

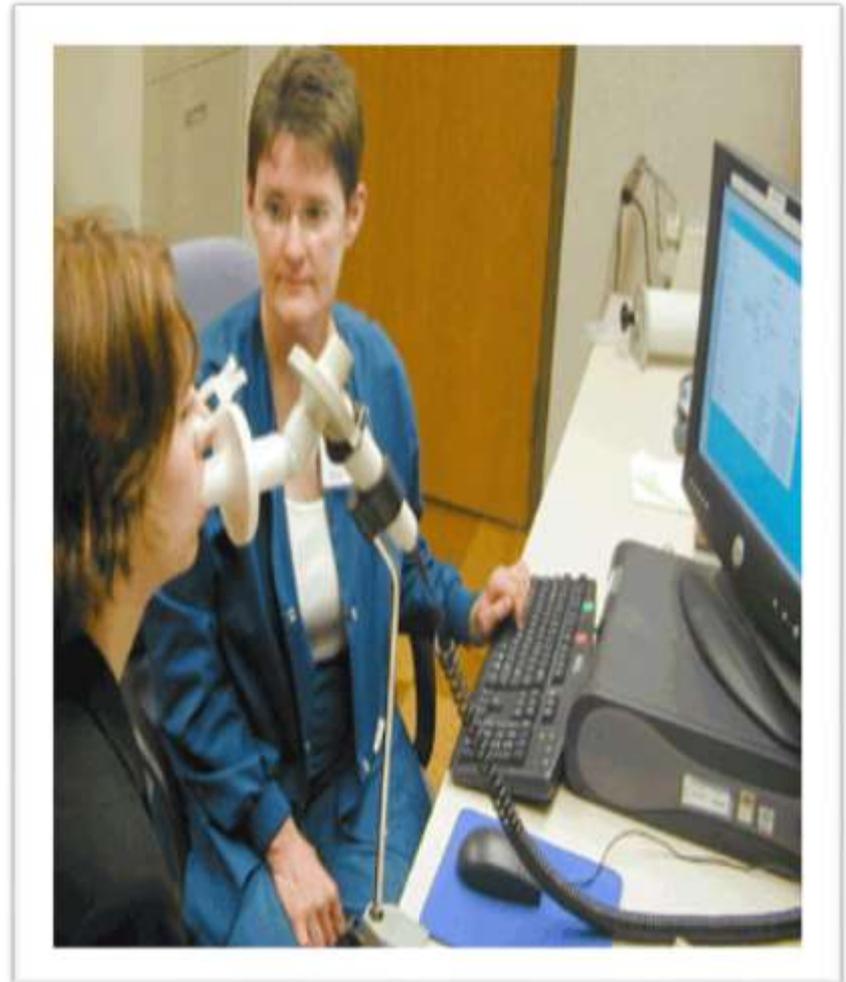
# Pulmonary Function Test

By

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**Assistant prof. of  
Pulmonology**

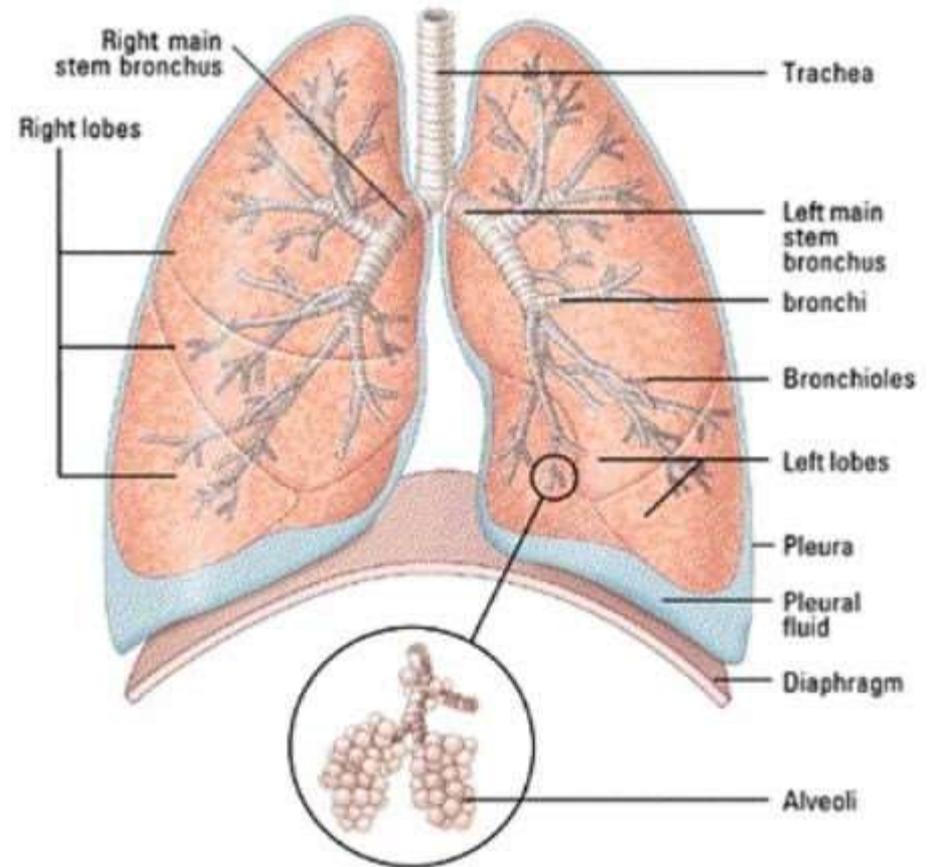
**Zagazig University,  
Egypt**



# Anatomy

- **Lungs comprised of:**

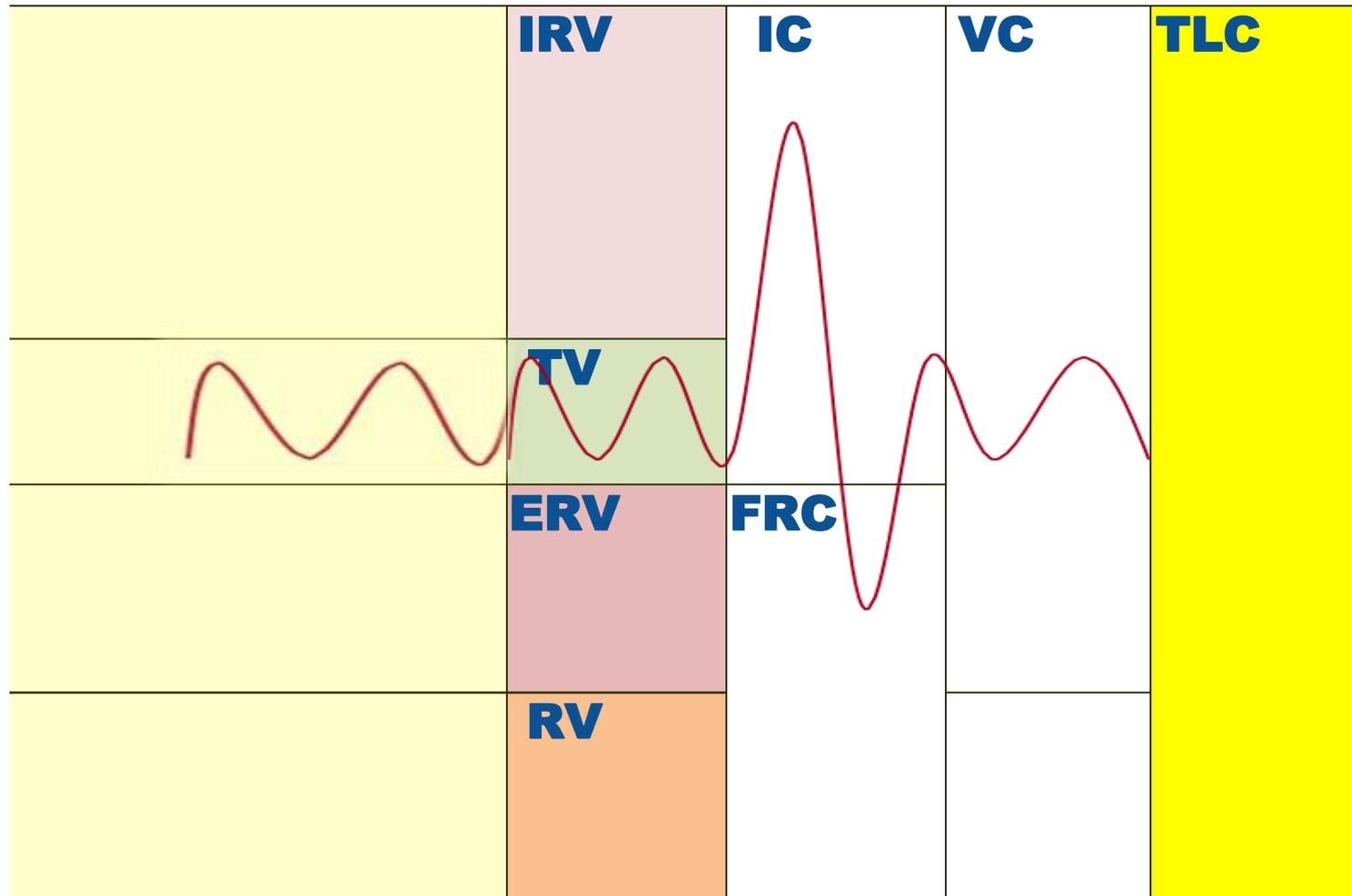
- **Airways**
- **Parenchyma**



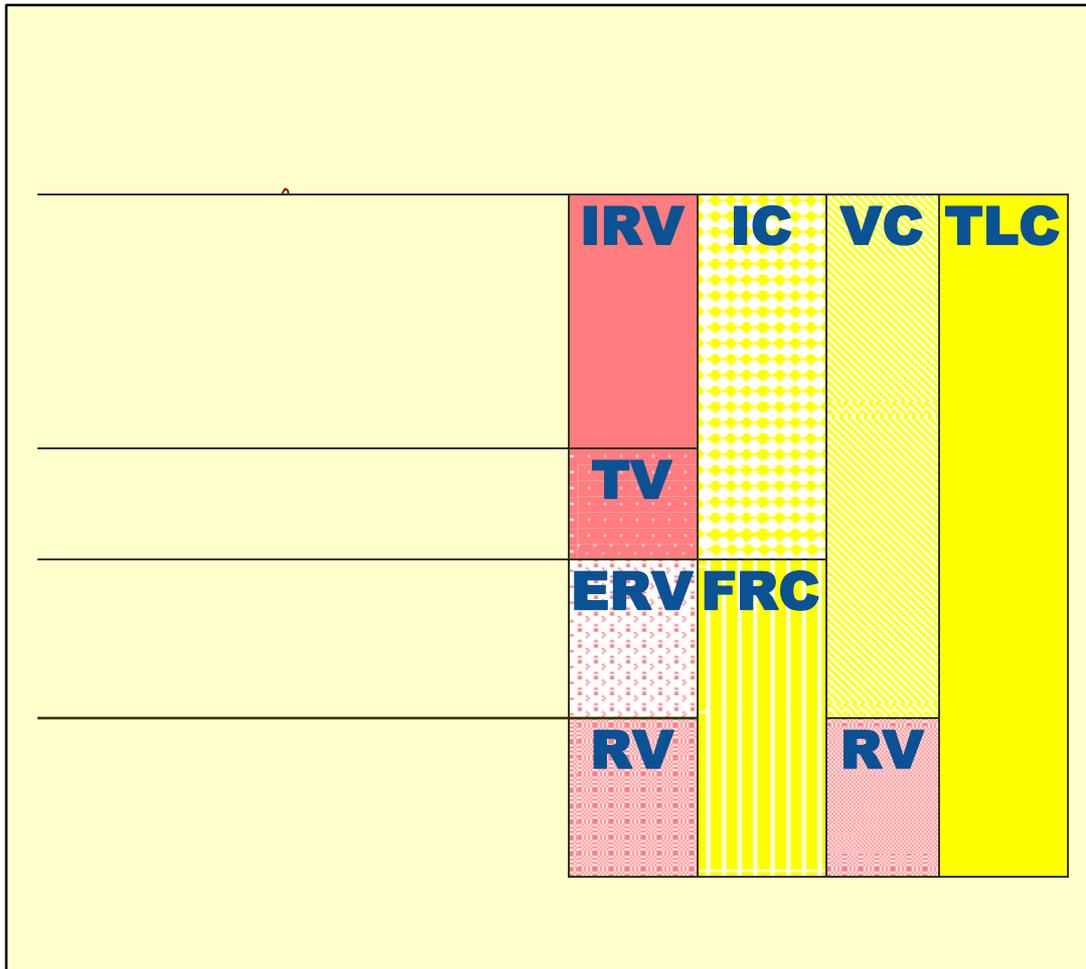
# Lung Volumes and Capacities

4 Volumes

4 Capacities: Sum of 2 or more lung volumes



# Vital Capacity (VC)



Volume of air that can be exhaled from the lungs after a maximum inspiration

FVC: when VC exhaled forcefully

$$VC = IRV + TV + ERV$$

N- 3 - 5 L.

(50-70 ml /kg)

# Indications for PFT

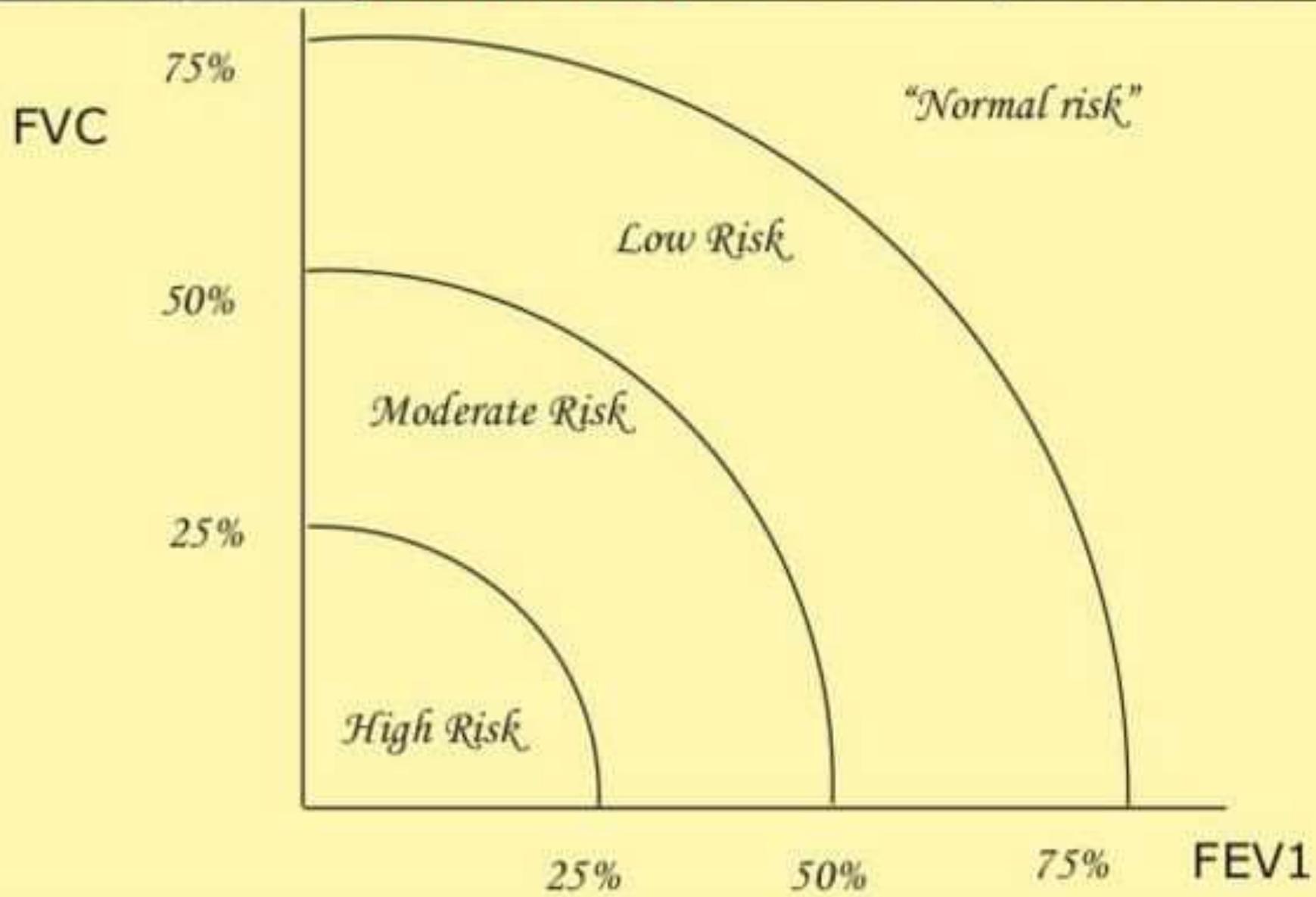
- 1. Diagnostic**
- 2. Monitoring the course of the disease and  
Evaluation of treatment**
- 3. Measure effects of exposures**
- 4. Disability/Impairment Evaluations by Measuring  
the effect of disease on PFT**

## **5- Assess pre-operative risk:**

- **Age > 70 yrs.**
- **Morbid obesity**
  
- **Smoking history and chronic cough**
- **Any known pulmonary disease**
  
- **Thoracic or Cardiac surgery**
- **Upper abdominal surgery**



# Pre-operative Evaluation For Surgery **Other Than** Pulmonary Resection



## Relative contraindications for spirometry

1. **Hemoptysis** of unknown origin (may aggravate underlying condition.)
2. **Pneumothorax**
2. **Recent abdominal or thoracic surgery**
3. **Recent eye surgery** (increases in intraocular pressure during spirometry)
4. **Recent** unstable angina or old myocardial infarction
2. **Thoracic, abdominal, or cerebral aneurysms** (risk of rupture because of increased thoracic pressure)

**Only Absolute Contraindication is:**

**Recent Myocardial Infarction  
within the Previous Month**

# **Possible side-effects**

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- 1. Dizziness and Syncope.**
- 2. Bronchospasm (e.g. Asthma)**
- 3. Increased intracranial pressure**
- 4. Pneumothorax (very rare)**
- 5. Nosocomial infections (very rare)**

# Preparation & instructions to the patient

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- 1- **Information about the purpose of the maneuver.**
2. **Demonstrating of breathing maneuver:** Possible even without spirometer. This can save a lot of time spent on repeated measurements.
3. Tell the pt. that **only the maximal effort** will lead to a reliable result. This may enhance his motivation to follow the instructions correctly.

# Guidelines for Holding Medical Drugs before spirometry

Inhaled bronchodilators	
• Short acting	4-8 hours
• long acting	24 hours
Oral short acting B- Agonists	8 hours
Oral long acting B- Agonists	24 hours
Anticholinergic	6 hours
Theophylline	
• twice daily preparations	24 hours
• once daily preparations	48 hours

Patient takes a deep breath and blows as hard as possible into tube

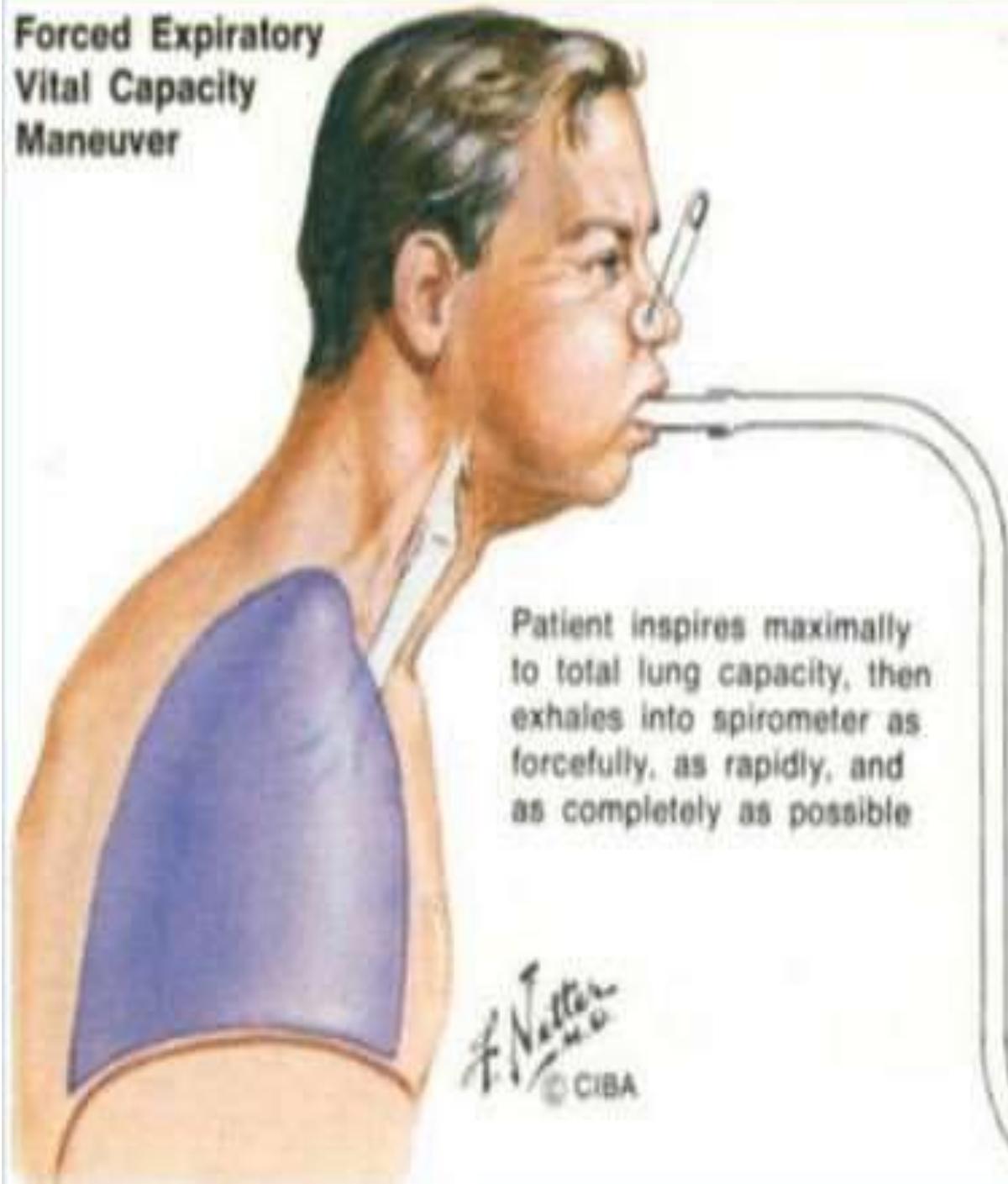
Clip on nose

Technician monitors and encourages patient during test

Machine records the results of the spirometry test

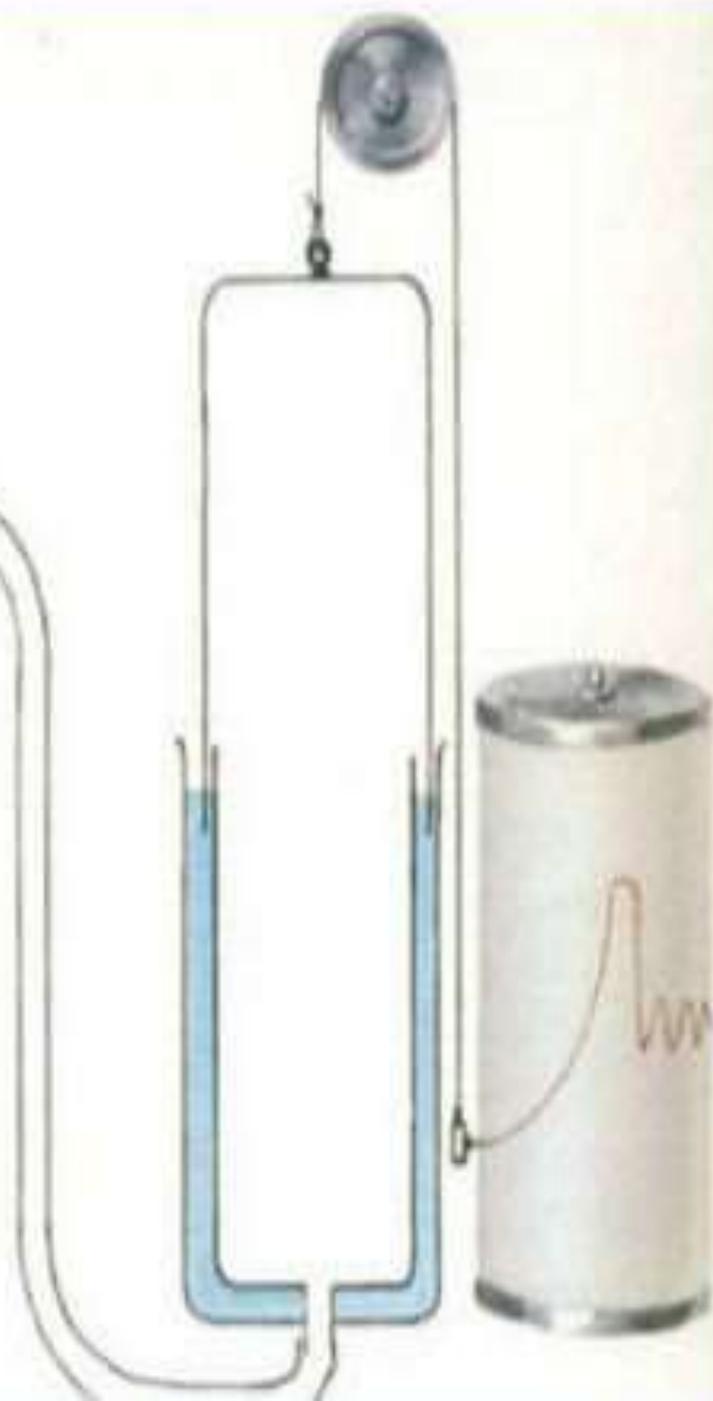


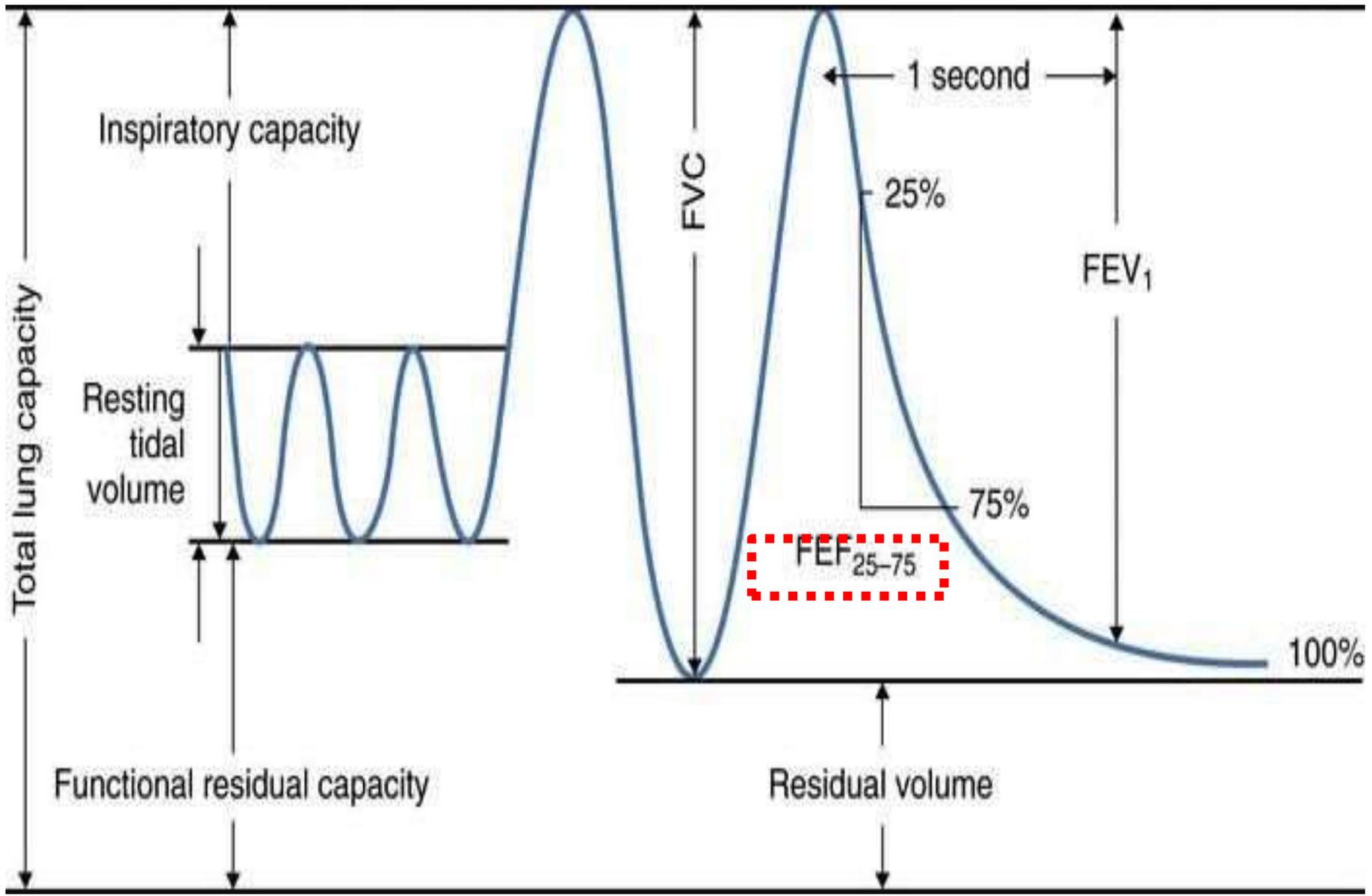
## Forced Expiratory Vital Capacity Maneuver

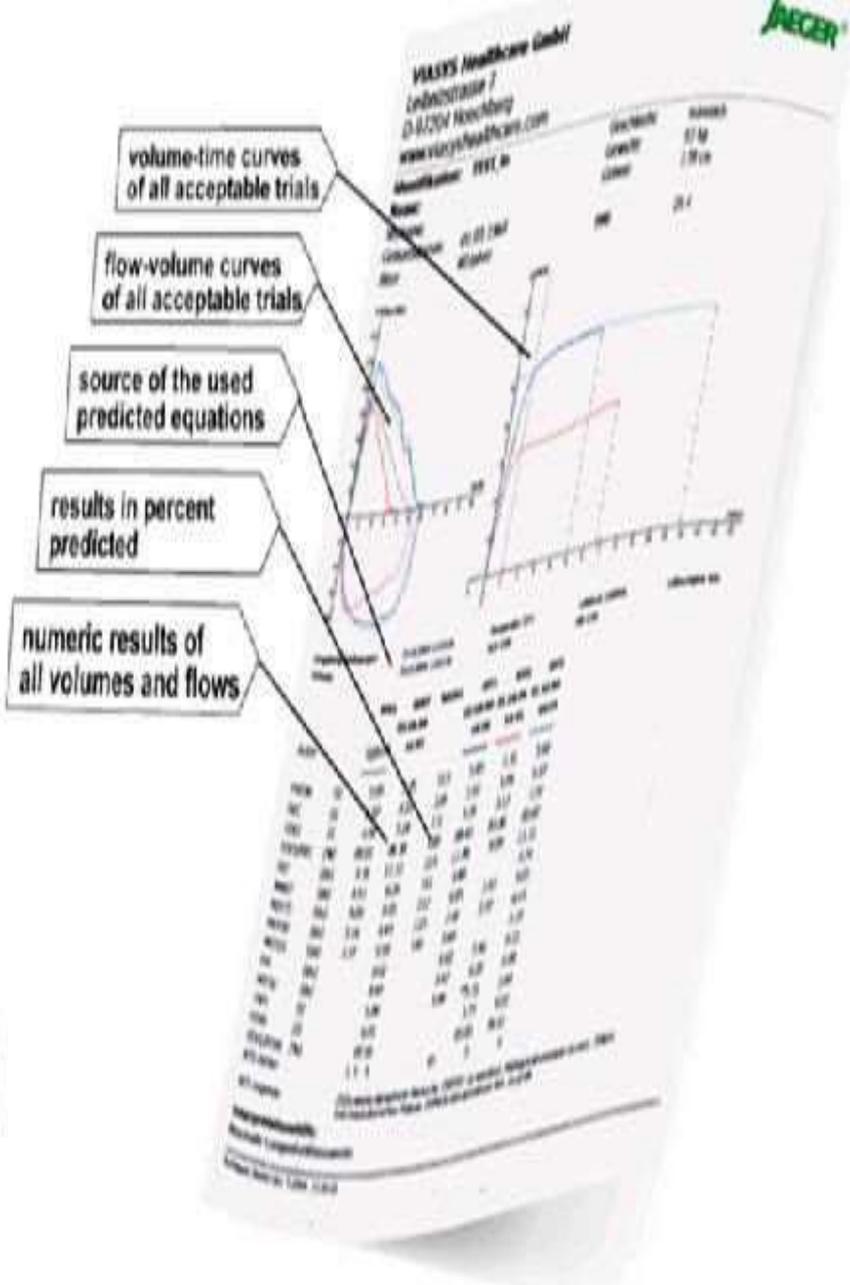


Patient inspires maximally to total lung capacity, then exhales into spirometer as forcefully, as rapidly, and as completely as possible

*F. Netter*  
© CIBA







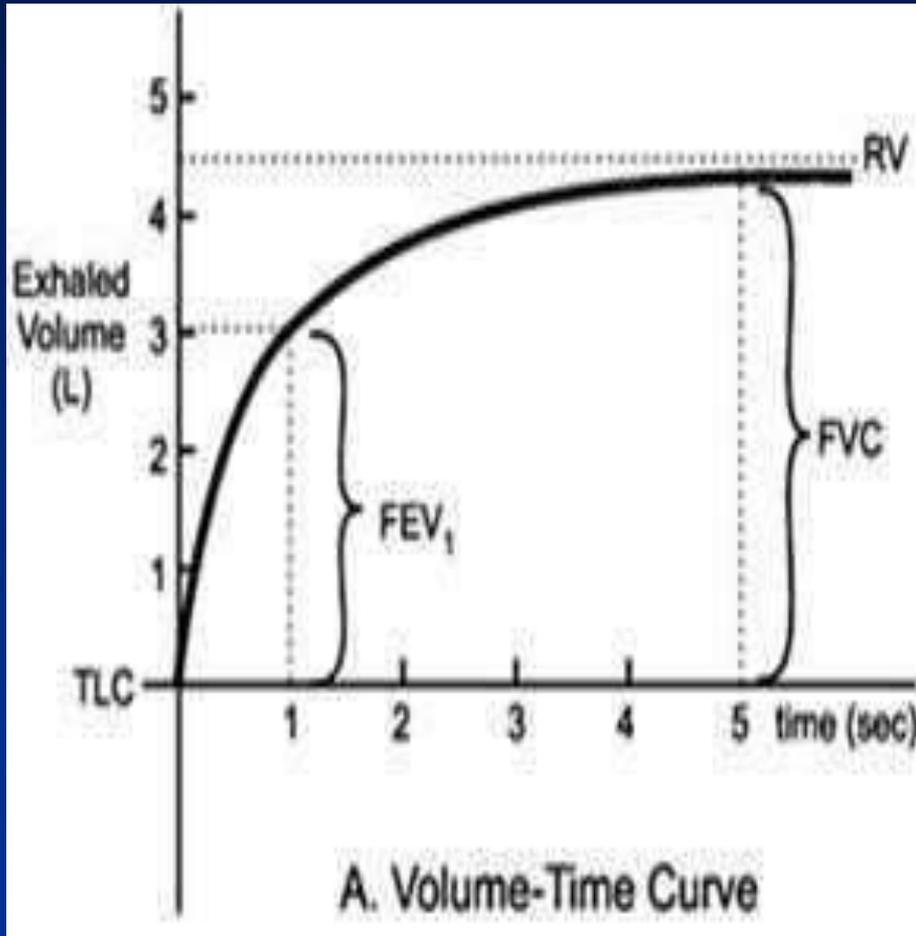
# Factors That Affect predictive values

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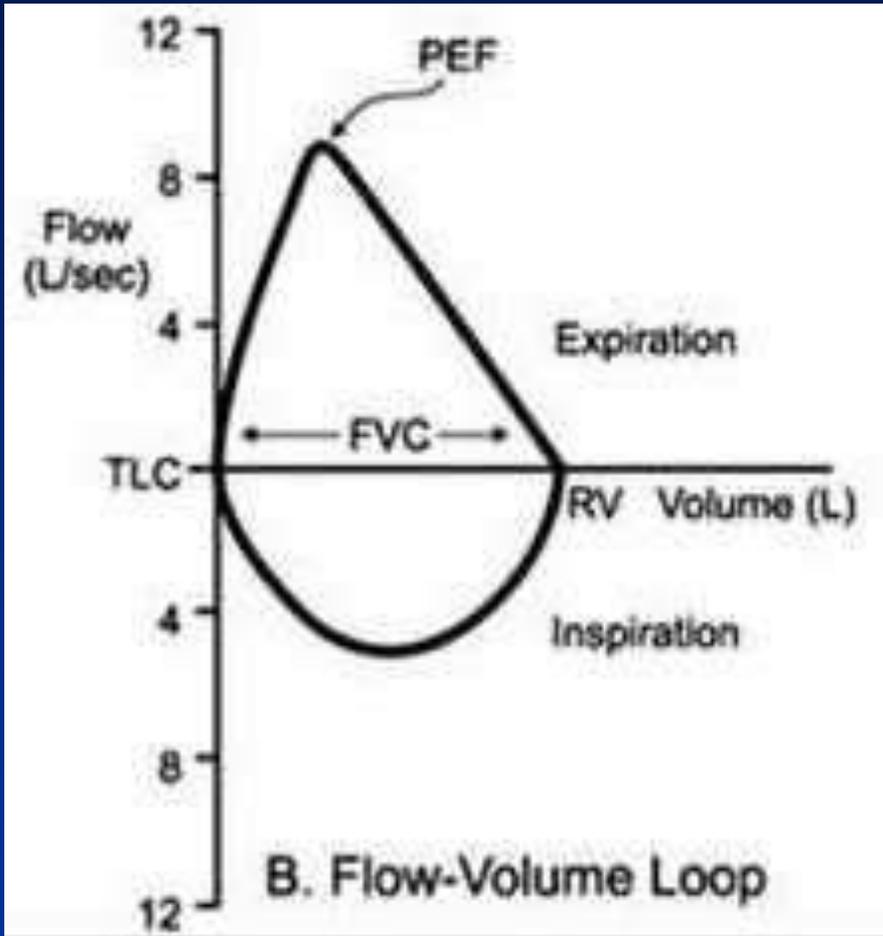
1. Age
2. Sex
3. Height
4. Weight
5. Race
6. Smoking

# 1. Volume Time Graph

it displays the expiration.

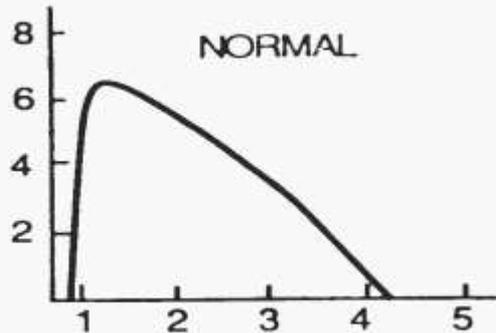


# 2. Flow-volume loops



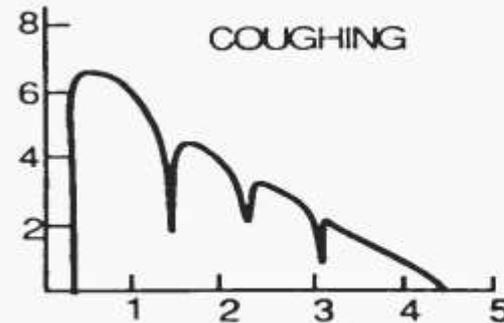
# Spirometry Quality

FLOW (L/SEC)



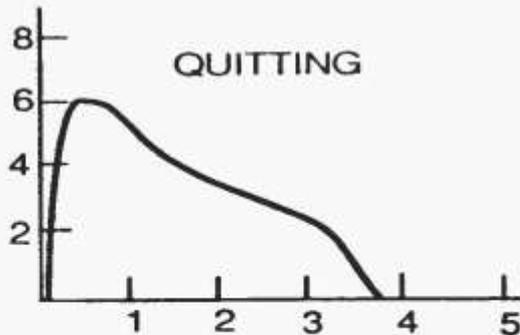
EXHALED VOLUME (LITERS)

FLOW (L/SEC)



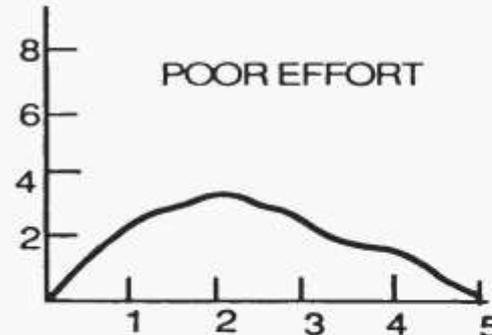
EXHALED VOLUME (LITERS)

FLOW (L/SEC)



EXHALED VOLUME (LITERS)

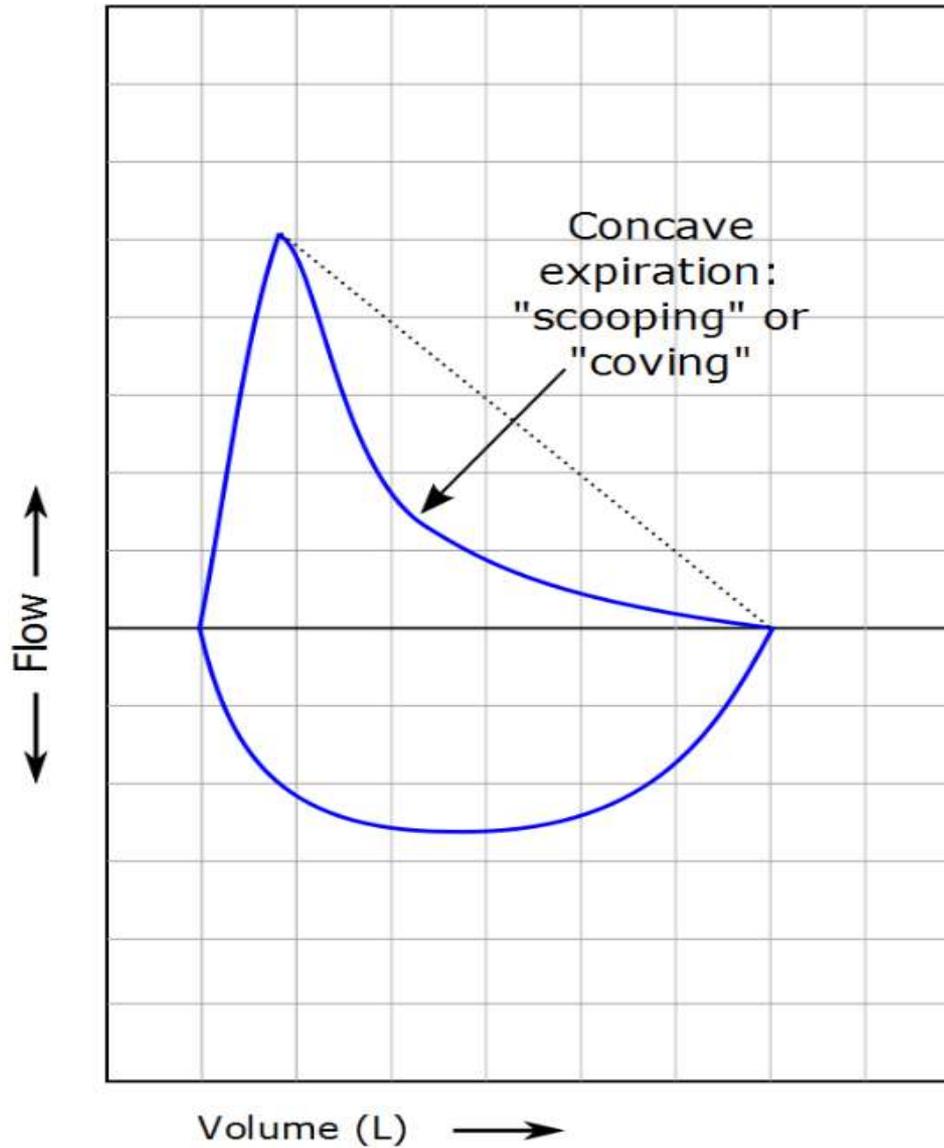
FLOW (L/SEC)



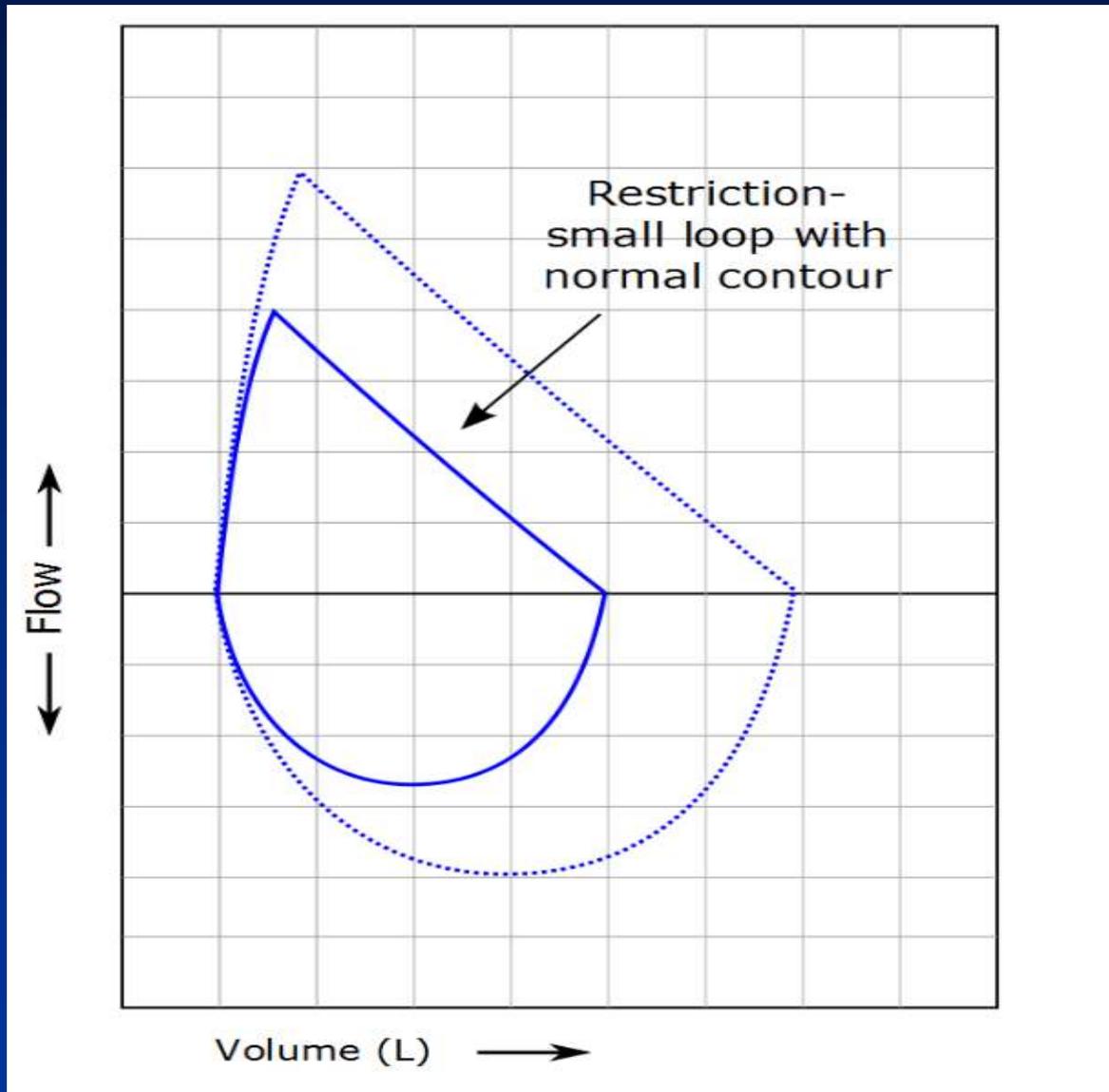
EXHALED VOLUME (LITERS)

**Figure 5.** Normal versus inadequate spirometry tracings. The value of pattern recognition cannot be overemphasized in the interpretation of spirometry results.

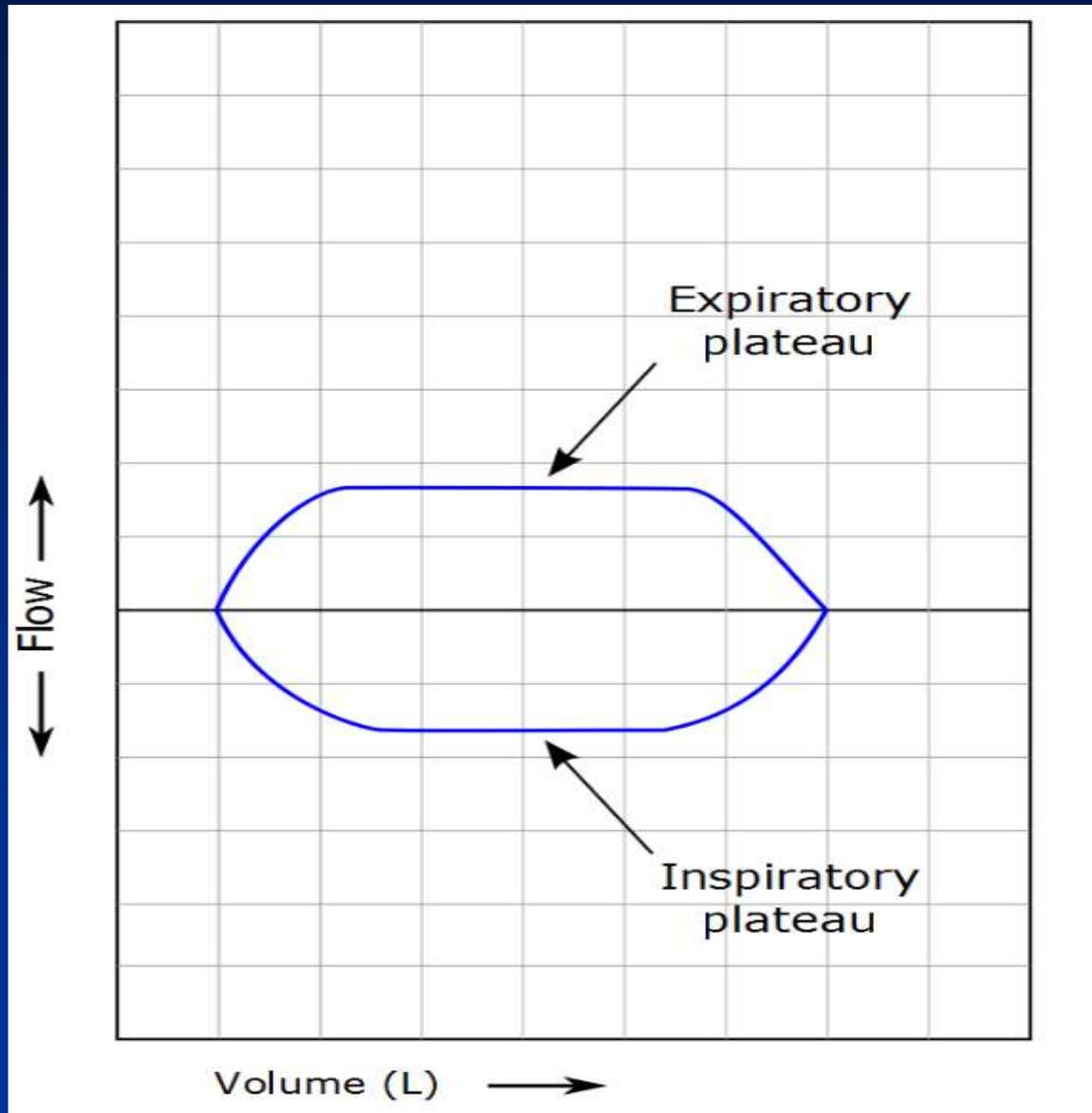
# Patterns in obstructive lung disorders.



# Patterns in restrictive lung disorders.



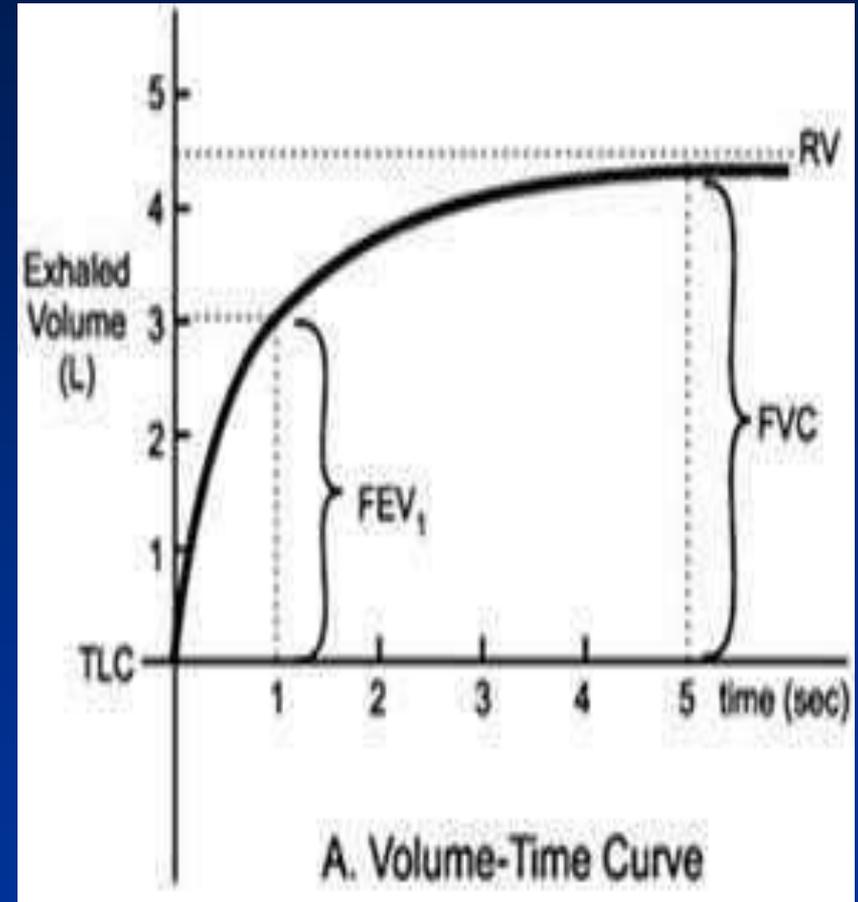
# Patterns in fixed UA Obstruction.



# Forced Vital Capacity (FVC)

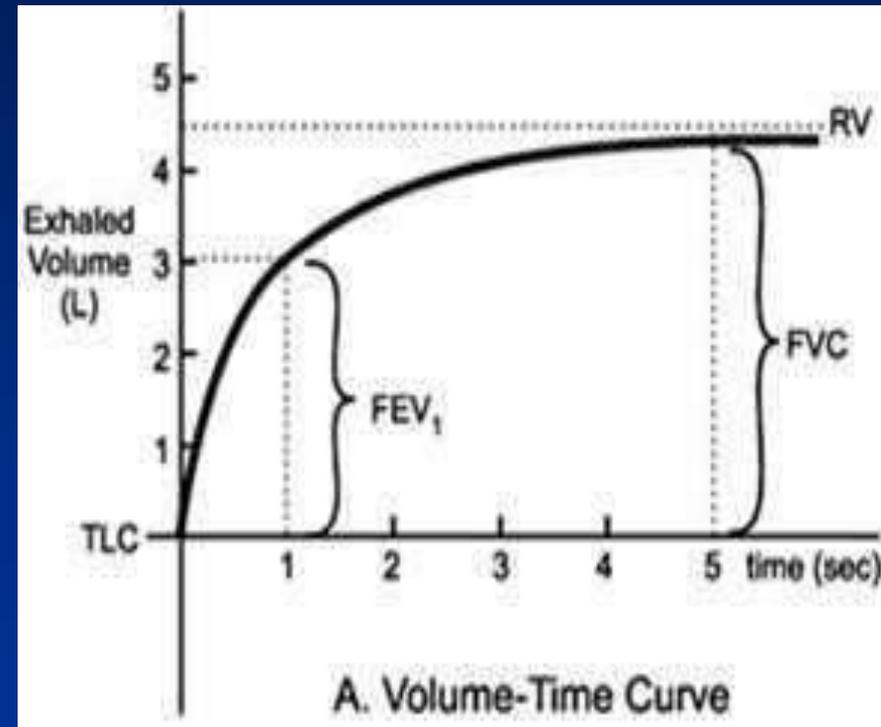
- The total amount of air expired as quickly and forcefully as possible after deepest breath.

- Normal >80%



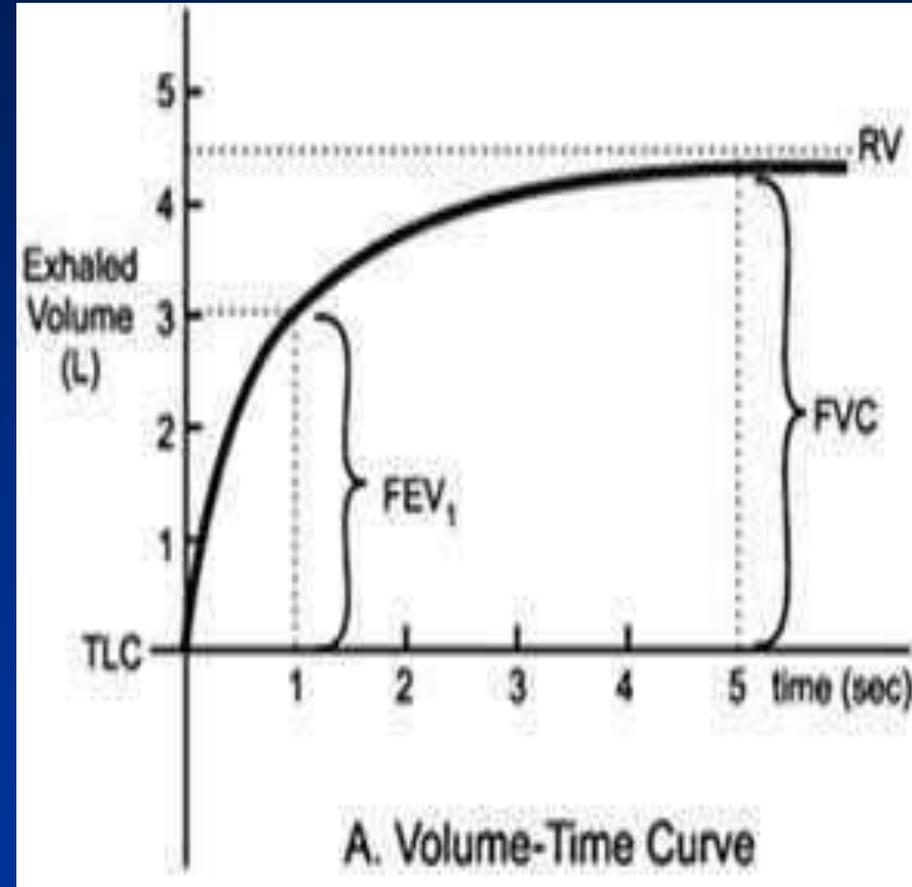
# *Forced expiratory volume in first second (FEV<sub>1</sub>) :*

- Volume of air which can be exhaled from in the first second of a forced expiratory maneuver.
- **Normal people can exhale more than 75% of their FVC in the first second.**
- **Normal >80%**



# *FEV<sub>1</sub>/FVC*

- Ratio of FEV<sub>1</sub> to FVC :
- It indicates what percentage of FVC was expelled during the first second
- **This value is critically important in the diagnosis of obstructive and restrictive diseases**
- **Normal >70%**



# P.E.F. – Peak Expiratory Flow

The highest flow achieved from a maximum forced expiratory manoeuvre. Can be expressed in litres per second, or litres per minute.

## FEF<sub>25%</sub>

Mean forced expiratory flow during the first 25 % of FVC.

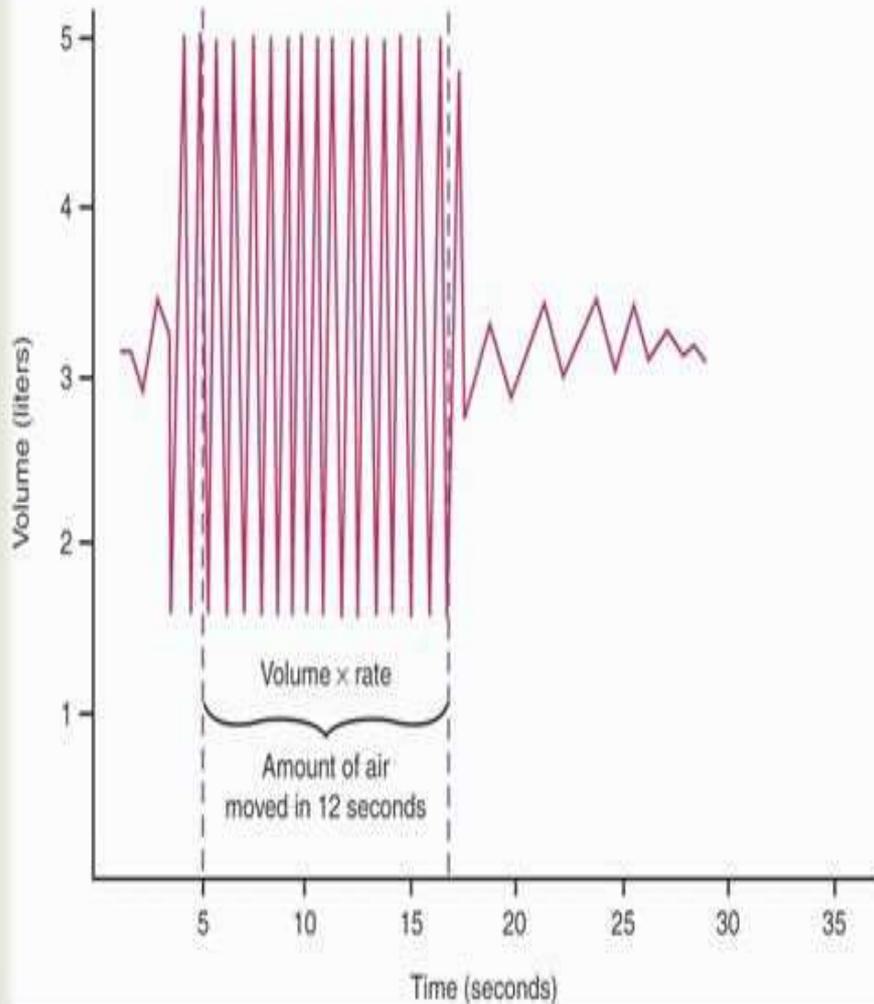
## FEF<sub>75%</sub>

Mean forced expiratory flow during the first 75 % of FVC.

## FEF<sub>25%-75%</sub>

Mean forced expiratory flow during middle half of FVC.

**A measure for small airway dysfunction**



- MVV

*It's the maximum volume of air which can be respired in 1min. By deepest and fastest breathing*

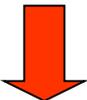
- **Test of entire respiratory system**
  - **Respiratory Muscles,**
  - **Compliance,**
  - **Airway resistance**
- **N- 150-175 L/min**

# Normal Values of PFT

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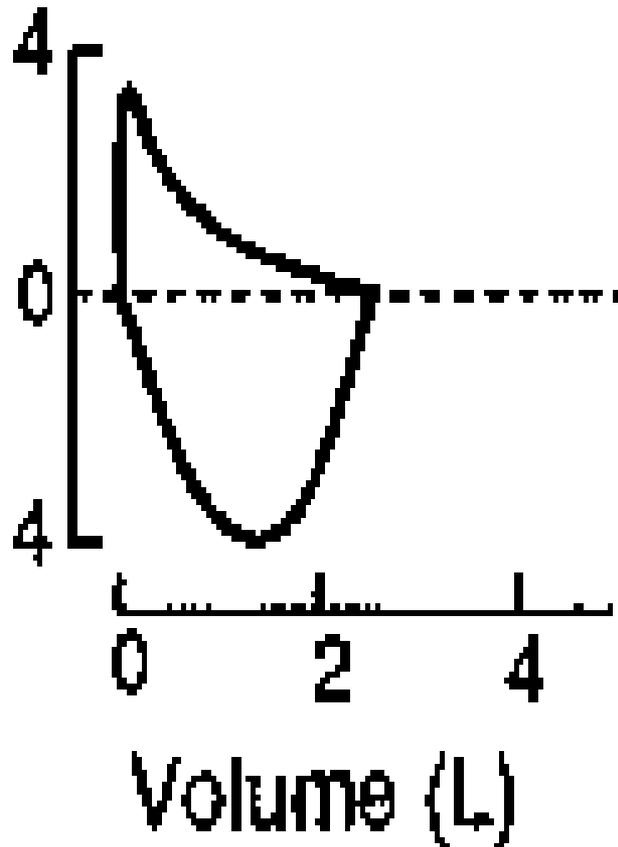
- FEV<sub>1</sub> ⇒ 80 – 120 %
- FVC ⇒ 80 – 120 %
- FEV<sub>1</sub> /FVC ⇒ > 70 %
- FEF<sub>25-75%</sub> ⇒ > 80 – 120 %
- TLC ⇒ 80 – 120 %
- FRC ⇒ 80 – 120 %
- RV ⇒ 80 – 120 %
- DLCO (Diffusing Capacity for CO) ⇒  
(N 15 - 30 ml/min/mmHg) > 80 – 120 %

**Obstructive V/S restrictive  
lung disease ???**

	Obstructive .	Restrictive
FEV1/FVC		
FEV1		
FVC		
TLC		
RV		
FRC		

# Obstructive Disorders

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Characterized by  
underlining airway  
obstruction especially  
during expiration

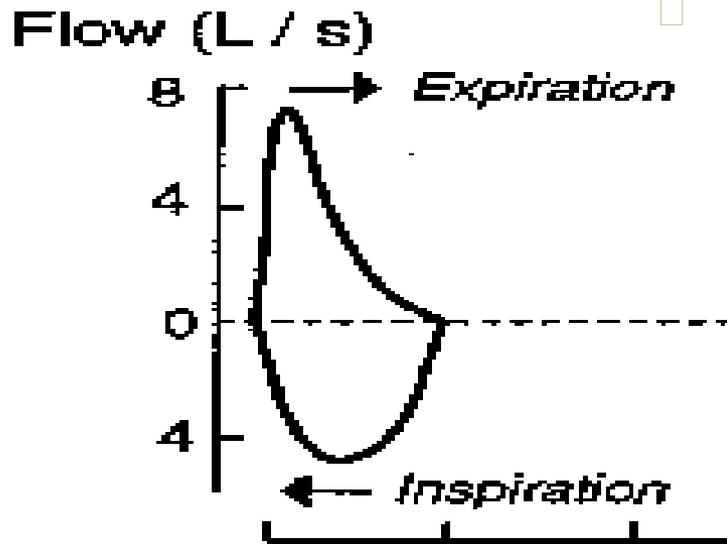
## Examples:

- Asthma,
- COPD
- Bronchiectasis
- Cystic fibrosis

# Restrictive Lung Disease

Characterized by diminished lung volume due to:

1. Change in lung parenchyma (interstitial lung disease)
2. Disease of pleura, chest wall, neuromuscular apparatus.



Decreased DLCO or normal according to the underlining aetiology

# Interpreting PFTs

## ■ Look at the Flow-Volume loop

- Determine acceptability of the test, and look for upper airway obstruction pattern.

## ■ Look at FEV<sub>1</sub>/FVC Ratio .

- <70% = obstructive lung disease

Then FEV<sub>1</sub>

- Grade severity of obstruction
- Check for reversibility

- Normal = restrictive lung disease or normal PFT

Then FVC

- If FVC is low = Restrictive lung disease
- If Normal = Normal pulmonary function

# **Remember:**

**Normal reduction of FEV1 is 30ml/year**

**Smokers: 90-150 mL/ year reduction**

A stack of several folders, with the top one being a light brown color. The word "REPORTS" is printed in blue, uppercase letters on the front of the top folder. The folders are stacked on a reflective surface, creating a faint reflection of the word "REPORTS" below it.

REPORTS

REPORTS

PRE Trial date 24/07/2003 14:34:17

Parameters	BTPS 1,092 25°C - 77°F	Pred	PRE	%Pred
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Best values from all loops

FVC	L	5,43	5,68	105
FEV1	L	4,49	5,12	114
FEV1/FVC	%	83,2	90,1	108
PEF	L/s	9,77	12,90	132

Values from best loop

FEF2575	L/s	4,71	7,33	156
FEF25	L/s	9,07	12,02	133
FEF50	L/s	5,56	7,21	130
FEF75	L/s	2,34	4,00	171
FEV3	L	5,04		
FET	s	6,00	2,06	34
FIVC	L	5,43	5,41	100
FIV1	L	4,49	5,10	114
FIV1/FIVC	%	83,2	94,3	113
PIF	L/s	9,77	6,07	62
ELA	Years	33	33	
EVC	L	5,43	6,11	113
IVC	L	5,43		
FEV1/VC	%	83,2	83,8	101
ERV	L	1,77	2,06	116
IC	L	3,65	4,05	111
MVV	L/min	149,8	164,2	110

<b>Spirometry</b>		<b>(BTPS)</b>	<b>PRED</b>	<b>PRE-RX BEST</b>	<b>%PRED</b>
<b>FVC</b>	<b>Liters</b>		<b>4.42</b>	<b>4.38</b>	<b>99</b>
<b>FEV1</b>	<b>Liters</b>		<b>3.54</b>	<b>3.73</b>	<b>105</b>
<b>FEV1/FVC</b>	<b>%</b>		<b>80</b>	<b>85</b>	
<b>FEF25-75%</b>	<b>L/sec</b>		<b>3.57</b>	<b>4.73</b>	<b>132</b>
<b>IsoFEF25-75</b>	<b>L/sec</b>		<b>3.57</b>	<b>4.73</b>	<b>132</b>
<b>FEF75-85%</b>	<b>L/sec</b>		<b>0.72</b>	<b>1.27</b>	<b>177</b>
<b>PEF</b>	<b>L/sec</b>		<b>8.58</b>	<b>6.49</b>	<b>76</b>
<b>FET100%</b>	<b>Sec</b>			<b>7.05</b>	
<b>FIVC</b>	<b>Liters</b>		<b>4.42</b>	<b>4.00</b>	<b>90</b>
<b>FEV1</b>	<b>Liters</b>		<b>3.54</b>	<b>3.73</b>	<b>105</b>
<b>FIV1</b>	<b>Liters</b>			<b>3.40</b>	
<b>FEF/FIF50</b>			<b>&lt;1.00</b>	<b>1.23</b>	
<b>Vol Extrap</b>	<b>Liters</b>			<b>0.19</b>	
<b>FVL ECode</b>				<b>000010</b>	

Spirometry (BTPS)		PRED	PRE-RX		POST-RX		% Chg
			BEST	%PRED	BEST	%PRED	
FVC	Liters	3.69	(2.34)	(63)	(2.26)	(61)	-3
FEV1	Liters	2.34	1.45	62	1.49	64	3
FEV1/FVC	%	67	62		66		
FEF25-75%	L/sec	2.03	0.64	32	0.81	40	27
PEF	L/sec	7.24	5.55	77	5.30	73	-4

### Lung Volumes (BTPS)

TLC	Liters	5.70			4.85	85	
RV	Liters	2.54			2.59	102	
RV/TLC	%	44			53		
FRC PL	Liters	3.45			2.81	82	
VC	Liters	3.69			(2.27)	(61)	

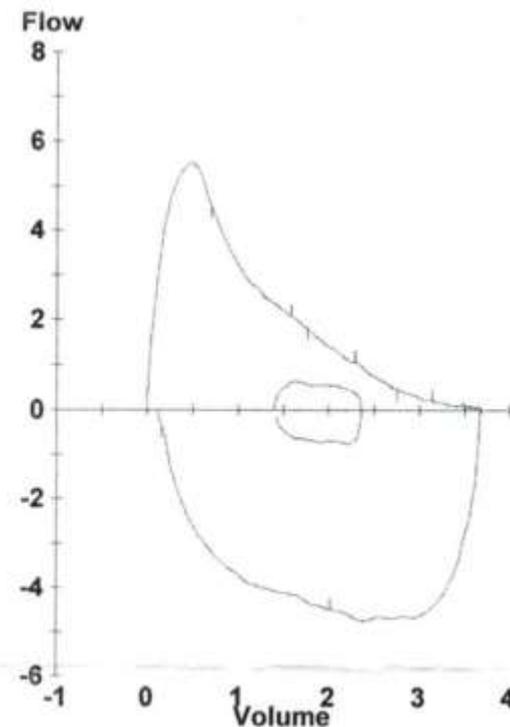
### Diffusion

DLCO	mL/mmHg/min	20.9			16.3	78	
DL Adj	mL/mmHg/min	20.9			17.5	83	
DLCO/VA	mL/mHg/min/L	3.33			4.10	123	
DLVA Adj	mL/mHg/min/L				4.39		
VA	Liters				3.98		

# Spirometry

Parameter	Units	Ref	Pre	% Ref
FVC	L	2.47	0.62	25
FEV <sub>1</sub>	L	2.14	0.49	23
FEV <sub>1</sub> / FVC	%	85	79	93
FEF <sub>25%-75%</sub>	L/s	3.31	0.49	15
PEFR	L/s	5.74	1.27	22
FET	sec		9.38	
FIF <sub>50%</sub>	L/s		0.58	
FEF <sub>50%</sub> / FIF <sub>50%</sub>			1.74	

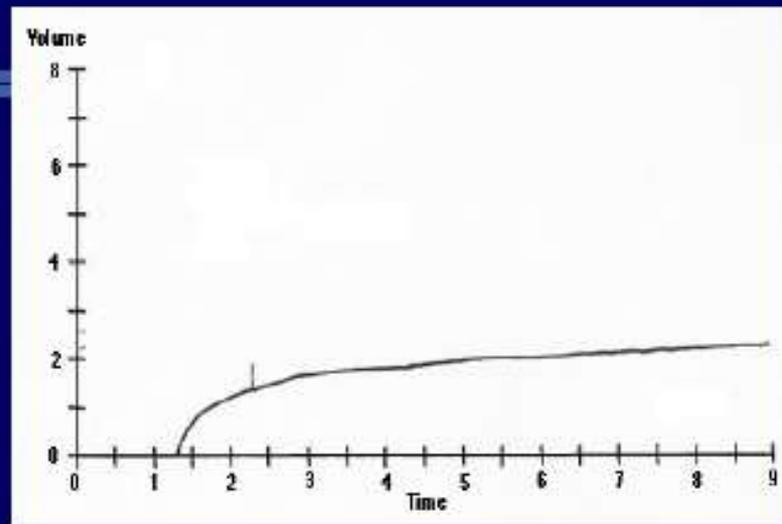
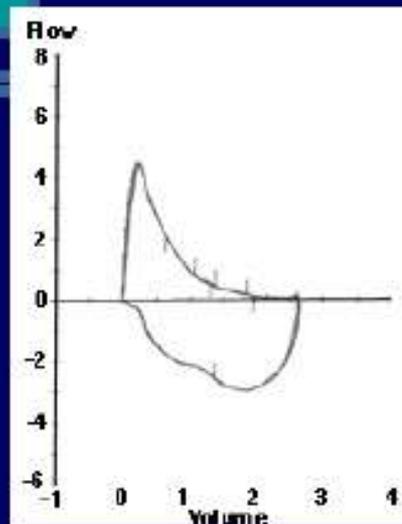
		Ref	(Normal Range)	Pre	% Ref	Post	% Ref	%Chg
<b>Spirometry</b>								
FVC	Liters	3.76	(2.9 - 4.6)	3.69	98			
FEV1	Liters	2.93	(2.3 - 3.5)	2.33	80			
FEV1/FVC	%	78	(68.4 - 87.1)	63				
FEF25-75%	L/sec	2.92	(1.6 - 4.2)	1.25	43			
FEF50%	L/sec	3.63	(3.2 - 4.1)	1.73	48			
FEF75%	L/sec	1.23	(0.6 - 1.8)	0.44	36			
PEF	L/sec	7.10	(5.3 - 8.9)	5.51	78			
FIF50%	L/sec	5.28	(3.4 - 7.1)	4.45	84			
FEF/FIF50		0.67	(0.2 - 1.1)	0.39	58			
<b>Lung Volumes</b>								
TLC	Liters	5.62	(4.7 - 6.6)	6.02	107			
VC	Liters	3.77	(3.0 - 4.5)	3.69	98			
IC	Liters	2.38	(1.9 - 2.8)	2.30	97			
FRC PL	Liters	2.98	(2.2 - 3.8)	3.63	122			
ERV	Liters	1.19	(1.0 - 1.4)	1.29	109			
RV	Liters	1.78	(1.2 - 2.4)	2.34	131			
RV/TLC	%	36	(24.1 - 48.7)	39				



### PULMONARY FUNCTION ANALYSIS

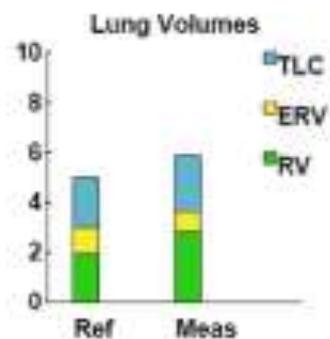
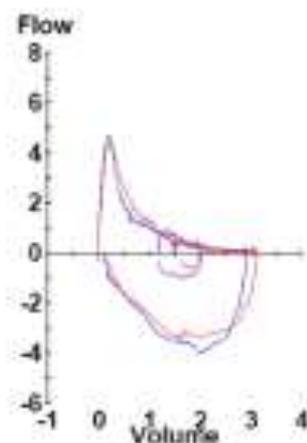
<i>Spirometry</i>		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.81	3.45	90	3.78	99	10
FEV1	Liters	3.27	2.34	72	2.90	89	24
FEV1/FVC	%	86	68	79	77	89	13
FEF25-75%	L/sec	3.83	1.44	38	2.40	63	67
FEF50%	L/sec	4.11	1.93	47	3.33	81	73
FEF75%	L/sec	1.91	0.57	30	0.98	51	73
PEF	L/sec	6.55	6.08	93	7.57	116	25
PIF	L/sec		3.63		4.53		25

## Example 1



Variable	means	predicted	%pred
<b>FVC</b>	<b>2.62</b>	<b>2.82</b>	<b>93</b>
<b>FEV1</b>	<b>1.45</b>	<b>1.98</b>	<b>73</b>
<b>FEV1/FVC</b>	<b>55</b>	<b>70</b>	
<b>FEF25-75%</b>	<b>0.43</b>	<b>2.20</b>	<b>20</b>
<b>PEF</b>	<b>4.50</b>	<b>5.48</b>	<b>82</b>

		Ref	Pre	% Ref	Post	% Ref	%Chg
<b>Spirometry</b>							
FVC	Liters	3.23	2.91	90	3.12	96	7
FEV1	Liters	2.47	1.31	53	1.42	57	8
FEV1/FVC	%	77	45		45		
FEF25-75%	L/sec	2.16	0.37	17	0.39	18	4
PEF	L/sec	6.08	4.71	77	4.71	78	0
FET100%	Sec		15.05		15.14		1
<b>Lung Volumes</b>							
TLC	Liters	4.97	5.84	117			
VC	Liters	3.23	3.04	94			
FRC PL	Liters	3.04	3.61	119			
ERV	Liters	1.01	0.79	78			
RV	Liters	1.94	2.79	144			
RV/TLC	%	39	48				
<b>Diffusing Capacity</b>							
DLCO	mL/mmHg/min	17.6	9.2	52			
DL Adj	mL/mmHg/min	17.6	9.2	52			
DLCO/VA	mL/mHg/min/L	3.74	1.91	51			
DL/VA Adj	mL/mHg/min/L		1.91				
VA	Liters	4.97	4.84	97			
IVC	Liters		2.91				



# A 66 year old female complains of cough after dust exposure

	Meas	Ref	%Pred
FVC	2.2	2.58	85
FEV1	1.79	1.85	97
FEV1/FVC	81	72	
FEF 25-75	1.82	2.23	82
PEF	5.67	5.2	109



# Normal Spirometry

- FEV1/FVC: 48%
- FVC: 3.24L (86%)
- FEV1: 1.55L (48%)
- FEF25-75%: 0.64L (28%)

- FEV1/FVC: 48% Severely ↓
- FVC: 3.24L (86%) Normal
- FEV1: 1.55L (48%) Severely ↓
- FEF25-75%: 0.64L (28%) Severely ↓
  
- Interpretation: Moderate obstruction

- FEV1/FVC: 59%
- FVC: 2.27L (71%)
- FEV1: 1.34L (49%)
- FEF25-75%: 0.95L (22%)

- FEV1/FVC: 59% Moderately ↓
- FVC: 2.27L (71%) Mildly ↓
- FEV1: 1.34L (49%) Severely ↓
- FEF25-75%: 0.95L (22%) Severely ↓
  
- Interpretation: Moderate obstructive impairment, FVC mildly reduced, can not rule out restrictive impairment

- FEV1/FVC: 86%
- FVC: 2.49 L (61%)
- FEV1: 1.96 L (64%)
- FEF25-75%: 2.83 L (98%)
  
- FRC: 1.94 L (59%)
- TLC: 4.03 L (70%)
- RV: 1.38 L (65%)
- DLCO: 55%

- Interpretation: Moderate Restrictive pattern with moderately reduced DLCO

# A 75 year old female has a history of dyspnea and palpitations

	Meas	Ref	%Pred
<b>FVC</b>	<b>2.62</b>	<b>2.82</b>	<b>93</b>
<b>FEV1</b>	<b>1.45</b>	<b>1.98</b>	<b>72</b>
<b>FEV1/FVC</b>	<b>55</b>	<b>69</b>	
<b>FEF25-75</b>	<b>0.43</b>	<b>2.20</b>	<b>20</b>
<b>PEF</b>	<b>4.50</b>	<b>5.48</b>	<b>82</b>



**Mild Obstructive defect**

Thank  
you!