75-85%	[L/S]	0.81		
EX Time	[S]	5.29		
FIVC	[L]	1.86		
FIV.5	[L]	0.73		
FEV.5/FIV.5		2.14		
PEF	[L/S]	4.95	7.89	62
FEF25%	[L/S]	4.77	6.96	68
FEF50%	[L/S]	4.47	4.16	107
FEF75%	[L/S]	1.28	1.48	86
FIF50%	[L/S]	3.79		
FEF50%/FIF50%		1.18		

2 Data, 3Accepted, 5Try

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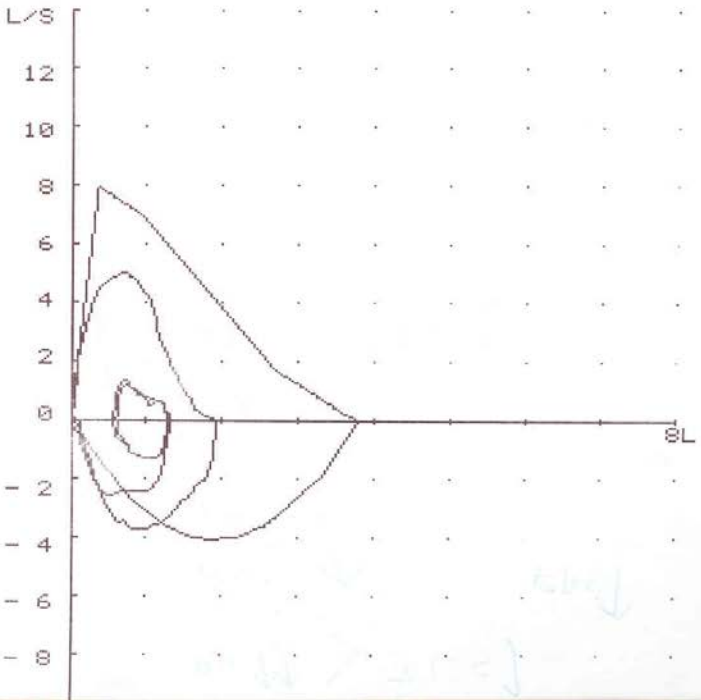
DATE: _____



TION		MEAS	PR	%PR
FVC	[L]	3.47	4.92	70
FEV.5	[L]	1.06		
FEV1	[L]	2.04	4.18	48
FEV3	[L]	3.45		
FEV1/FVC%	[%]	58.79		
FEV1/SVC%	[%]		82.71	
FEV3/FVC%	[%]	42		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	2.04		
FEF25-75%	[L/S]	1.88	4.96	37
FEF75-85%	[L/S]	1.38		
EX Time	[S]	3.95		
FIVC	[L]	2.09		
FIV.5	[L]	0.03		
FEV.5/FIV.5		35.33		
PEF	[L/S]	2.11	9.64	21
FEF25%	[L/S]	2.05	8.20	25
FEF50%	[L/S]	1.95	5.39	36
FEF75%	[L/S]	1.61	2.50	64
FIF50%	[L/S]	0.99		
FEF50%/FIF50%		1.97		

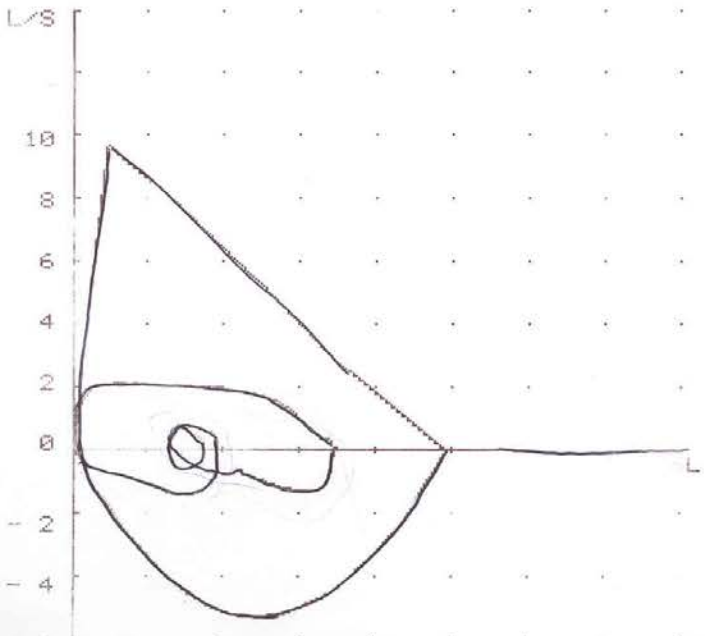
2 Data, [illegible]cepted, 2Try

INTERPRETA[illegible] < Ellis >

NOTES: This report is not to be used until signed by a physician.

Reviewed by: _____

DATE: _____



PULMONARY FUNCTION TEST REPORT

DATE: 81-8-25
24°C 47% 680torr

NAME:
ID.#: 589000000001
SEX : FEMALE AGE: 18 YRS
RACE: WHITE 100% HEIGHT: 160 Cm
WEIGHT: 57 Kg

[FVC DATA]

NCTION		MEAS	PR	%PR
J	[L]	3.29	3.55	92
J.5	[L]	1.80		
J1	[L]	2.44	3.10	78
J3	[L]	3.16		
J1/FVC%	[%]	74.16		
J1/SVC%	[%]		84.35	
J3/FVC%	[%]	96.05		
J3/SVC%	[%]			
F.2-1.2	[L/S]	4.35		
F25-75%	[L/S]	1.87	4.07	45
F75-85%	[L/S]	0.64		
Time	[S]	4.13		
JC	[L]	3.38		
J.5	[L]	1.30		
J.5/FIV.5		1.38		
F	[L/S]	5.36	6.94	77
F25%	[L/S]	4.60	6.13	75
F50%	[L/S]	2.21	4.46	49
F75%	[L/S]	0.86	2.17	39
F50%	[L/S]	3.42		
F50%/FIF50%		0.65		

1 Data, 3Accepted, 16Try

INTERPRETATION < Ellis >

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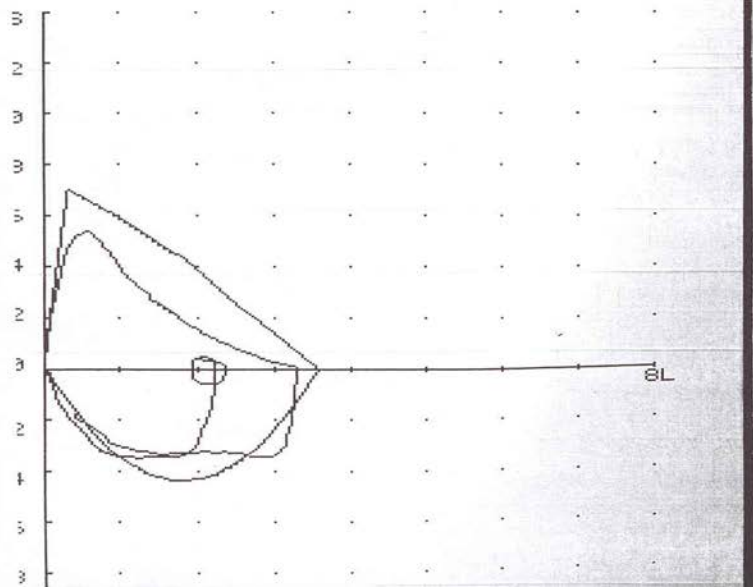
Reviewed by: _____
DATE: _____



PULMONARY FUNCTION TEST REPORT

DATE: 81-8-25
24°C 47% 680torr

NAME:
ID.#: 589000000000
SEX : FEMALE AGE: 18 YRS
RACE: WHITE 100% HEIGHT: 160 Cm
WEIGHT: 57 Kg

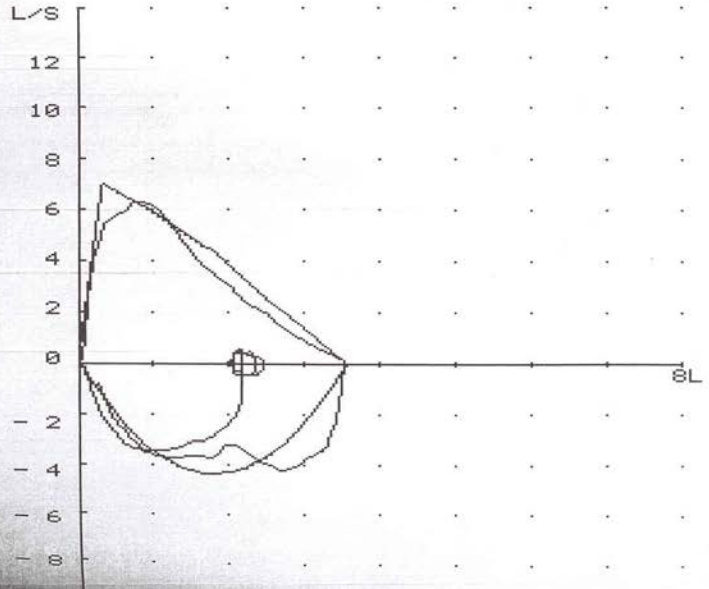
[FVC DATA]

FUNCTION		MEAS	PR	%PR
FVC	[L]	3.52	3.55	99
FEV.5	[L]	2.25		
FEV1	[L]	2.99	3.10	96
FEV3	[L]	3.52		
FEV1/FVC%	[%]	84.94		
FEV1/SVC%	[%]		84.35	
FEV3/FVC%	[%]	100.00		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	5.56		
FEF25-75%	[L/S]	3.14	4.07	77
FEF75-85%	[L/S]	1.17		
EX Time	[S]	2.75		
FIVC	[L]	2.54		
FIV.5	[L]	1.38		
FEV.5/FIV.5		1.63		
PEF	[L/S]	6.28	6.94	90
FEF25%	[L/S]	6.21	6.13	101
FEF50%	[L/S]	3.51	4.46	78
FEF75%	[L/S]	1.53	2.17	70
FIF50%	[L/S]	3.58		
FEF50%/FIF50%		0.98		

3 Data, 3Accepted, 4Try

INTERPRETATION < Ellis >

NOTES: This report is not to be used until signed by a physician.
Reviewed by: _____
DATE: _____



WEIGHT: 78 Kg

[FVC DATA]

NCTION		MEAS	PR	%PR
C	[L]	4.93	4.52	109
V.5	[L]	3.05		
V1	[L]	3.90	3.76	103
V3	[L]	4.77		
V1/FVC%	[%]	79.11		
V1/SVC%	[%]		80.37	
V3/FVC%	[%]	96.75		
V3/SVC%	[%]			
F.2-1.2	[L/S]	9.09		
F25-75%	[L/S]	3.42	4.38	78
F75-85%	[L/S]	0.98		
Time	[S]	4.59		
VC	[L]	4.65		
V.5	[L]	3.84		
V.5/FIV.5		0.79		
F	[L/S]	10.39	9.02	115
F25%	[L/S]	8.86	7.76	114
F50%	[L/S]	4.40	4.95	88
F75%	[L/S]	1.39	2.14	64
F50%	[L/S]	9.66		
F50%/FIF50%		0.46		

2 Data, 3Accepted, 16Try

INTERPRETATION < Ellis >

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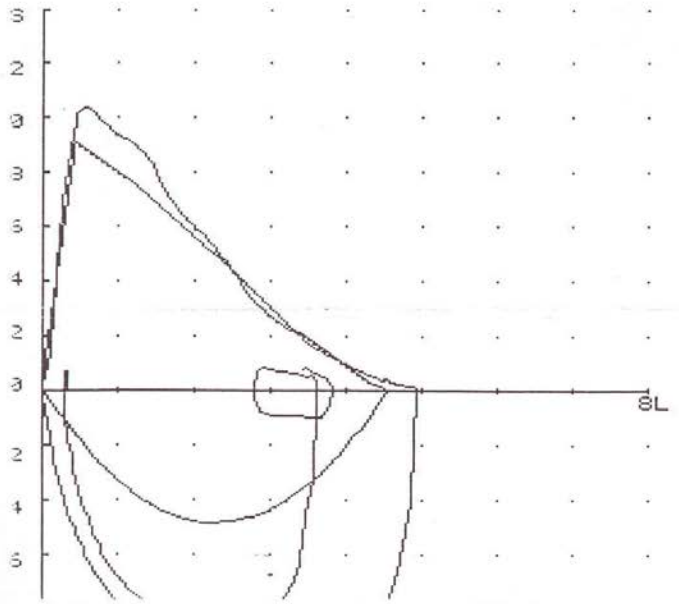

WEIGHT: 78 Kg

[FVC DATA]

FUNCTION		MEAS	PR	%PR
FVC	[L]	5.12	4.52	113
FEV.5	[L]	3.40		
FEV1	[L]	4.25	3.76	113
FEV3	[L]	4.95		
FEV1/FVC%	[%]	83.01		
FEV1/SVC%	[%]		80.37	
FEV3/FVC%	[%]	96.68		
FEV3/SVC%	[%]			
FEF.2-1.2	[L/S]	9.09		
FEF25-75%	[L/S]	4.56	4.38	104
FEF75-85%	[L/S]	1.25		
EX Time	[S]	4.86		
FIVC	[L]	4.77		
FIV.5	[L]	2.09		
FEV.5/FIV.5		1.63		
PEF	[L/S]	9.90	9.02	109
FEF25%	[L/S]	8.75	7.76	112
FEF50%	[L/S]	5.55	4.95	112
FEF75%	[L/S]	1.85	2.14	86
FIF50%	[L/S]	5.62		
FEF50%/FIF50%		0.99		

2 Data, 2Accepted, 2Try

INTERPRETATION < Ellis >

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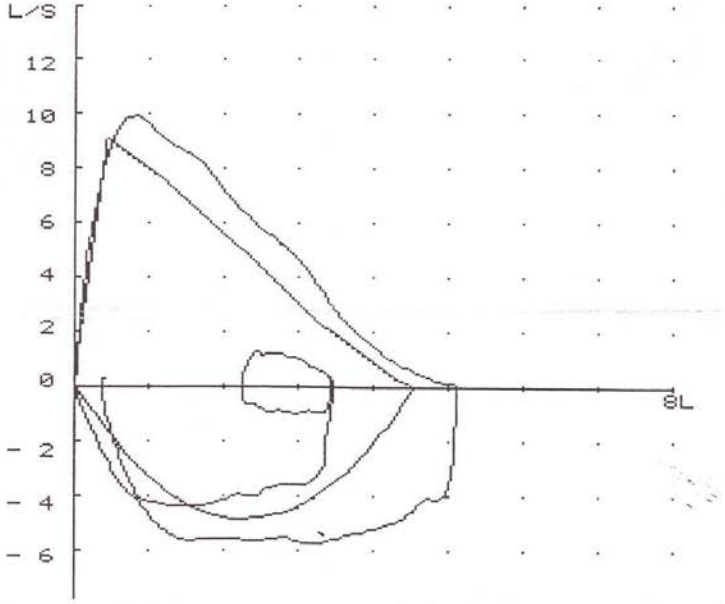
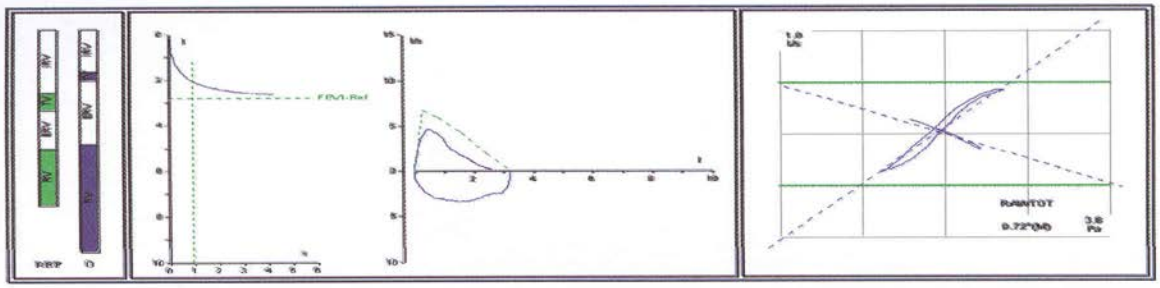


NATIONAL RESEARCH INSTITUTE OF TUBERCULOSIS AND LUNG DISEASES
SHAHID BEHESHTI UNIVERSITY OF MEDICAL SCIENCES
CARDIO-PULMONARY LAB
Darabad, Tehran - IRAN

SADR, ZAHRA
ID-Nr: SADZAH010262
Comment:

163 cm, 60 kg, female *01.02.1962 =40Y
Test: 04.11.2002 / 12:30 h

Body-Plethysmograpy



Spirometry, Flow-Volume

Parameter	Value	%Ref	Ref	Unit
VC	3.26	99	3.27	l
IC	1.44			l
FVCex	2.82	86	3.29	l
FEV1	2.17	76	2.84	l
FEV1/IVC	66	81	82	%
FEV1/FVC	77	94	82	%
PEF	4.57	69	6.66	l/s
MEF25	4.26	73	5.85	l/s
MEF50	2.09	50	4.15	l/s
MEF75	0.72	40	1.82	l/s
MEF25-75	1.78	49	3.60	l/s

Resistance :

RAWtot	0.72	240	0.30	kPa/(l/s)
sRAWtot	3.48	548	0.64	kPa*s

Volumes :

TGV	4.83	179	2.69	l
IC	1.44			l
TLC	6.27	126	4.97	l
VC	3.26			l
RV	3.02	190	1.59	l
TGV/TLC	77	149	52	%
RV/TLC	48	148	33	%

Test : 04.11.2002/12:30
BTPS : 24/900/20 [°C/mbar/%]

Comment: