Pulmonary Function Testing : Spirometry

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Types of Pulmonary Fuction Testing

1. Spirometry
   - Measures inhaled and exhaled volumes of air as a function of time
   - Simple office test which takes 10-15 minutes; no risk and low cost
   - Should include flow-volume loops and volume-time curves
   - Measures FEV1 and FVC
   - Essential for diagnosing obstruction; can rule-out restriction if FVC normal but not adequate for diagnosing restriction
   - Post-bronchodilator spirometry can be obtained if baseline airway obstruction present or if asthma suspected

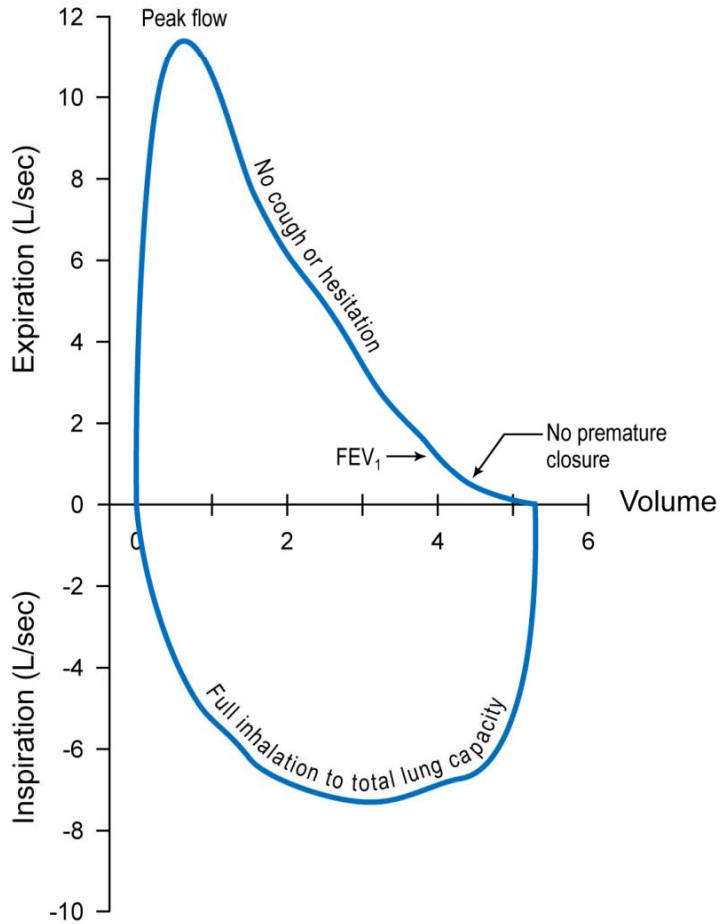
Indications for Spirometry

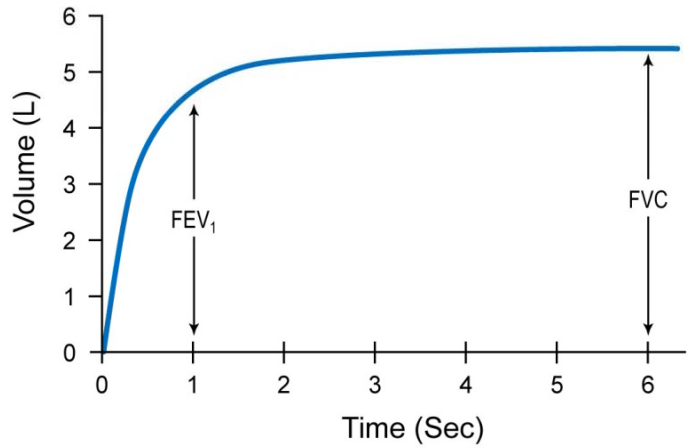
- Evaluation of respiratory symptoms
  - Dyspnea, wheeze, cough, chest tightness
- Diagnosis, staging and monitoring lung diseases
  - COPD, asthma, ILD
- Assessment of bronchodilator therapy
- Evaluation of effects of irritant exposures
- Risk evaluation prior to thoracic surgery
- Objective assessment of impairment or disability
- Monitor for adverse reactions to drugs
- Screen asymptomatic smokers?

Contraindications for PFTs

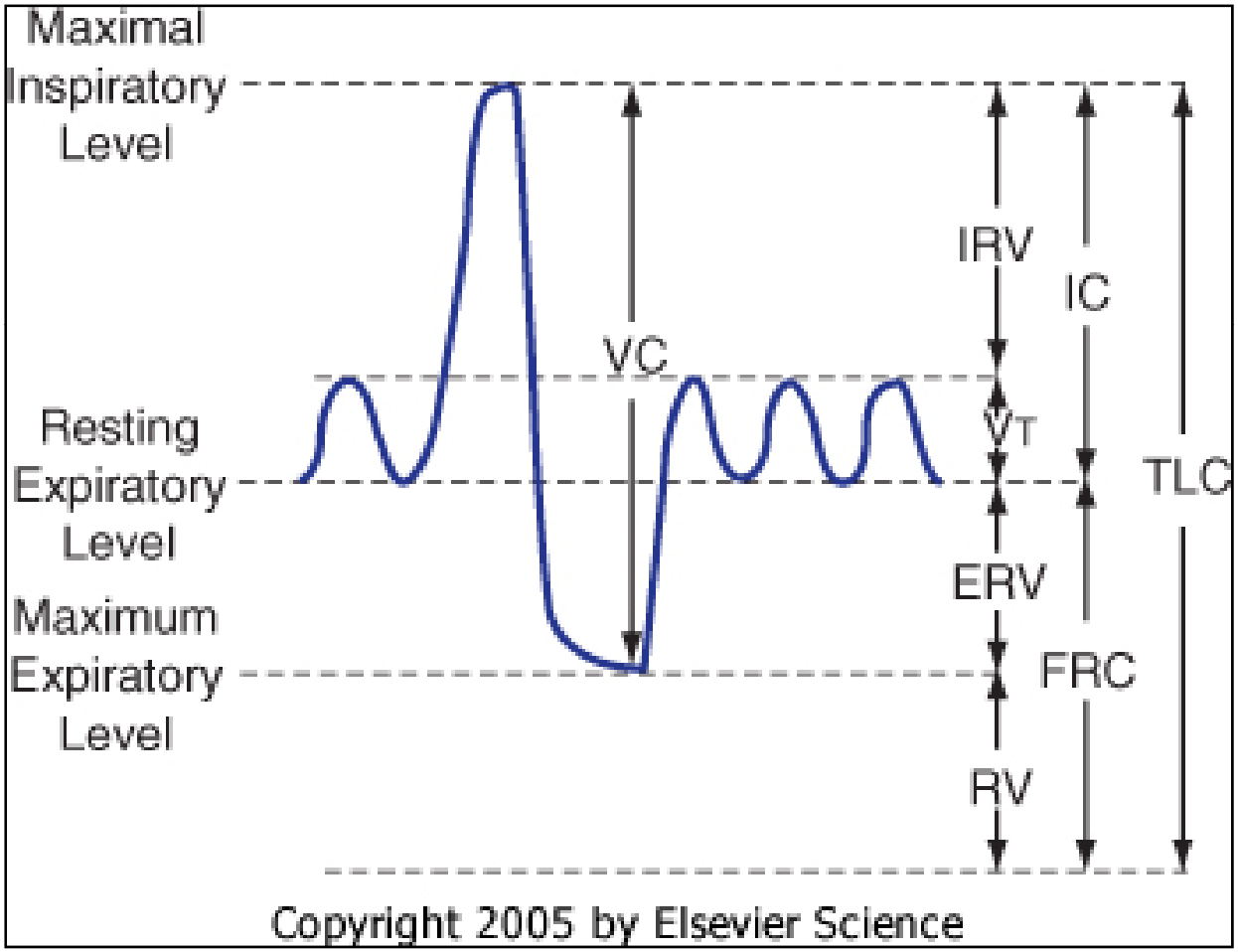
- MI within 1 month on testing
- Hemoptysis of unknown origin
- Untreated pneumothorax
- Unstable Angina
- Thoracic aneurysm
- Abdominal aneurysm
- Recent eye surgery
- Recent thoracic or abdominal surgery (3-4 wks)

Flow Volume Loop and Volume Time Curves





Static Lung volumes



Spirometry Performance: ATS/ERS Criteria

- Good effort and absence of artifact
  - Sub-maximal effort manifest by variable or truncated peak flow
  - No cough or glottic closure – especially in first second of expiration
  - No leak
  - Watch for obstructed mouthpiece – tongue or dentures
  - Complete inhalation limb

Eur Respir J 2005; 26:319

Spirometry Performance: ATS/ERS Criteria

- Start-of-test
  - Abrupt take off without hesitation
  - Extrapolated volume < 5% of FVC or 0.15 L whichever is smaller
  - Reproducible peak flow

Eur Respir J 2005; 26:319

Spirometry Performance: ATS/ERS Criteria

- End-of-test
  - Minimum exhalation time of 6 sec (3 sec for children) or a plateau seen (< 25 ml volume change for 1 sec)
  - Incomplete exhalation will result in falsely low FVC and falsely high FEV1/FVC ratio

Eur Respir J 2005; 26:319

Keys To Good Spirometry – ATS/ERS Standards

Acceptability and Reproducibility Criteria

<u>Acceptability</u>
Must have a clear, quick start
Must be free from artifacts, including:
Cough or glottic closure, early termination, variable efforts, leaks, or obstructed mouthpiece
Must have a satisfactory exhalation - a minimum of 6 seconds or a plateau in the volume time curve

<u>Reproducibility</u>
After three acceptable spirograms, apply the following tests:
Are the two largest FVC & FEV1 measurements within 0.15 L?
If both criteria are met, the test session is concluded. If not, continue testing

<u>Three keys to a good quality test</u>

1. Taking in the largest possible breath before blowing.

2. A quick start with maximal effort (BLAST the air out)

3. A good duration of exhalation

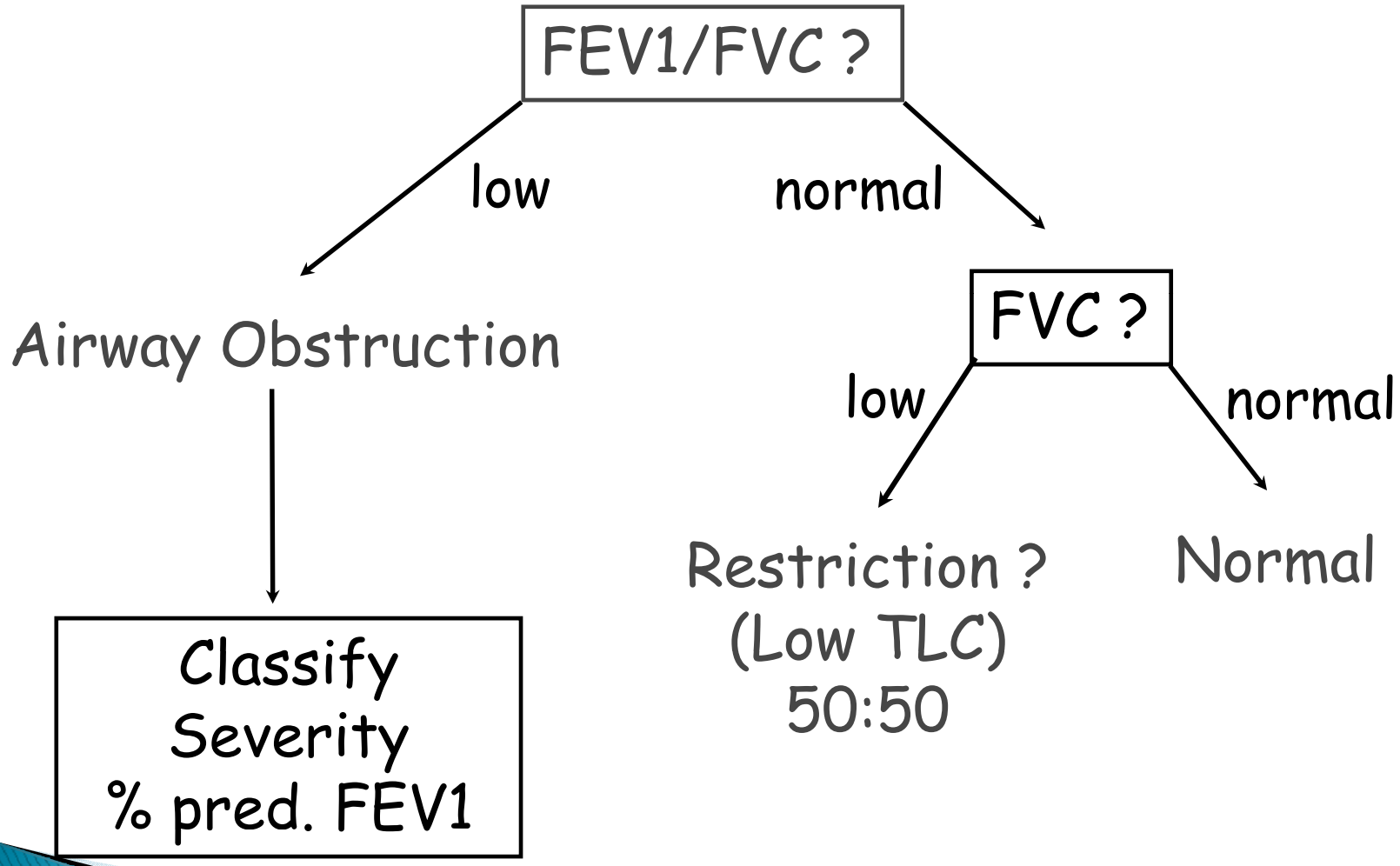
Eur Respir J 2005; 26:948

Factors that Reduce Lung Function

Reduced FVC –
*Intersititial disease
*Neuromuscular disease
*Pleural disease
*Chest wall abnormality (cardiomegaly)

Airway resistance – reduced FEV1
*Asthma
*COPD
*Bronchiolitis
*Upper airway obstruction

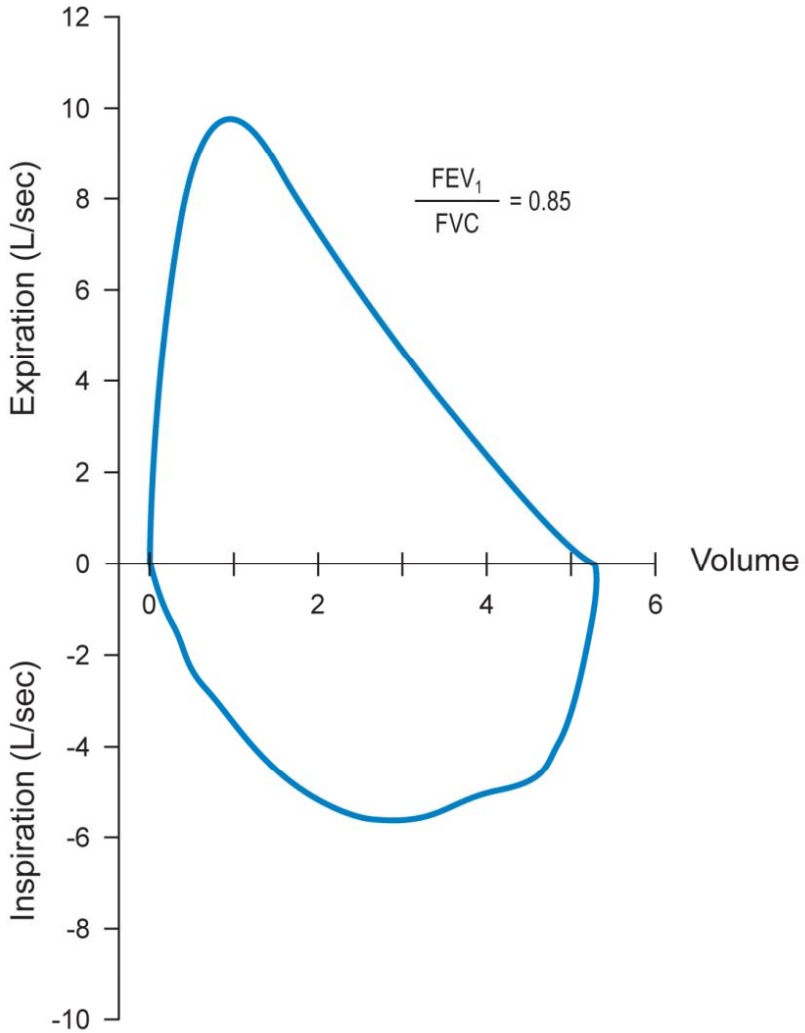
Spirometry Interpretation



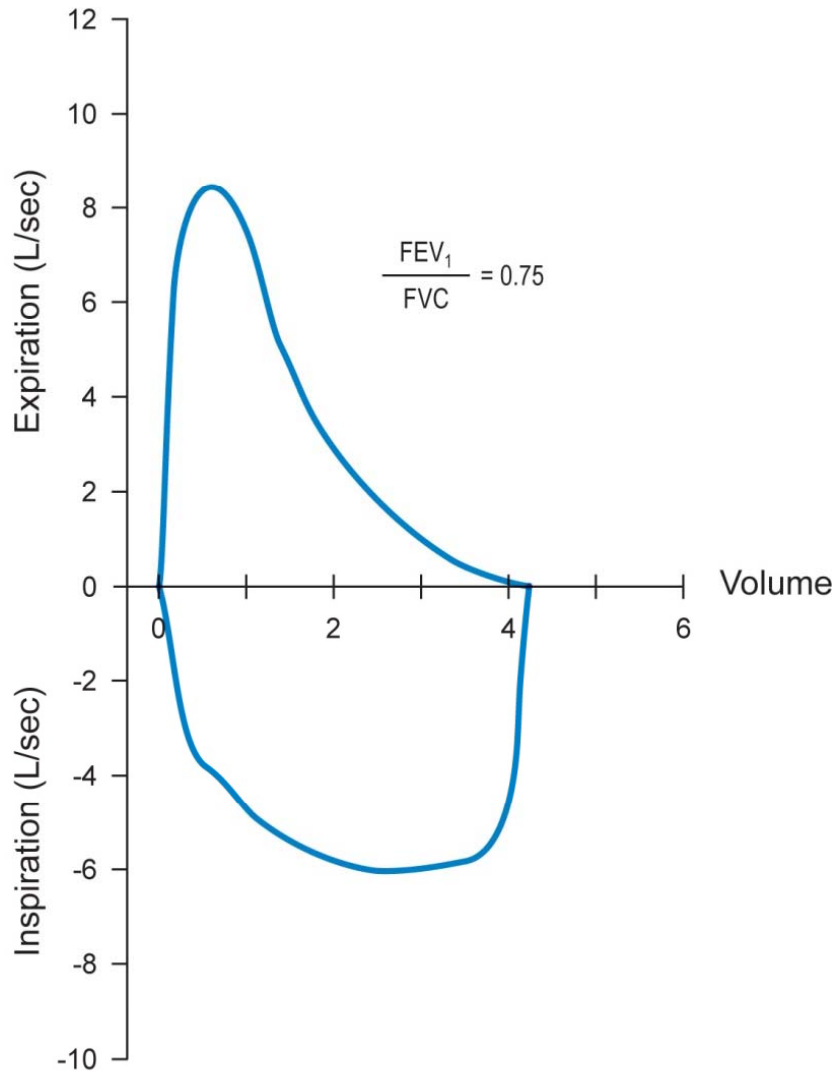
Definition of Obstruction and Classification of Severity by Spirometry

ATS/ERS $FEV_1/FVC<LLN$		GOLD $FEV_1/FVC<0.70$	
FEV_1 % Predicted			FEV_1 % Predicted
>70	Mild	Stage I: Mild	≥80
60-69	Moderate	Stage II: Moderate	<80
50-59	Moderately severe	Stage III: Severe	<50
35-49	Severe	Stage IV: Very severe	<30
<35	Very severe		

Normal 20 yr Male



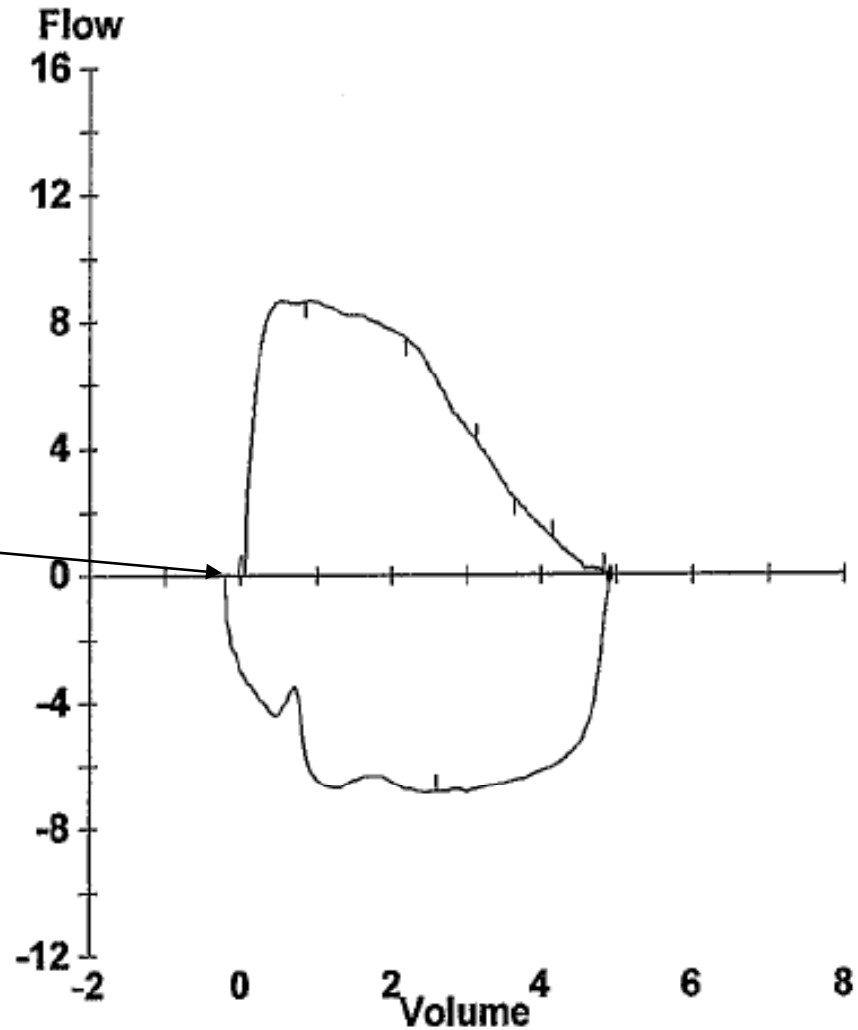
Normal 80 yr Male



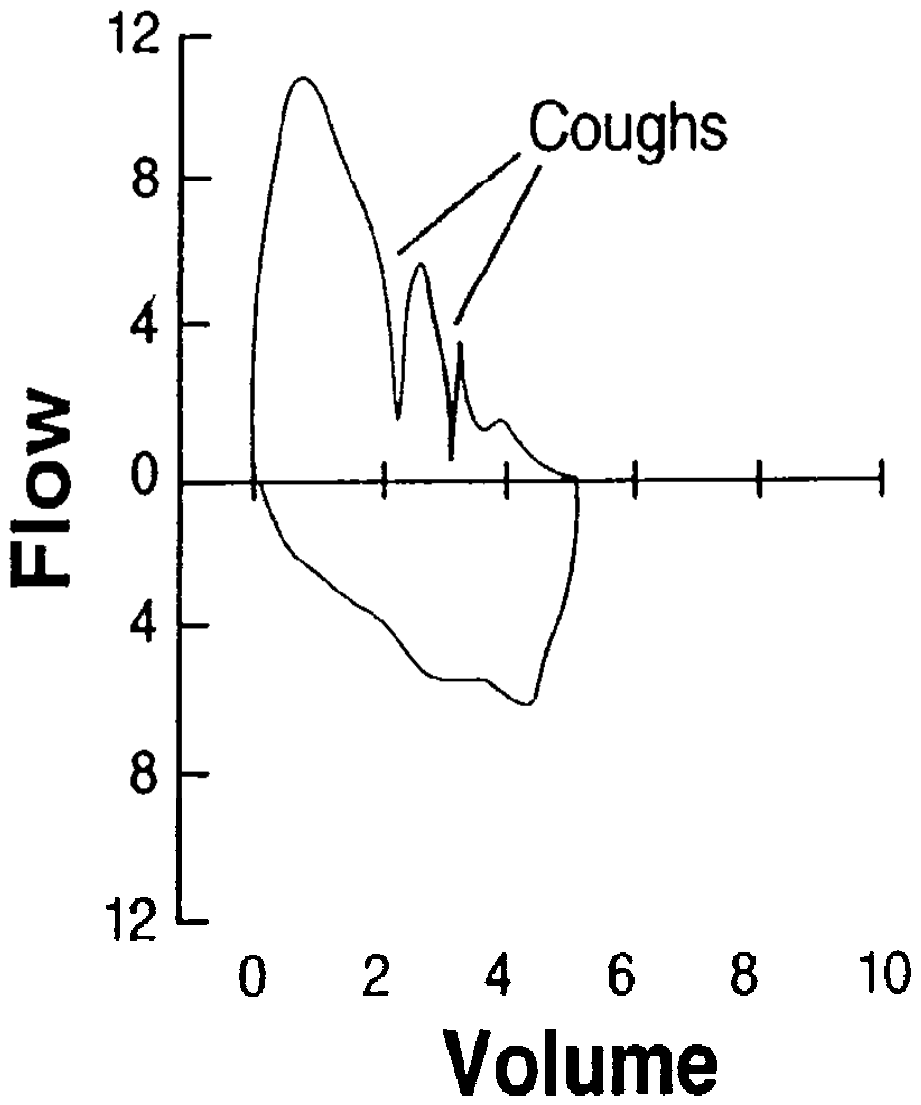
Faulty Spirograms

IVC > FVC

mouthpiece or nose clip leak

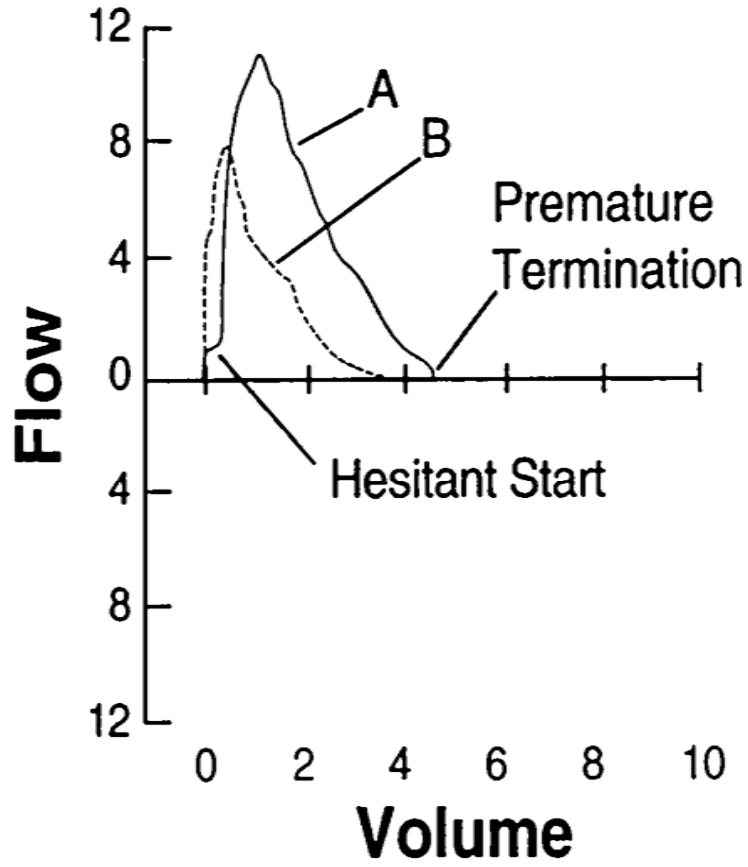


Faulty Spirograms



Coughs are characterized by sharp falls in flow followed by a sharp rise in flow which may rise above the flow volume envelope

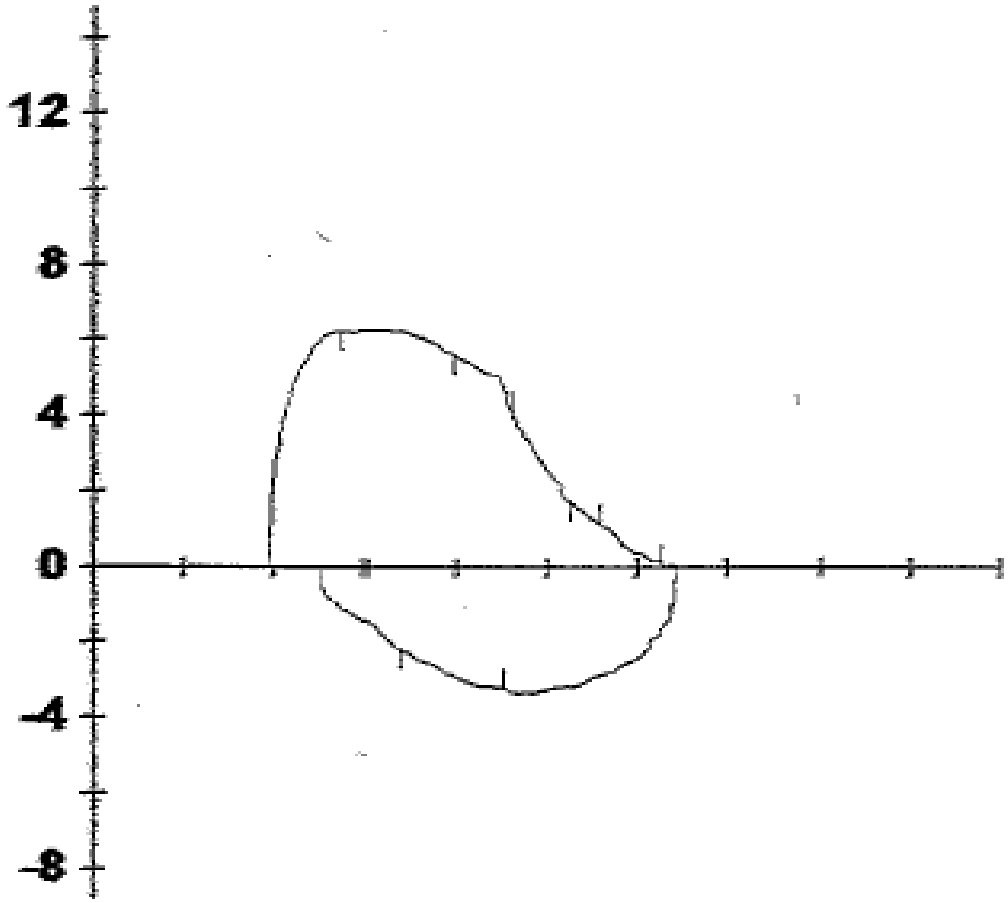
Faulty Spirograms



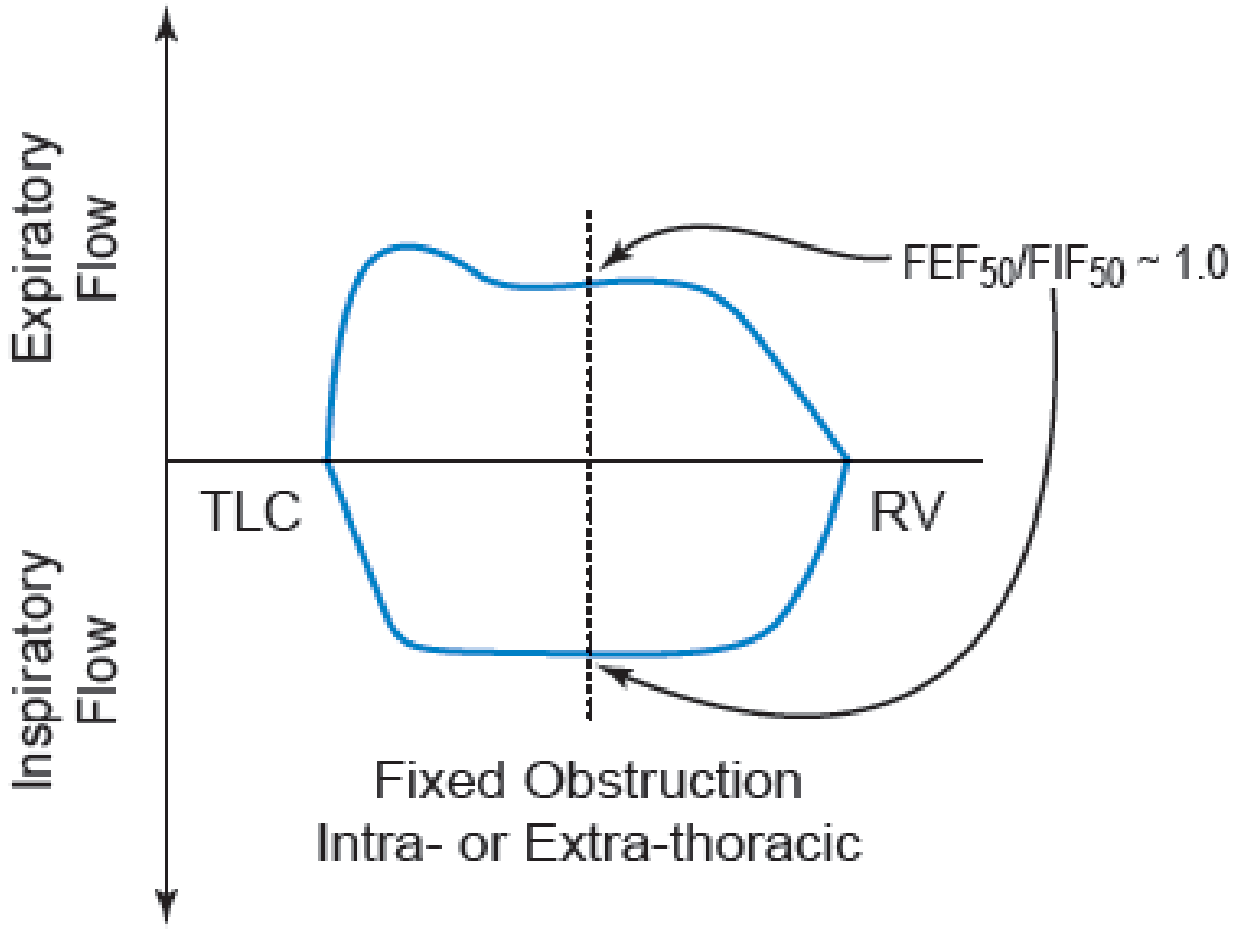
Tracing A shows a hesitant start and a premature termination of the spirogram

Tracing B illustrates the effect of a submaximal inhalation with a good start of test. It looks like a good test but it is small compared to tracing A

30 yo patient with dyspnea and reflux – diagnosis of asthma but no improvement with ICS:
WHY?: Upper Airway Obstruction

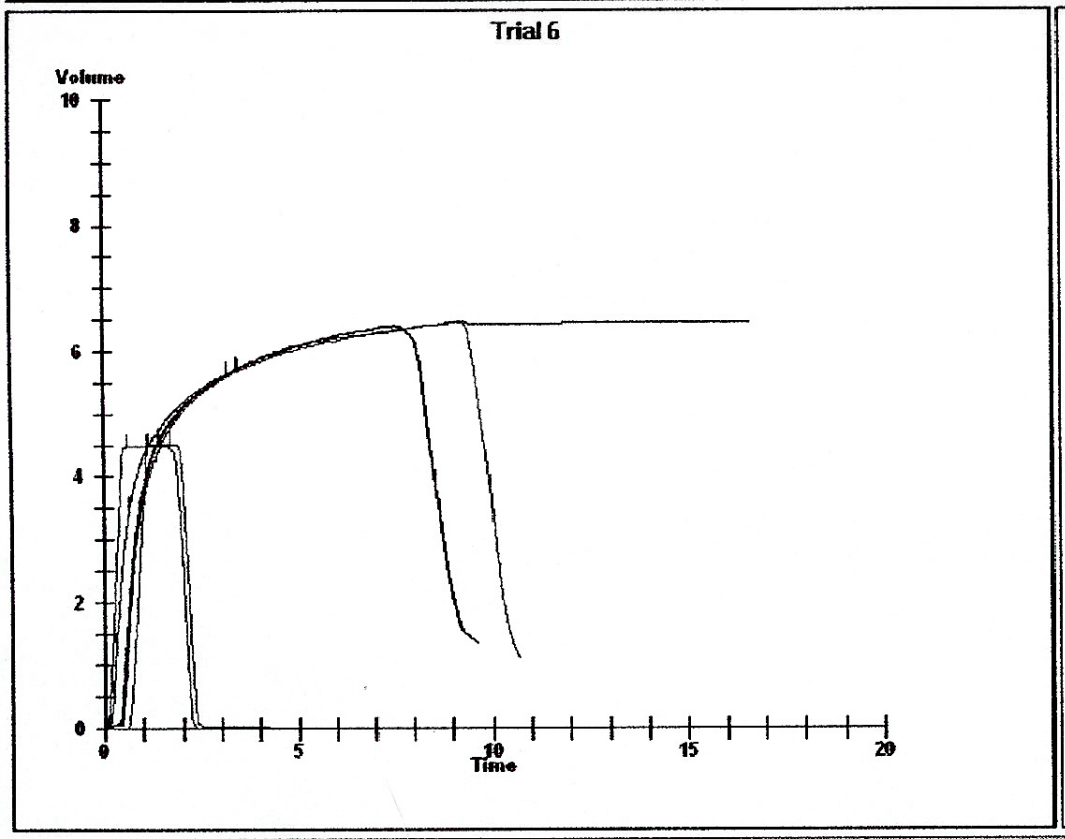


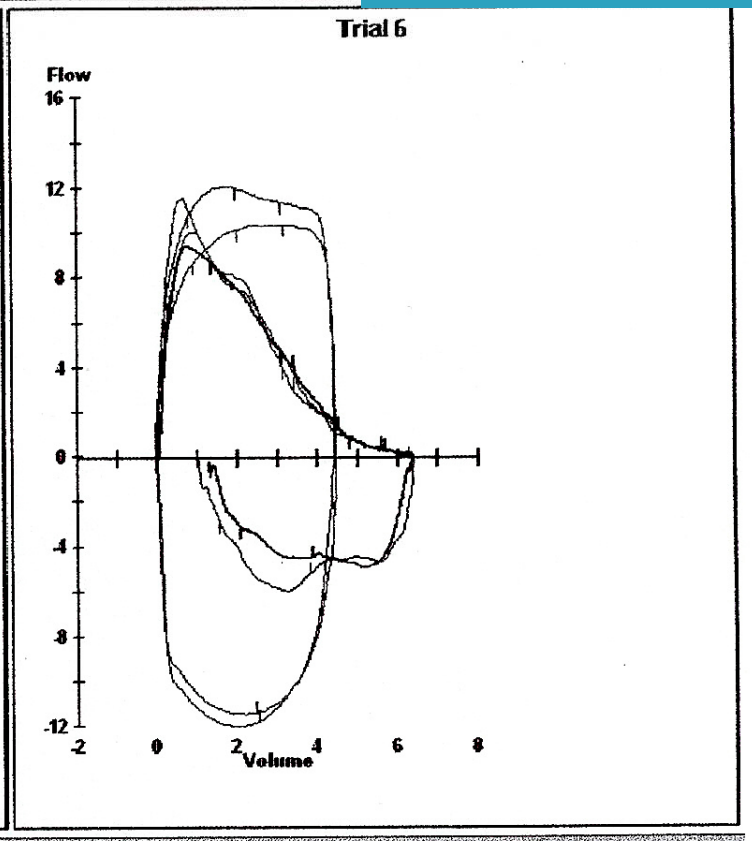
Upper Airway Obstruction Patterns



	Ref	Best	% Ref	1	2	3	4	5	
FVC	4.63	6.47	140	4.60	6.39	6.46	6.47	4.52	4.48
FEV1	3.50	4.57	131	4.30	4.57	4.49	4.49	4.52	4.48
FEV1/FVC	76	71		93	71	70	69	100	100
FEV3/FVC	90	88			89	87	88		
PEF		12.16		9.64	9.48	10.14	11.66	10.46	12.16

3 liter syringe injections Should be ~ 3.3 liters d/t BTPS Correction



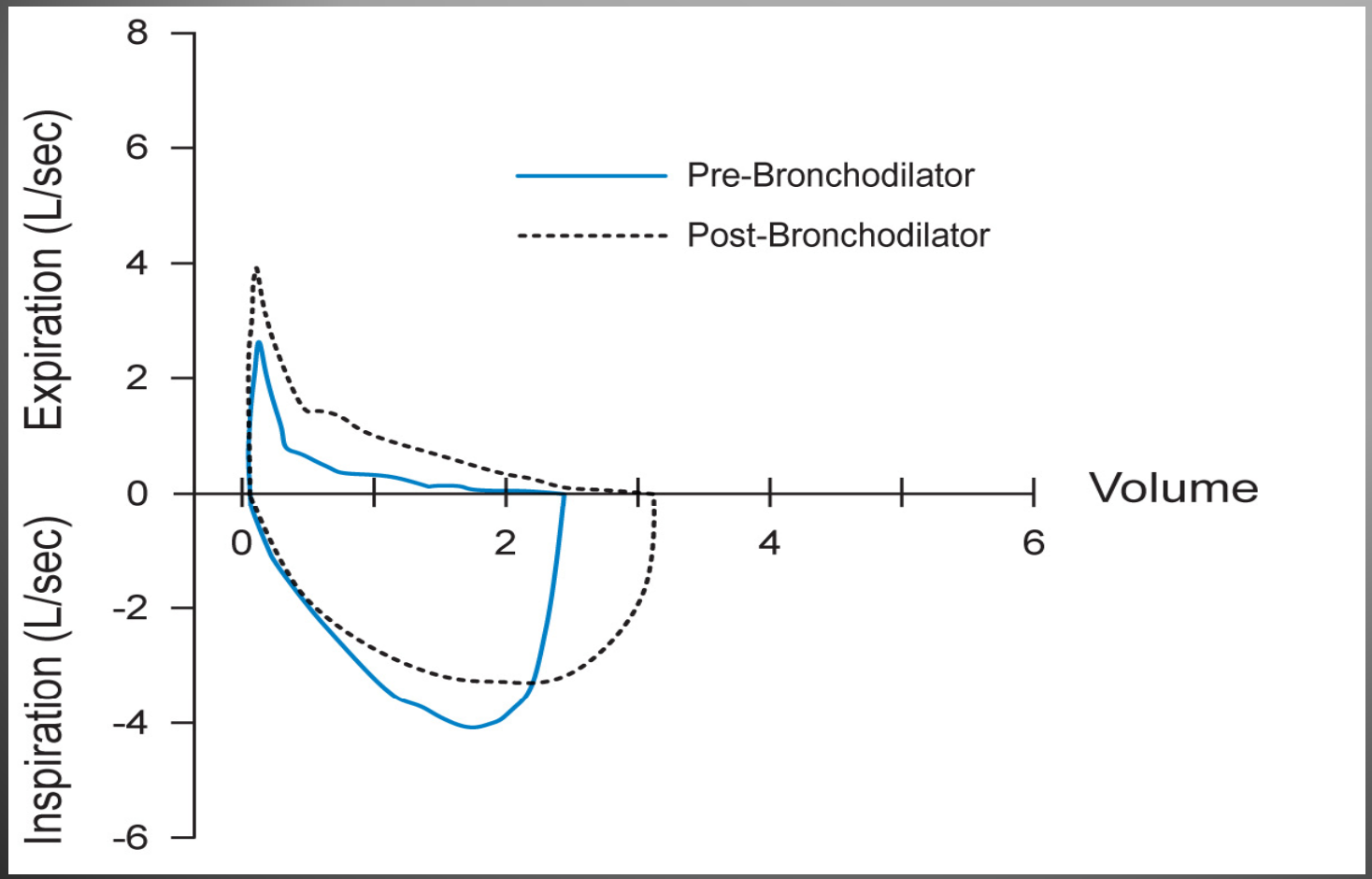


BD Testing Procedure

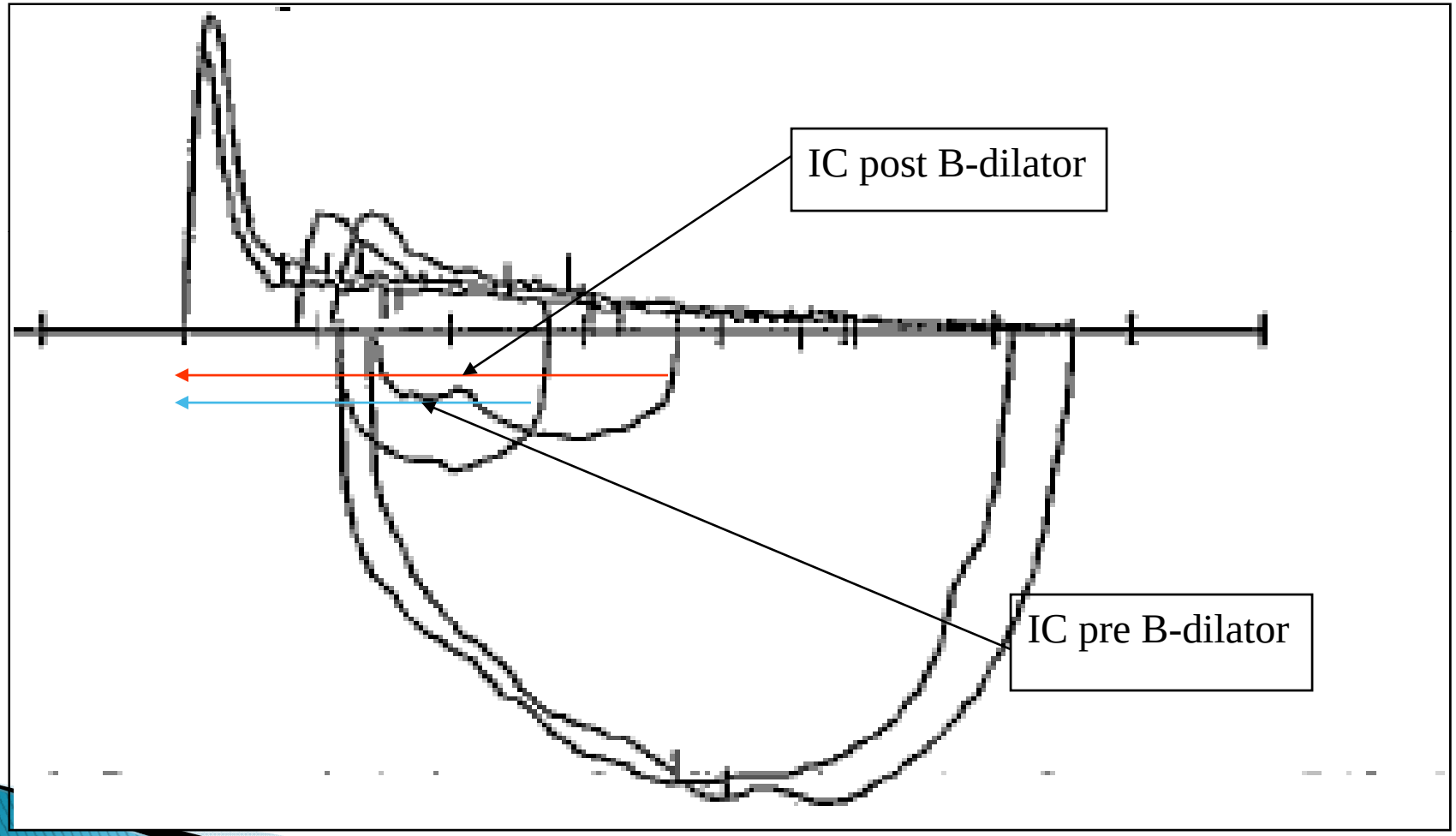
1. Obtain acceptable baseline spirometry
2. Administer albuterol 4 puffs with spacer
3. Wait 15 minutes and then repeat spirometry

A positive test is an improvement in FEV1 or FVC of 12% and 200 mL

SPIROMETRY TRACING AFTER BRONCHODILATOR



Not According to ATS/ERS but Note Improvement in Inspiratory Capacity (IC)



SUMMARY

1. Simple spirometry can obtain diagnosis information.
2. If done incorrectly, values may be misinterpreted. Most common errors are wrong height/gender.
3. Pts. Need to be instructed and coached as needed.
4. Look at tracings first, then numbers.