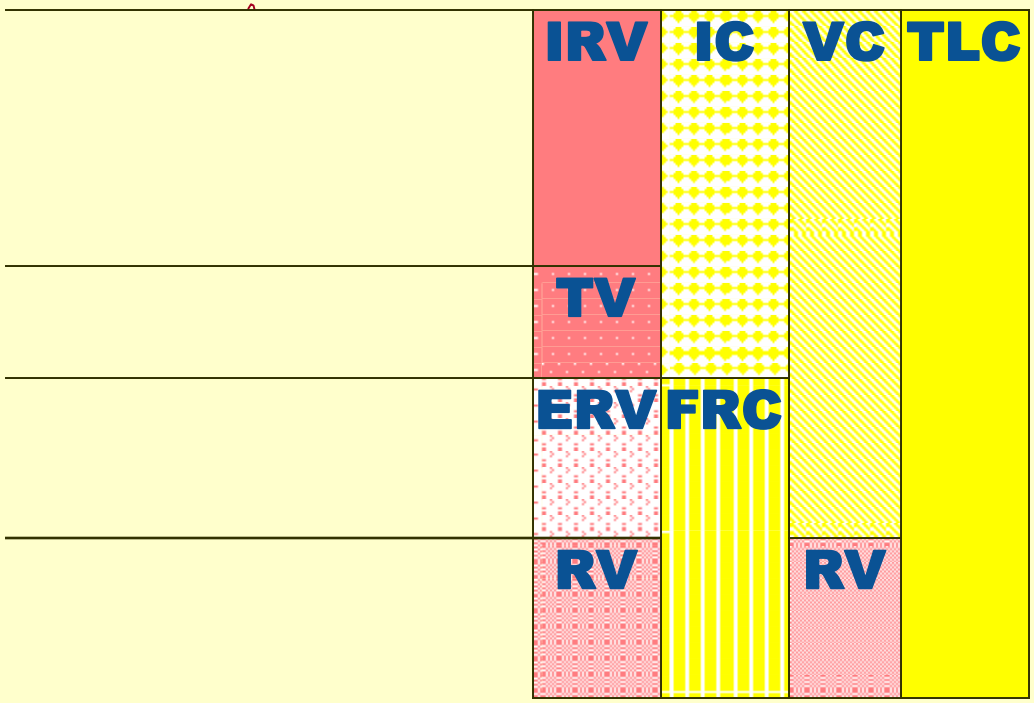
PULMONARY FUNCTION TEST (PFT)

Associate Professor
DR. Samah Shehata

Objectives

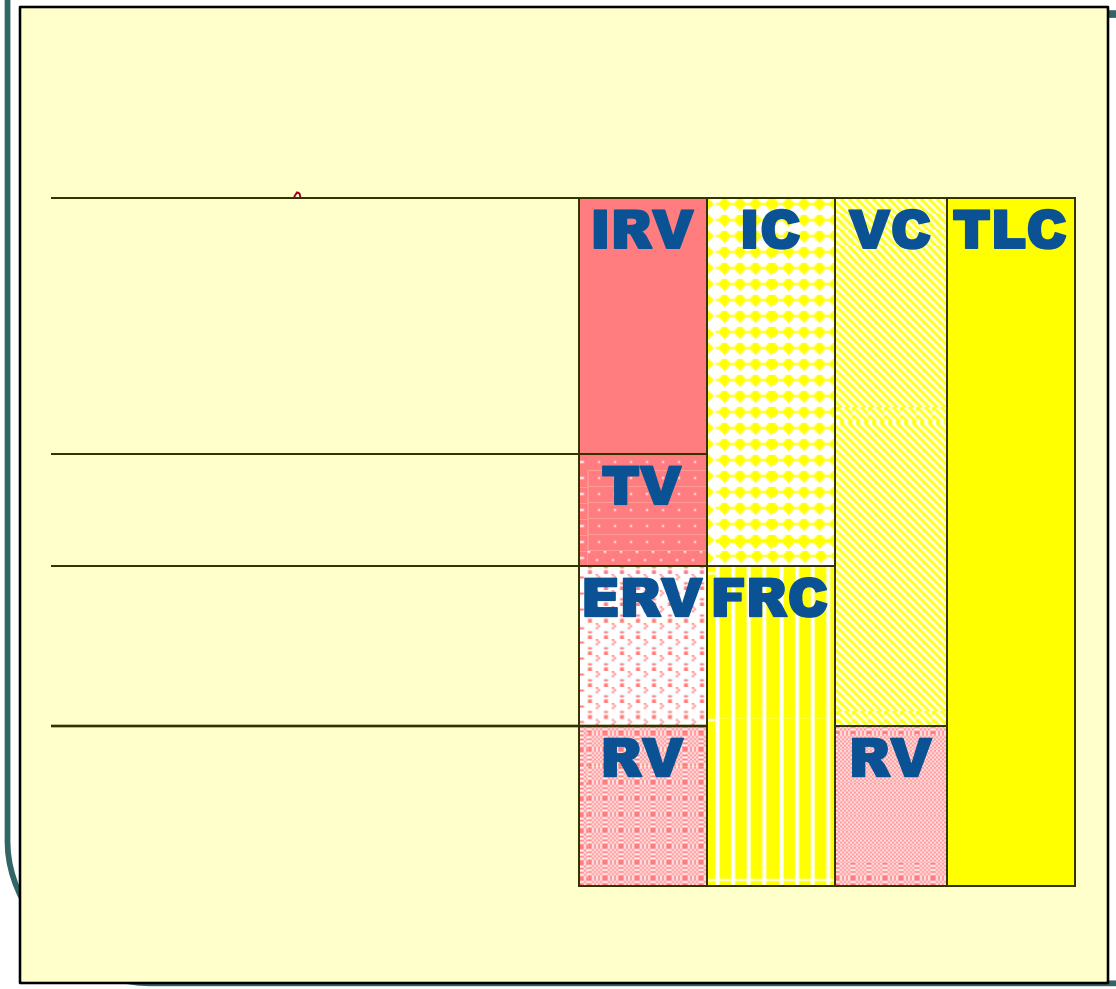
- Review lung volumes and capacities
- Provide an overview of PFTs
- Discuss spirometry and review its clinical applications

Lung Volumes



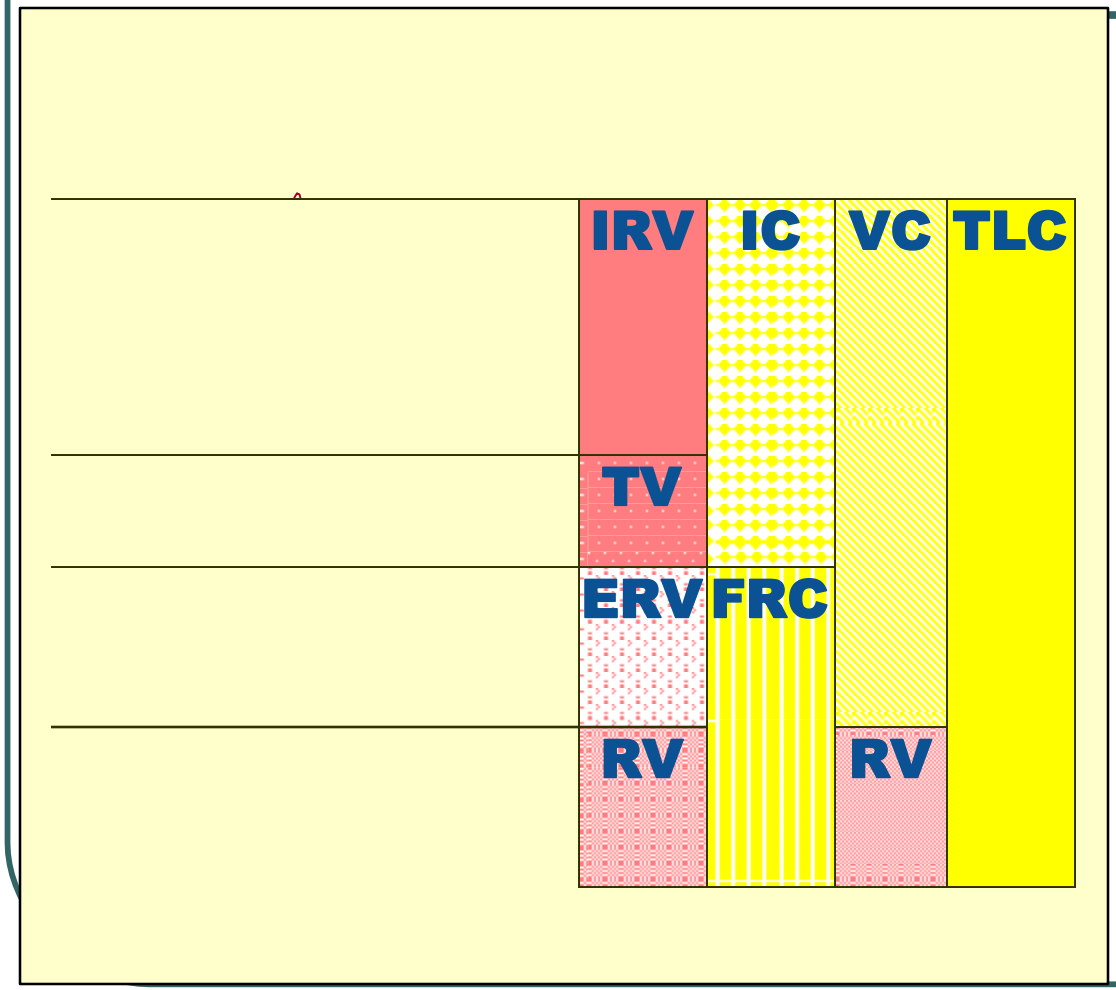
- 4 Volumes
- 4 Capacities
  - Sum of 2 or more lung volumes

Tidal Volume (TV)



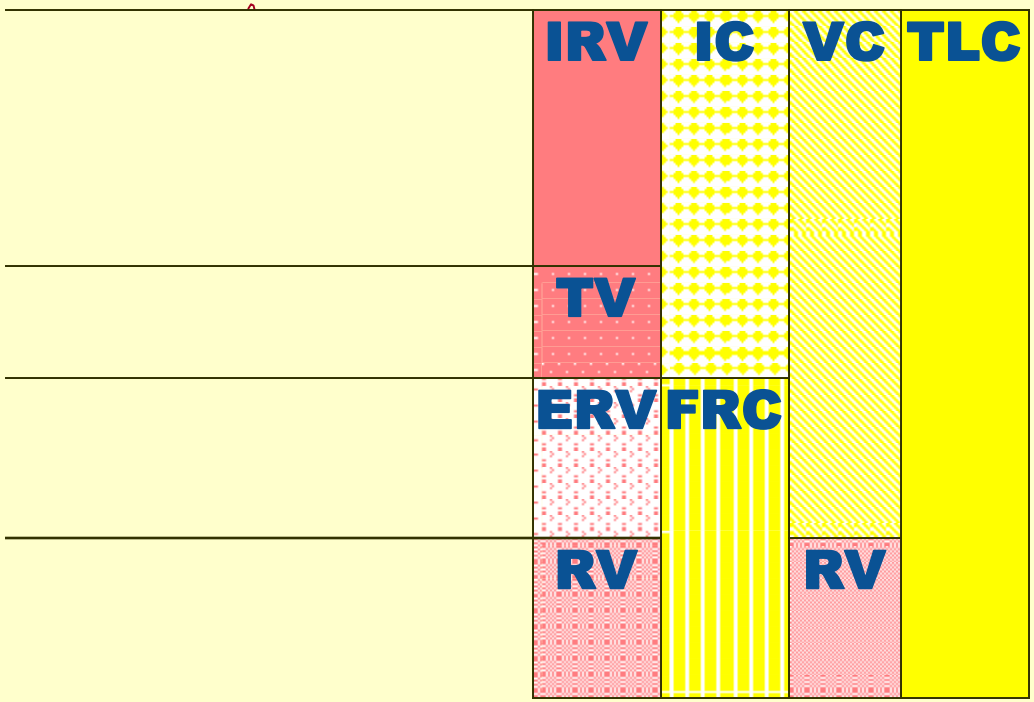
- Volume of air inspired or expired during normal quiet breathing
  - N – ~6-8 ml/kg.

Inspiratory Reserve Volume (IRV)



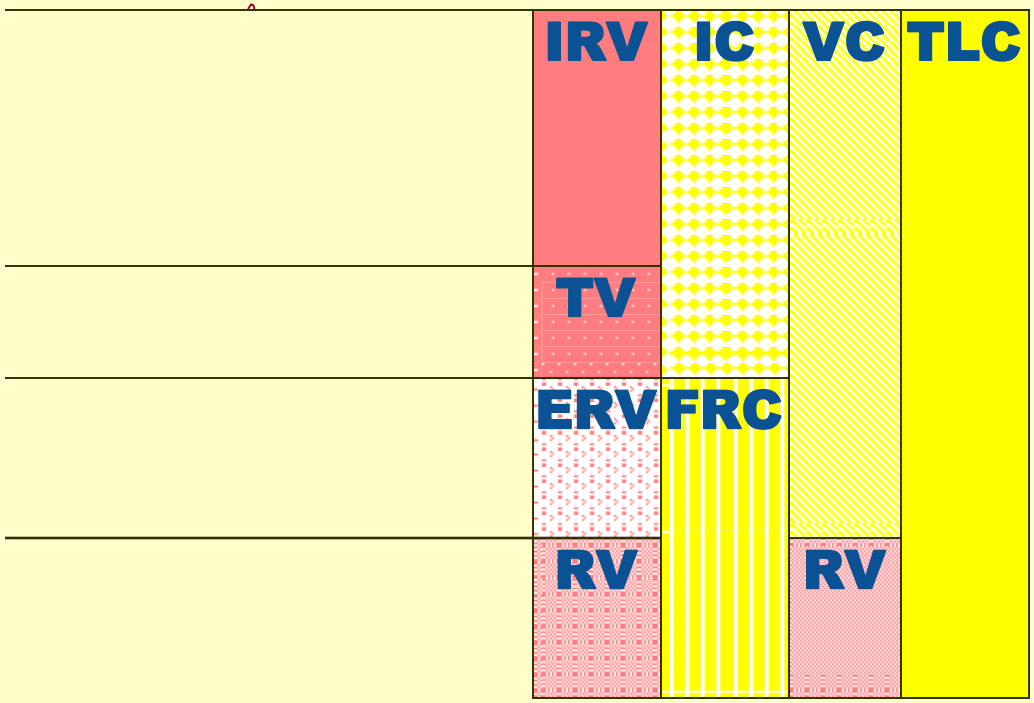
- The maximum amount of air that can be inhaled after a normal tidal volume inspiration
  - N- 1900 ml- 3300 ml.

Expiratory Reserve Volume (ERV)



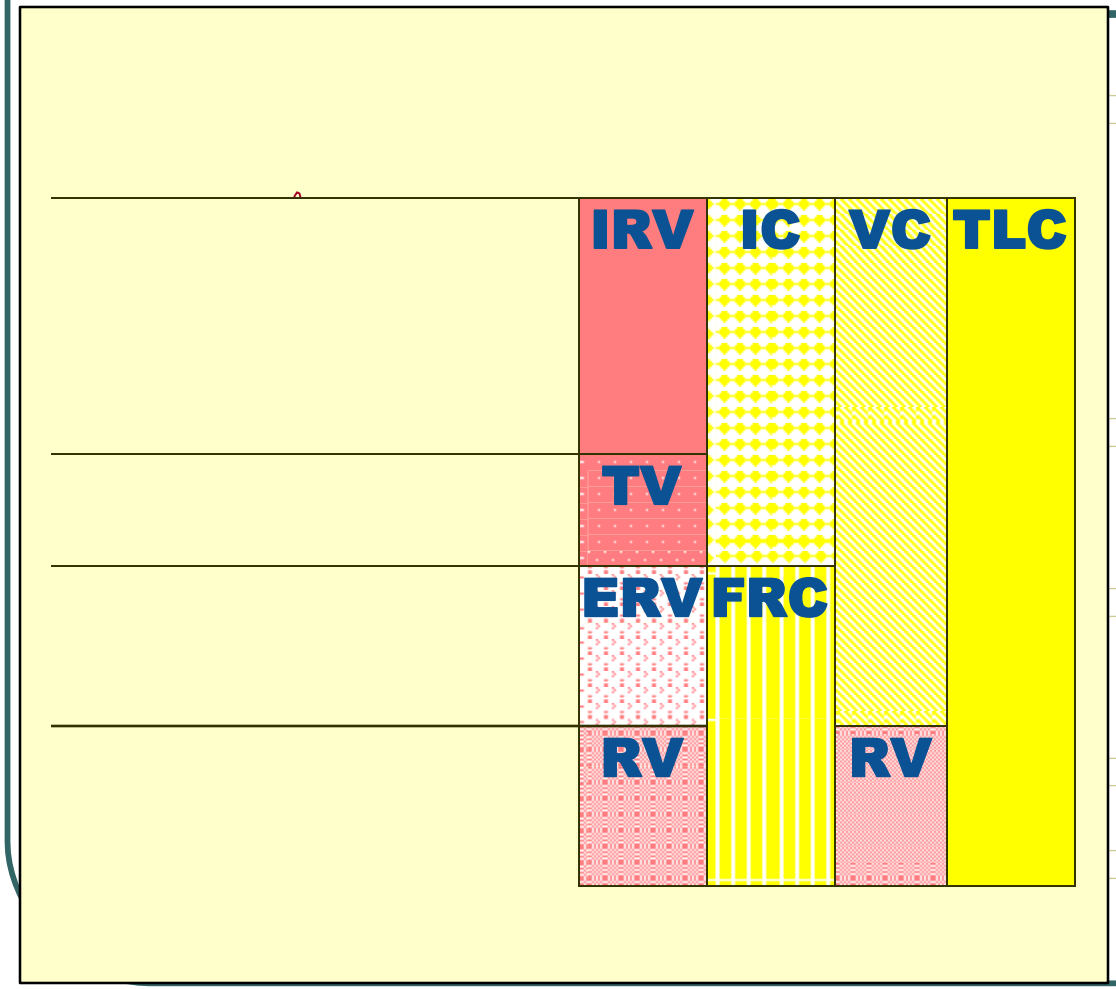
- Maximum amount of air that can be exhaled from the resting expiratory level
  - N- 700 ml- 1000 ml.

Residual Volume (RV)



- Volume of air remaining in the lungs at the end of maximum expiration
  - N- 1700 ml- 2100 ml. (20-25ml/kg)

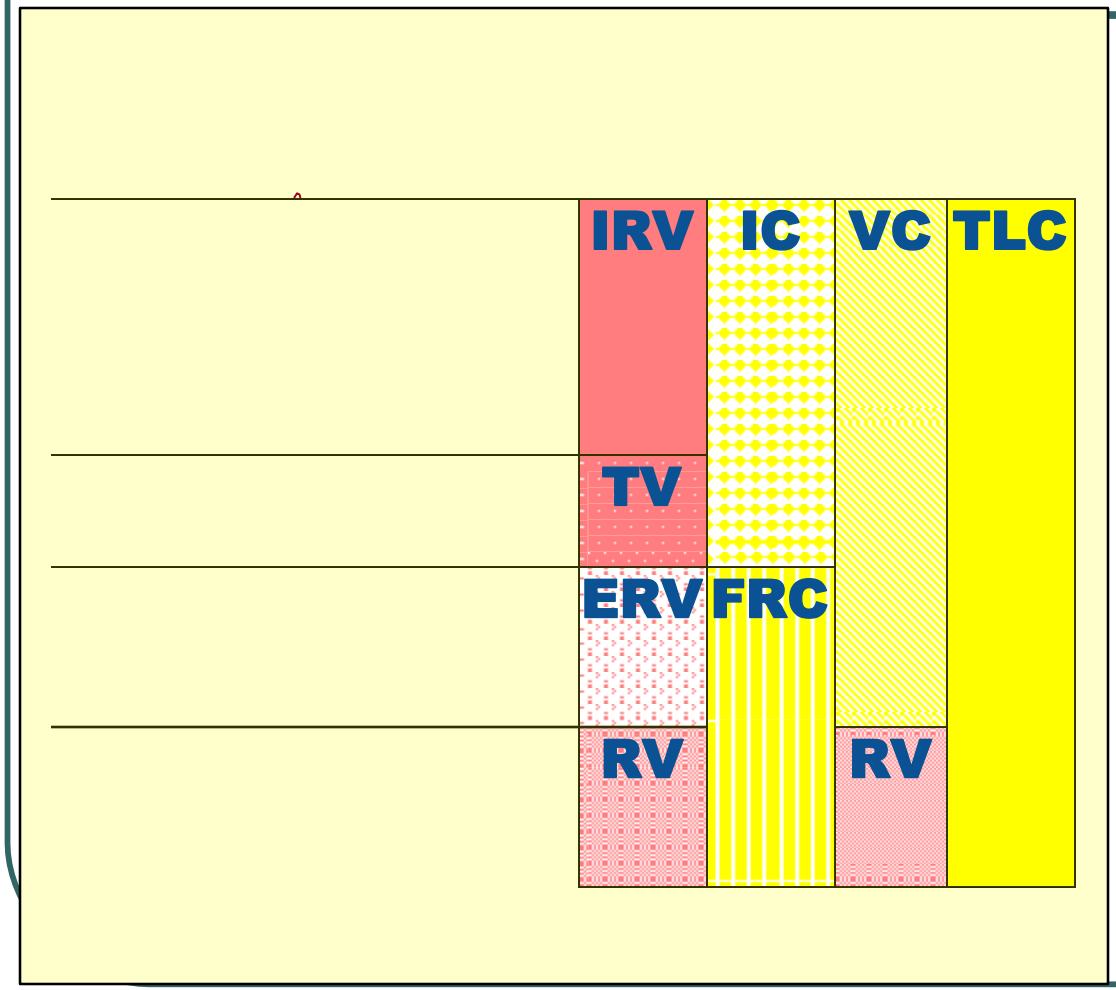
Vital Capacity (VC)



- Volume of air that can be exhaled from the lungs after a maximum inspiration
- **FVC: when VC exhaled forcefully**
- SVC: when VC is exhaled slowly
- VC = IRV + TV + ERV
- N- 3100 ml- 4800 ml.

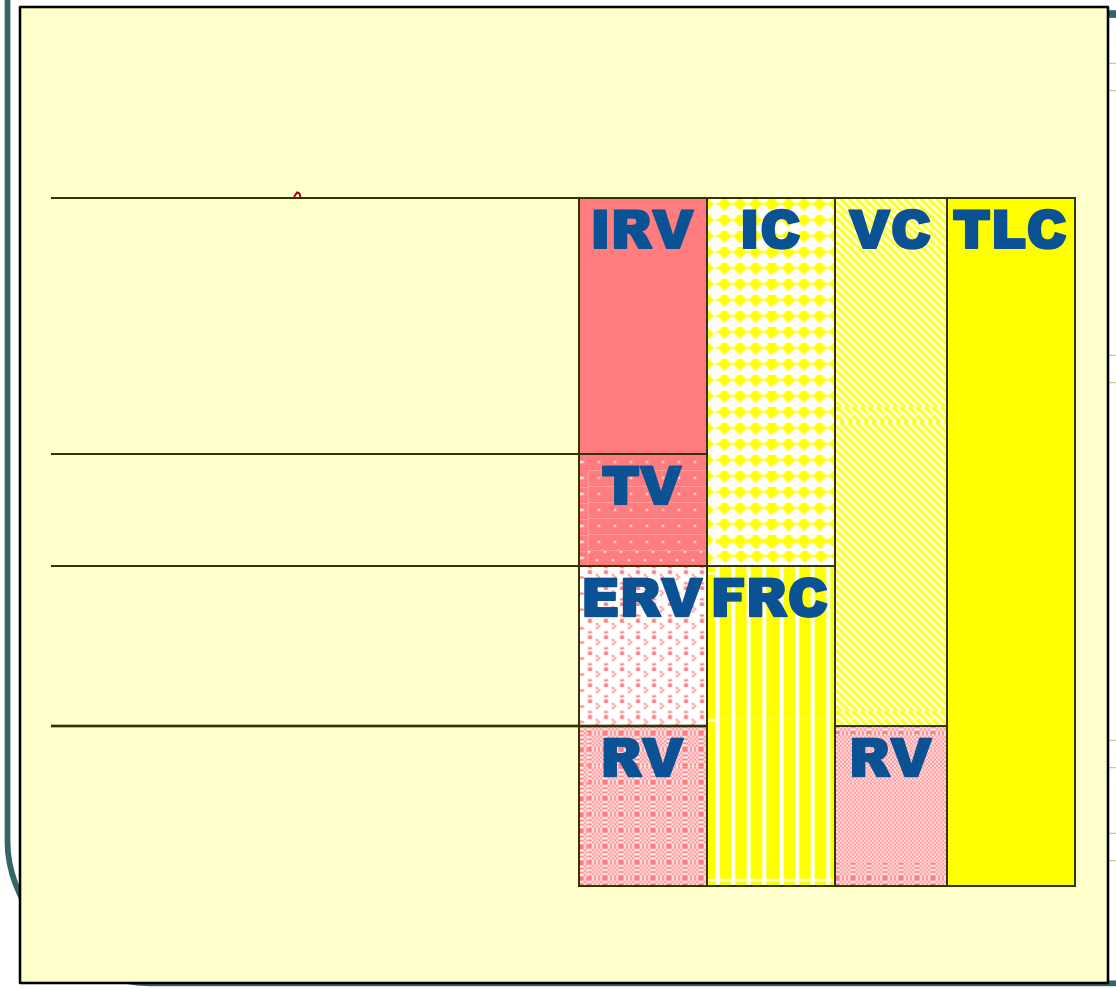
  (60-70ml/kg)

Inspiratory Capacity (IC)



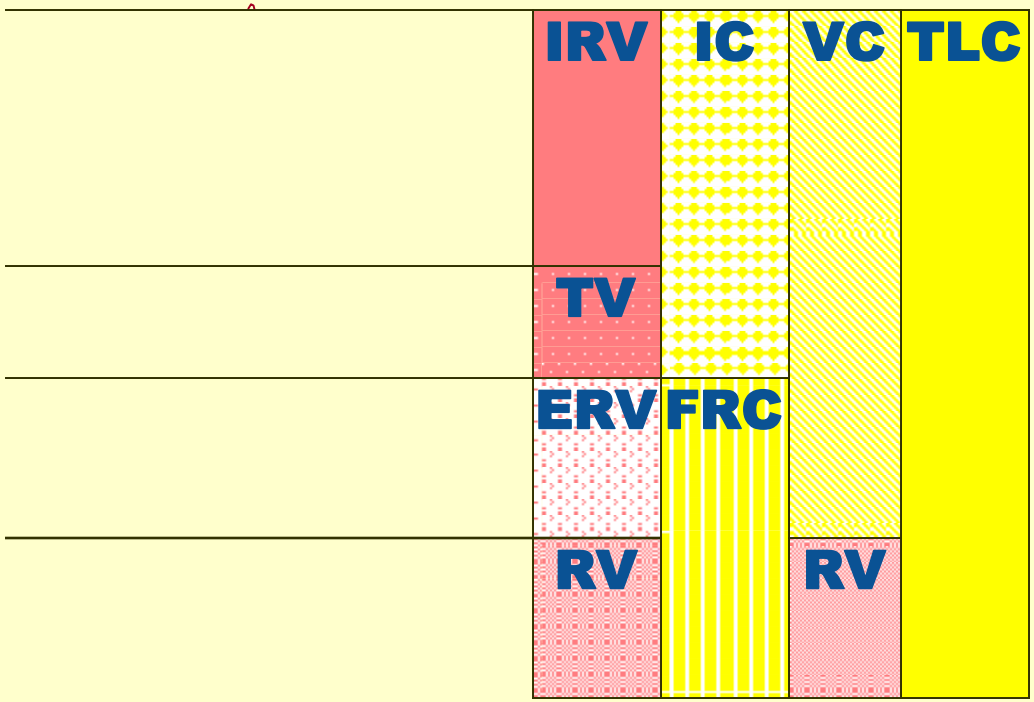
- Maximum amount of air that can be inhaled from the end of a tidal volume
- IC = IRV + TV
- N- 2400 ml- 3800 ml.

Functional Residual Capacity (FRC)



- Volume of air remaining in the lungs at the end of a TV expiration
- The elastic force of the chest wall is exactly balanced by the elastic force of the lungs
- FRC = ERV + RV
- N- 2300 ml- 3300 ml.
  (30-35ml/kg)

Total Lung Capacity (TLC)



- Volume of air in the lungs after a maximum inspiration
- TLC = IRV + TV + ERV + RV (VC + RV)
- N- 4000 ml- 6000 ml. (80-100ml/kg)

PFTs can include:

1) Simple screening Spirometry,
2) Formal Lung Volume measurement,
3) Diffusing Capacity for Carbon Monoxide (DLco), and
4) Arterial Blood Gases.

These studies may collectively be referred to as:

***complete pulmonary function survey*.**

Spirometry

- Measurement of the pattern of air movement into and out of the lungs during controlled ventilatory maneuvers.

- Often done as a maximal expiratory maneuver.


volume-time curves of all acceptable trials
flow-volume curves of all acceptable trials
source of the used predicted equations
results in percent predicted
numeric results of all volumes and flows

Indications

1 To evaluate symptoms, signs or abnormal laboratory tests

- o***Symptoms***: dyspnea, wheezing, orthopnea, cough, phlegm production, chest pain
- o***Signs:*** diminished breath sounds, overinflation, expiratory slowing, cyanosis, chest deformity, unexplained crackles
- o***Abnormal lab***: hypoxemia, hypercapnia, polycythemia, abn CXR

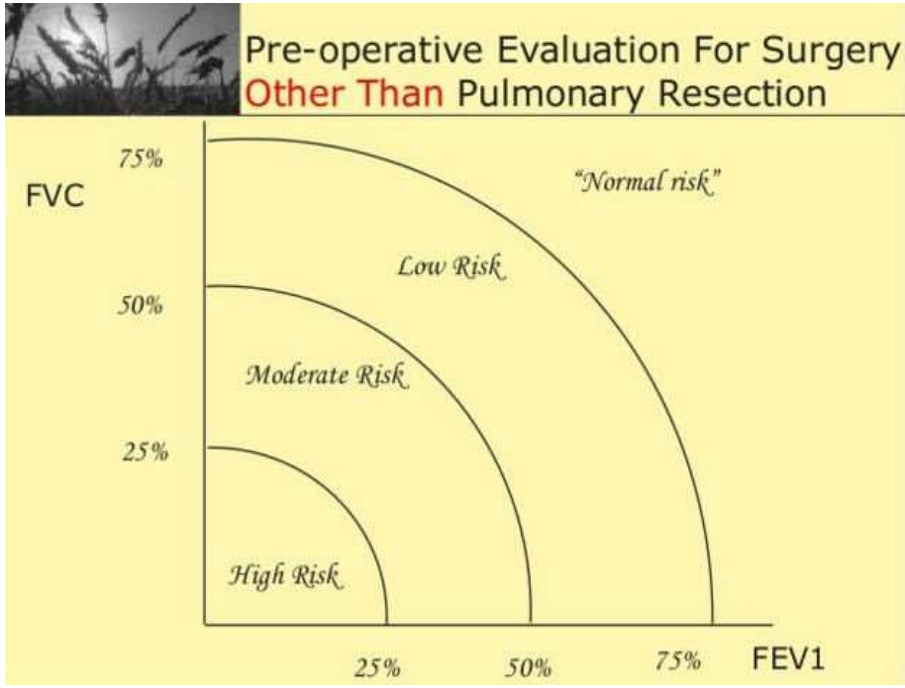
2 To screen individuals at risk of having pulmonary disease

- oSmokers
- oIndividuals in occupations with exposures to injurious subs.
- o Some routine physical examinations

3- Measure the effect of disease on pulmonary function

4 Assess pre-operative risk:

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



5Assess prognosis (after ttt, lung transplant ...etc.)

6- **Assess health status before beginning strenuous physical activity**

Relative contraindications for spirometry

1. Acute disorders affecting test performance (e.g. vomiting, nausea, vertigo)
2. Hemoptysis of unknown origin (FVC maneuver may aggravate underlying condition.)
3. Pneumothorax
4. Recent abdominal or thoracic surgery
5. Recent eye surgery (increases in intraocular pressure during spirometry)
6. Recent myocardial infarction or unstable angina
7. Thoracic, abdominal, or cerebral aneurysms (risk of rupture because of increased thoracic pressure)

Only **Absolute Contraindication** is:

Myocardial Infarction within the Previous Month

Possible side-effects

1. Serious complications are rare: Syncope, dizziness, light-headedness
2. Paroxysmal coughing
3. Bronchospasm (e.g. Asthma)
4. Increased intracranial pressure
5. Thoracic pain
6. Pneumothorax (very rare)
7. Nosocomial infections (very rare)

Preparation & instructions to the patient

1- Information about the purpose: before starting, explain to the pt. how fast & how much he can exhale from his lungs.

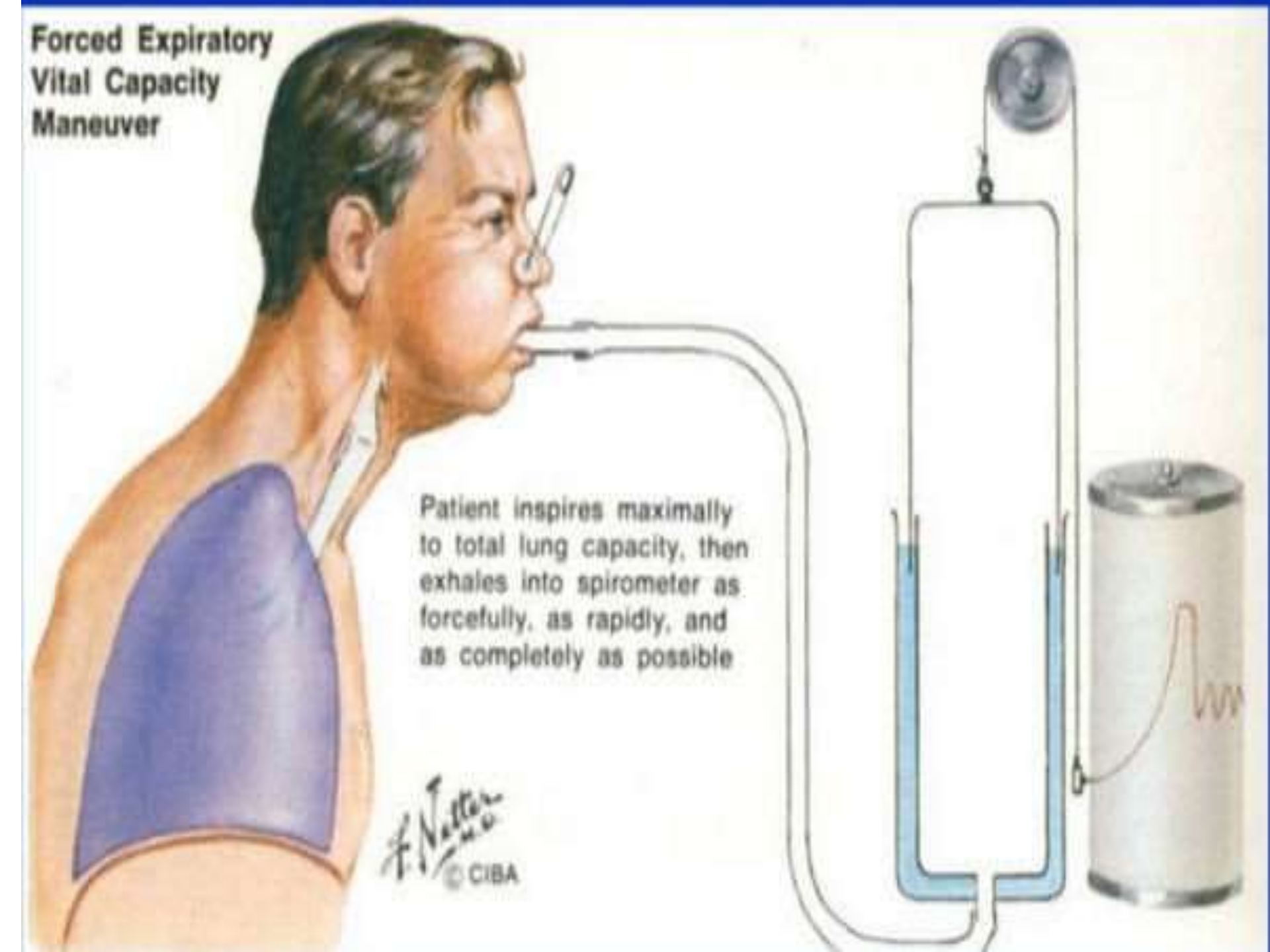
2. Tell the pt. that only the maximal effort will lead to a reliable result. This may enhance his motivation to follow the instructions correctly.

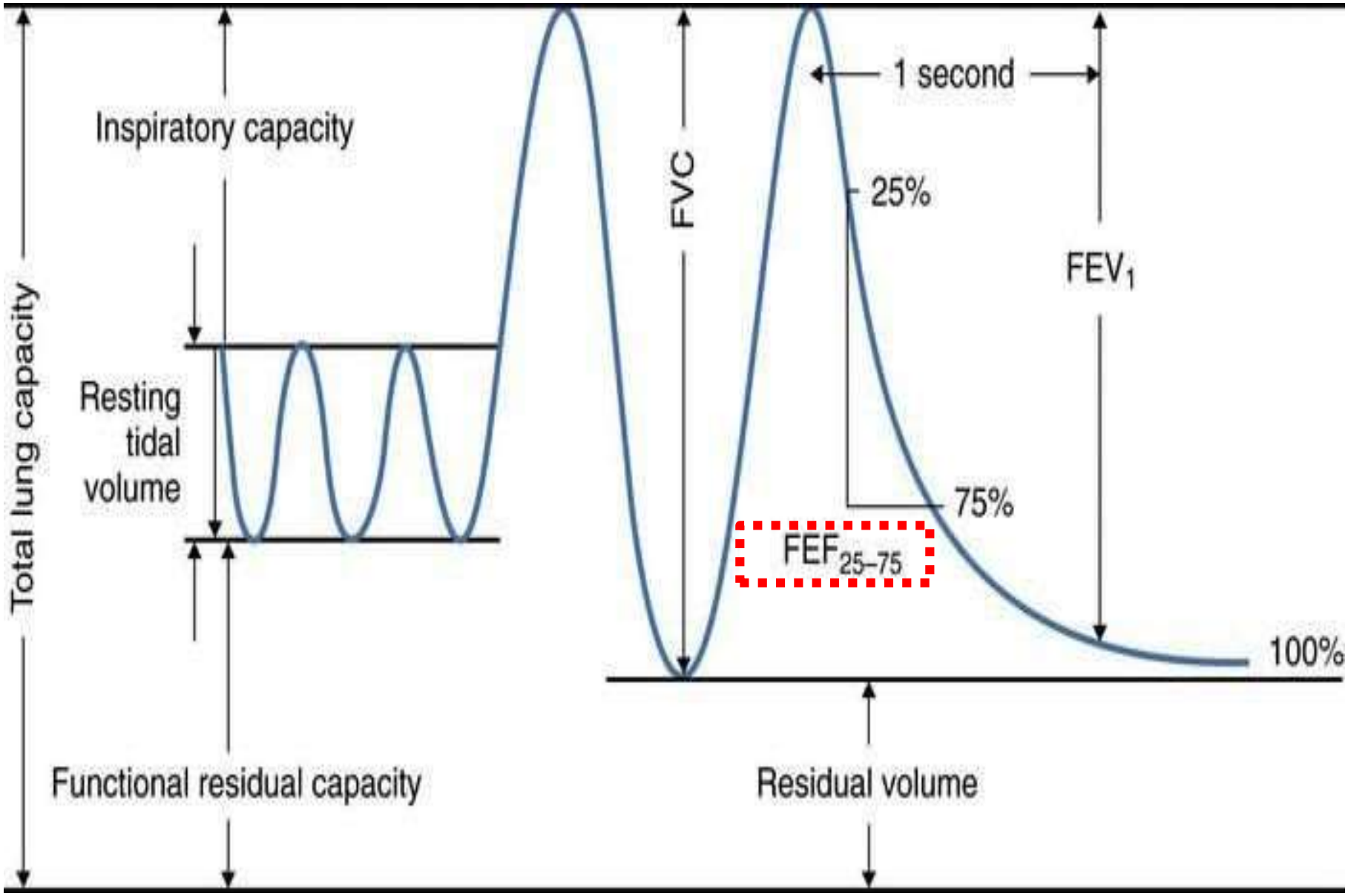
3. Demonstrating of breathing maneuver: Possible even without spirometer. This can save a lot of time spent on repeated measurements.

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

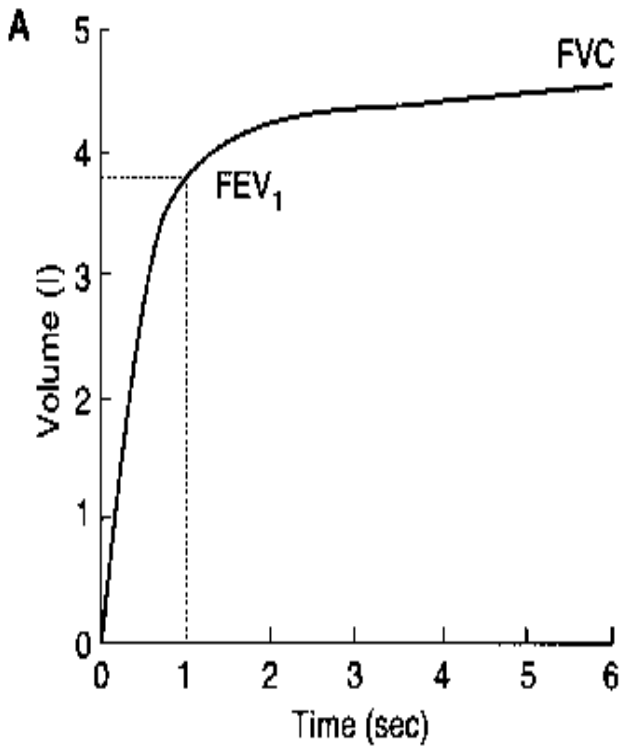

Forced Expiratory
Vital Capacity
Maneuver
Patient inspires maximally to total lung capacity, then exhales into spirometer as forcefully, as rapidly, and as completely as possible
F. Netter M.D.
© CIBA


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

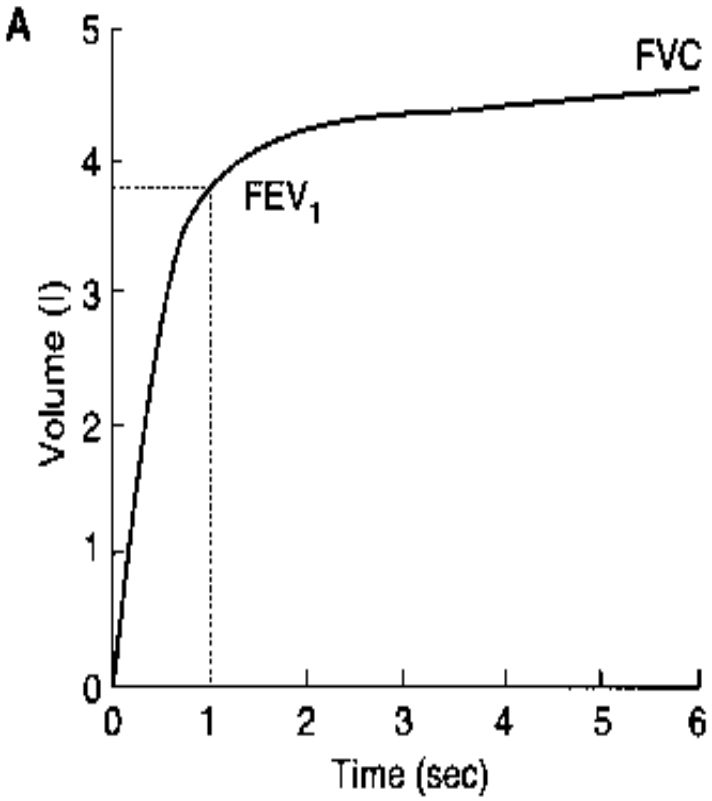
Factors That Affect Results

- Age
- Sex
- Height
- Weight
- Race
- Disease
- Speed & Effort of the test
- Rest before test (15 mins at least)
- Max inhalation time (2-4 sec)
- Interpretation (combine parameters with graphs)

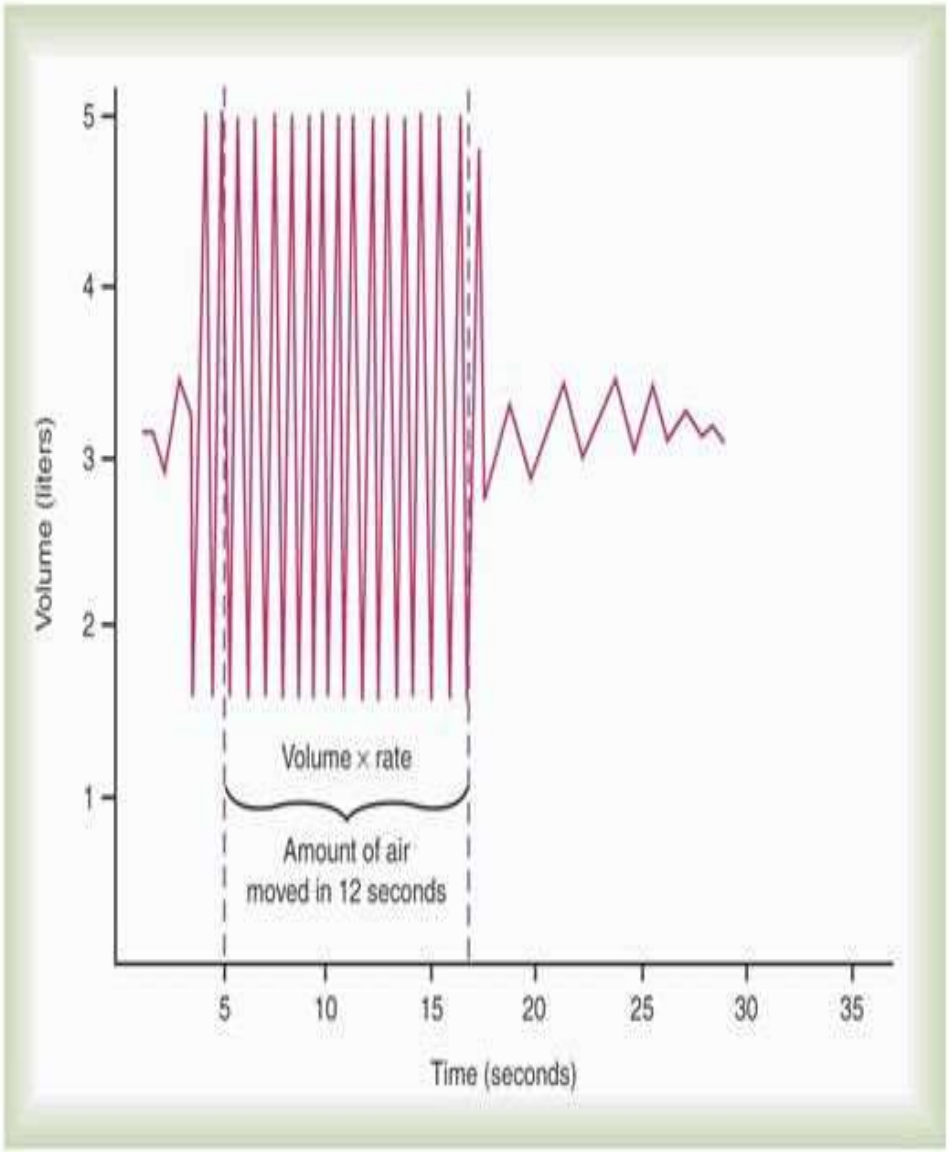
Terminology & Interpretation



- ***Forced vital capacity (FVC):***
  - Total volume of air that can be exhaled forcefully from TLC
  - The majority of FVC can be exhaled in <3 seconds in normal people, but often is much more prolonged in obstructive diseases
  - Measured in liters (L)



- ***Forced expiratory volume in 1 second: (FEV_1)***
  - Volume of air forcefully expired from full inflation (TLC) in the first second
  - Measured in liters (L)
  - Normal people can exhale more than 75-80% of their FVC in the first second; thus the FEV1/FVC can be utilized to characterize lung disease



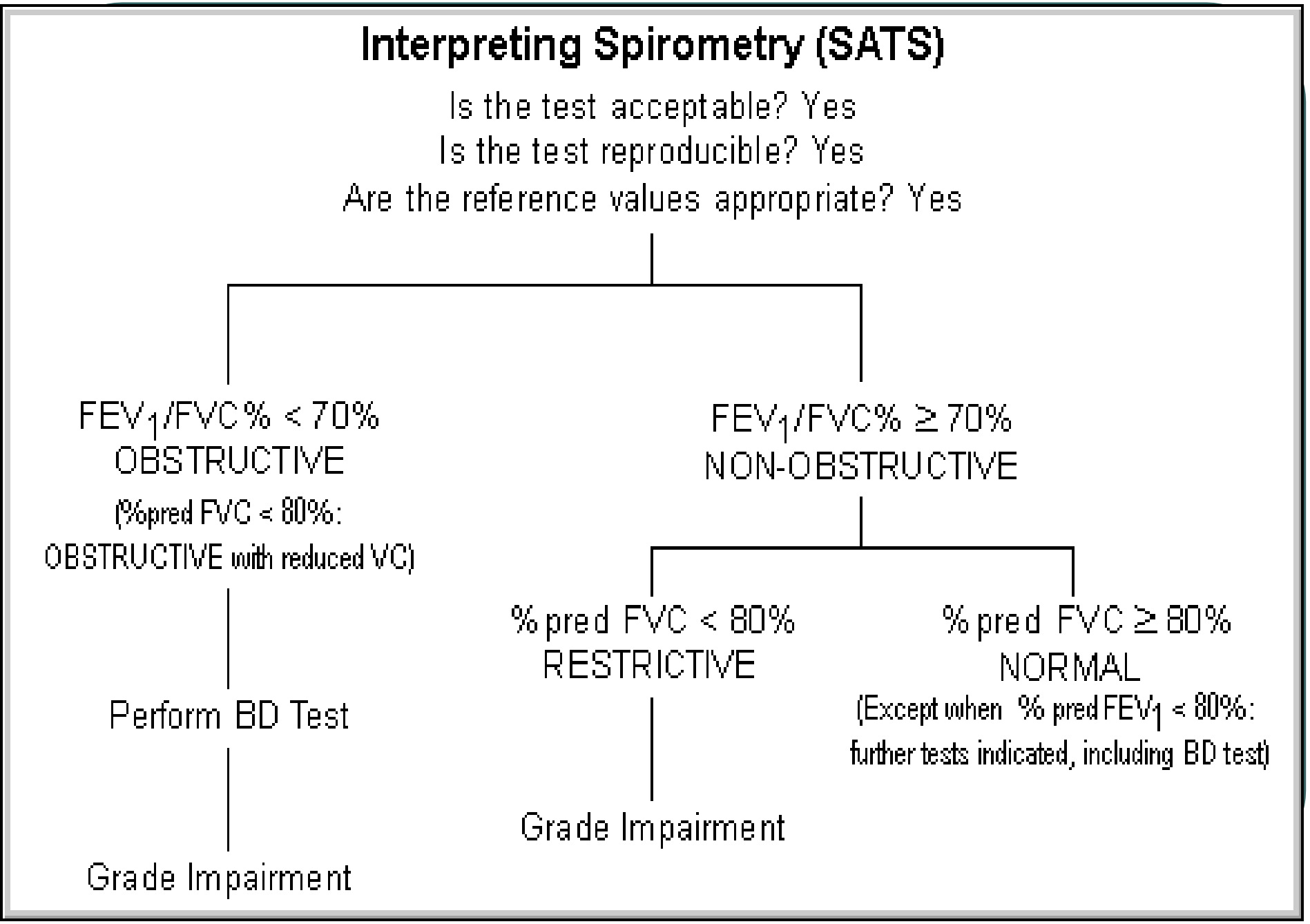
- ***MVV***

- ***It's*** the maximum volume of air which can be respired in 1min. By deepest and fastest breathing (test of entire respiratory system).
- MVV = FEV1 x 35
- *Reflects* the status of the respiratory muscles, compliance of the thorax-lung complex, and airway resistance
- N- 150-175 L/min

Normal Values of PFT

- BMI 21- 25 kg/m2
- FEV1 N: 80% to 120%
- FVC N: 80% to 120%
- FEV1 /FVC N: >70%, within 5% of the predicted ratio
- **FEF25-75%** N: >60-125%.
- PEFR N: 80-100%.
- TLC N: 80% to 120%
- FRC N: 80% to 120%
- **RV** N: 65% to 135%
- RV/TLC N: 25-35%
- FRC/TLC N: 50%
- DLCO (N 15-32 ml/min/mmHg) >80% to < 120%
- KCo Krogh coefficient = DLCO/VA Diffusing capacity for carbon monoxide per unit of alveolar volume

Interpreting Spirometry (SATS)




REPORTS

Pulmonary Function Test Results | **Flow / Volume Loop and Volume / Time Curve**

e-hospital

Department of Pneumology

Dr. John Smith

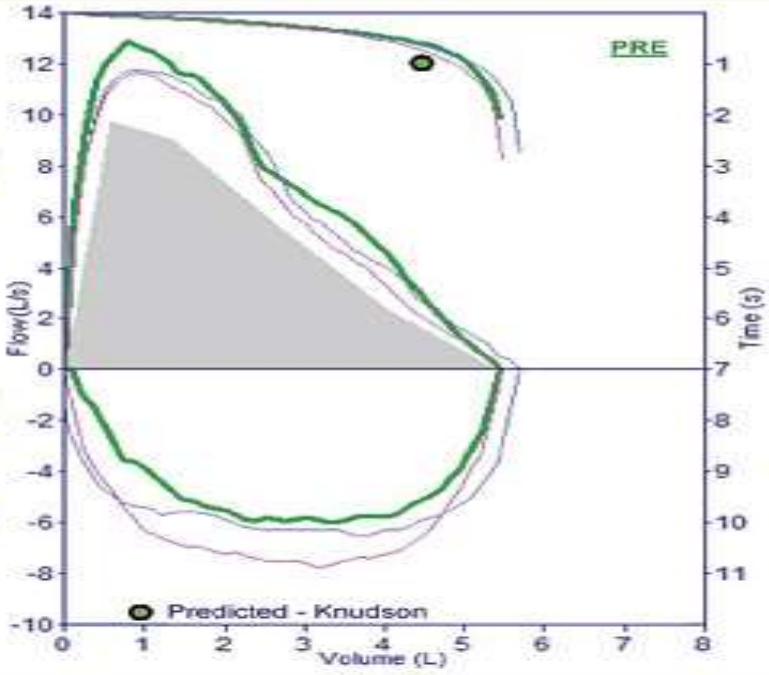
Visit date 24/07/2003

Patient code	0		
Surname	MARTINI	Age	28
Name	DAVID	Gender	Male
Date of birth	06/05/1975	Height, cm	180
Ethnic group	Caucasian	Weight, kg	76
Smoke	Smoker	Pack-Year	5
Patient group			

Interpretation

Normal Spirometry

Conclusion / Medical report



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

Parameters	BTPS 1.092 25°C - 77°F	Pred	PRE	%Pred	POST	%Pred	%Chg	PRE#1	PRE#2	PRE#3
Best values from all loops										
FVC	L	5,43	5,68	105				5,45	5,68	5,47
FEV1	L	4,49	5,12	114				5,06	5,12	4,85
FEV1/FVC	%	83,2	90,1	108				92,8	90,1	88,7
PEF	L/s	9,77	12,90	132				12,90	11,91	11,73
Values from best loop										
FEF2575	L/s	4,71	7,33	156				7,33	6,38	5,88
FEF25	L/s	9,07	12,02	133				12,02	11,36	10,94
FEF50	L/s	5,56	7,21	130				7,21	6,55	6,23
FEF75	L/s	2,34	4,00	171				4,00	3,06	2,67
FEV3	L	5,04								
FET	s	6,00	2,06	34				2,06	2,78	2,88
FIVC	L	5,43	5,41	100				5,41	5,78	5,56
FIV1	L	4,49	5,10	114				5,10	5,74	5,56
FIV1/FIVC	%	83,2	94,3	113				94,3	99,3	100,0
PIF	L/s	9,77	6,07	62				6,07	6,55	7,77
ELA	Years	33	33					33	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						

Quality Report **D**

Repeatable FVC, Repeatable FEV1, Repeatable PEF

Breathe out for a longer time, Breathe out ALL air in the lungs

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

Parameters	BTPS 1,092 25°C - 77°F	Pred	PRE	%Pred
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

Spirometry (BTPS)

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

			PRE-RX		POST-RX		
Spirometry	(BTPS)	PRED	BEST	%PRED	BEST	%PRED	% Chg
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	
DL/VA 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_1	L	2.14	0.49	23
FEV_1 / FVC	%	85	79	93
$FEF_{25\%-75\%}$	L/s	3.31	0.49	15
PEFR	L/s	5.74	1.27	22
FET	sec		9.38	
$FIF_{50\%}$	L/s		0.58	
$FEF_{50\%}$ / $FIF_{50\%}$			1.74	


Thank
you!