Dynamic Spirometry

Dr. Thouraya Said

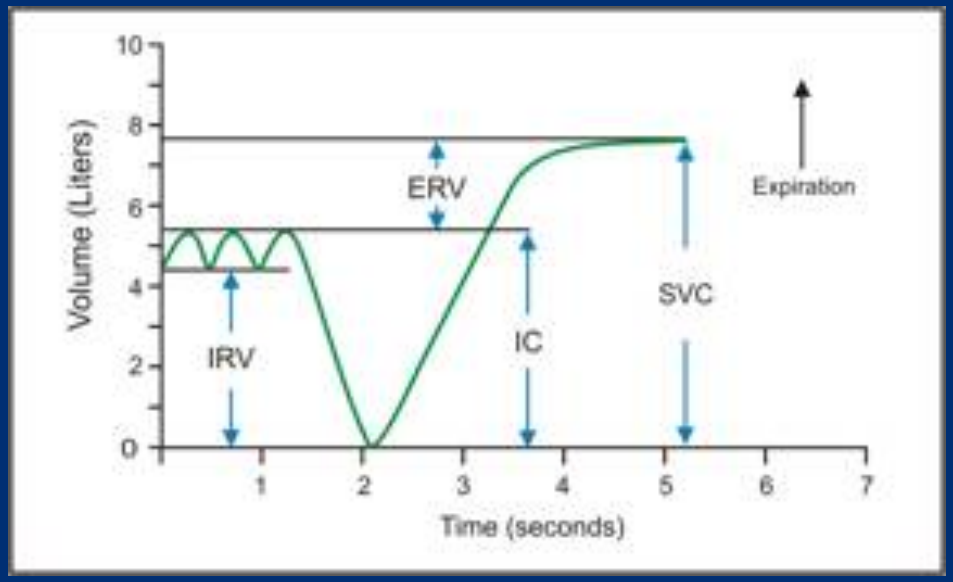
Spirometry

It provides an objective measurement of lung function.

It analyzes volume and velocity of expired air

Static test

Performed without regard to time



Relaxed Vital capacity: Max Volume of air expired during relaxed expiration after a maximal inspiration

Dynamic test

Performed at forcible and max effort against time

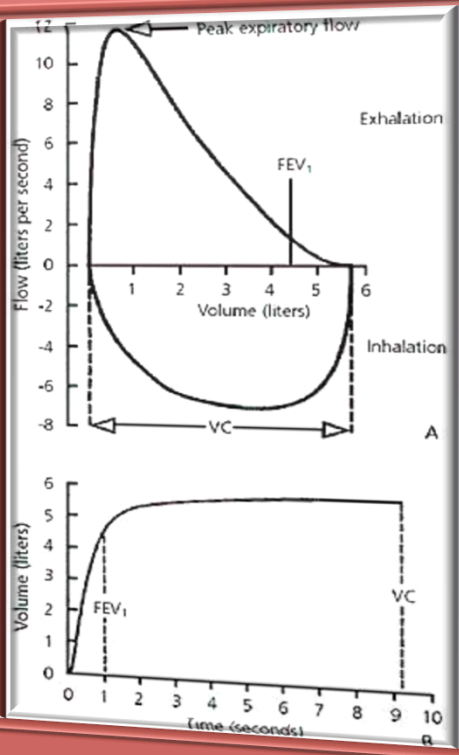
Measures the rate at which the lung changes volume during forced breathing.

Forced vital capacity

The max volume of air that can be forcibly and rapidly exhaled following a max inspiration.

Two types of curves can be obtained

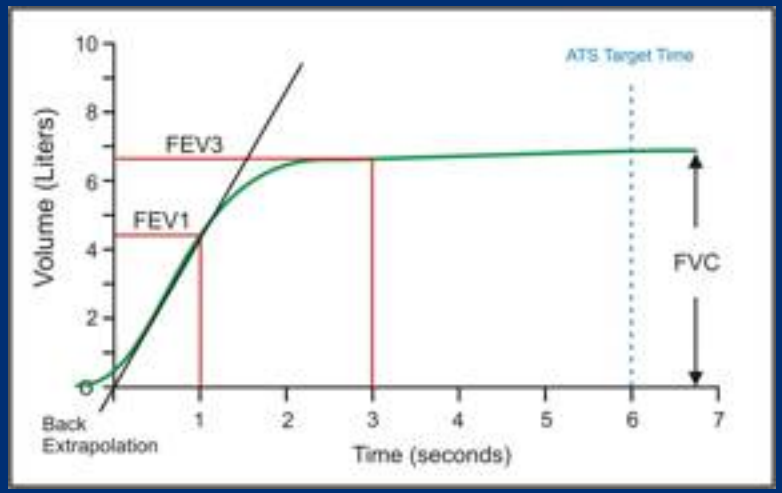
Forced expiratory curve



Flow Volume curve

Forced Expiratory Curve

- The subject takes a maximal inspiration and then exhales as rapidly, as forcibly,& as maximally as possible.
- A plot of exhaled volume against time:



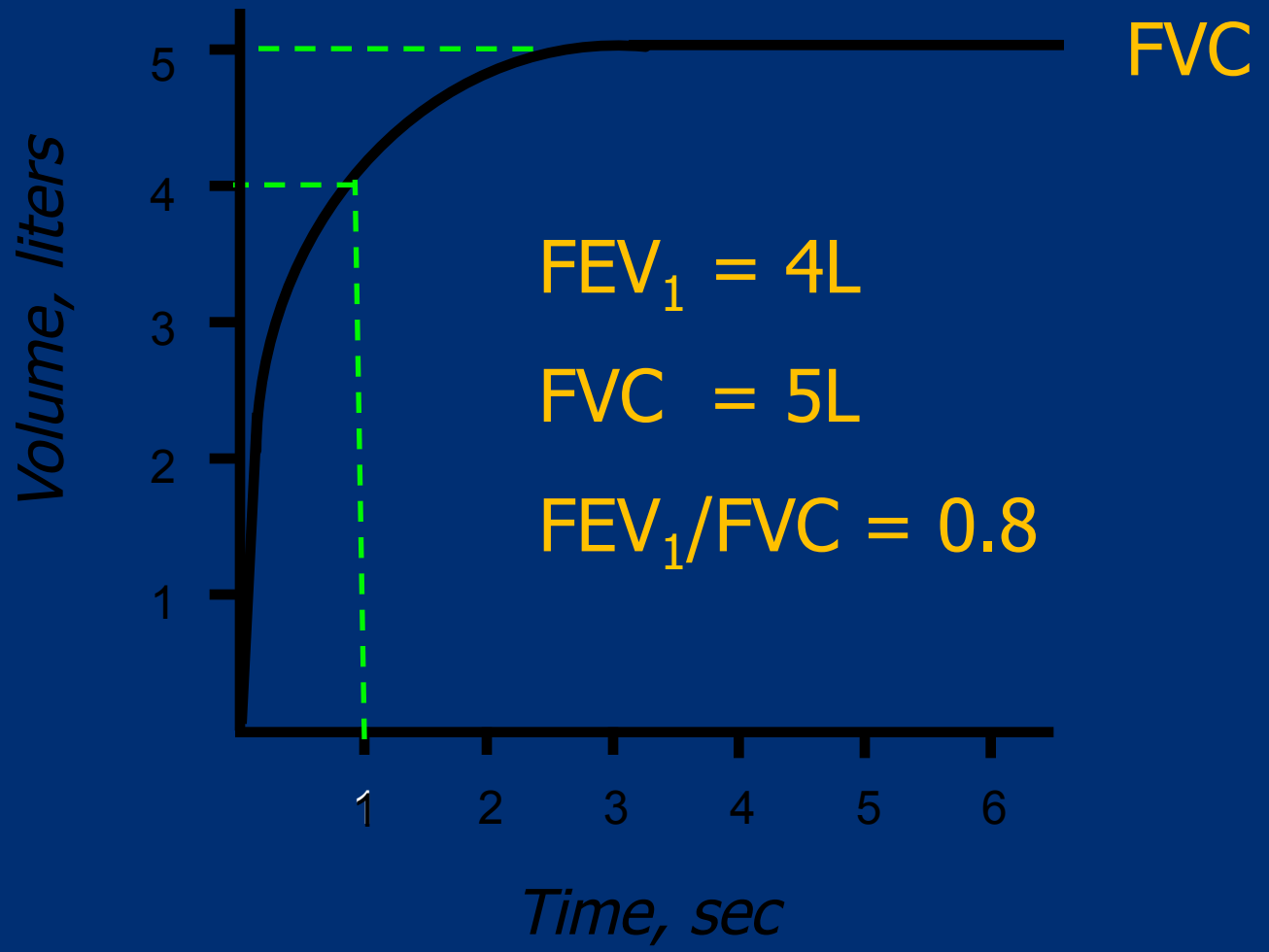
FEV_1 : Volume of air expelled in the 1st sec of forced expiration starting from full inspiration

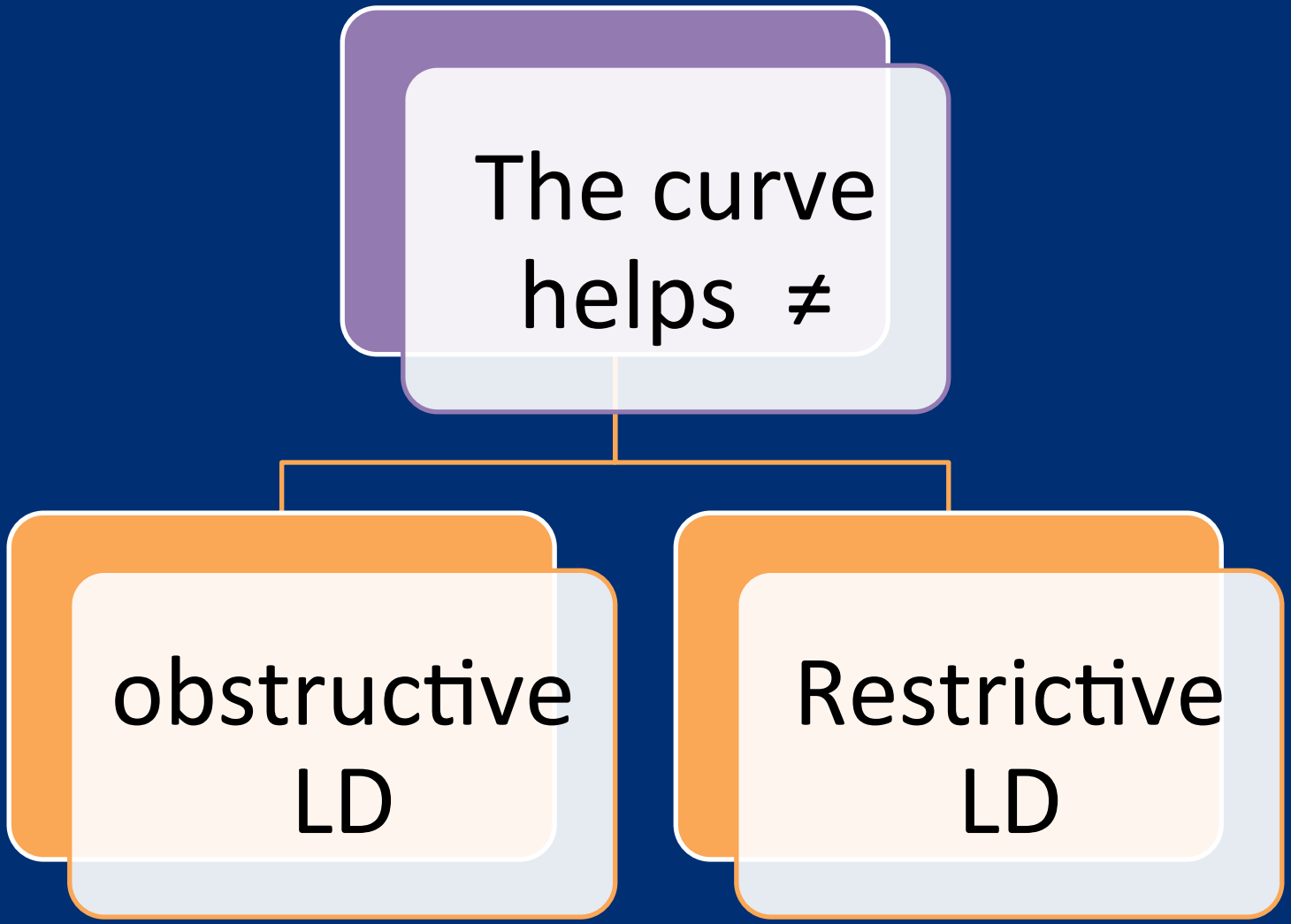
Plateau: **FVC**

FEV1 % or ratio = (FEV_1/FVC) * 100

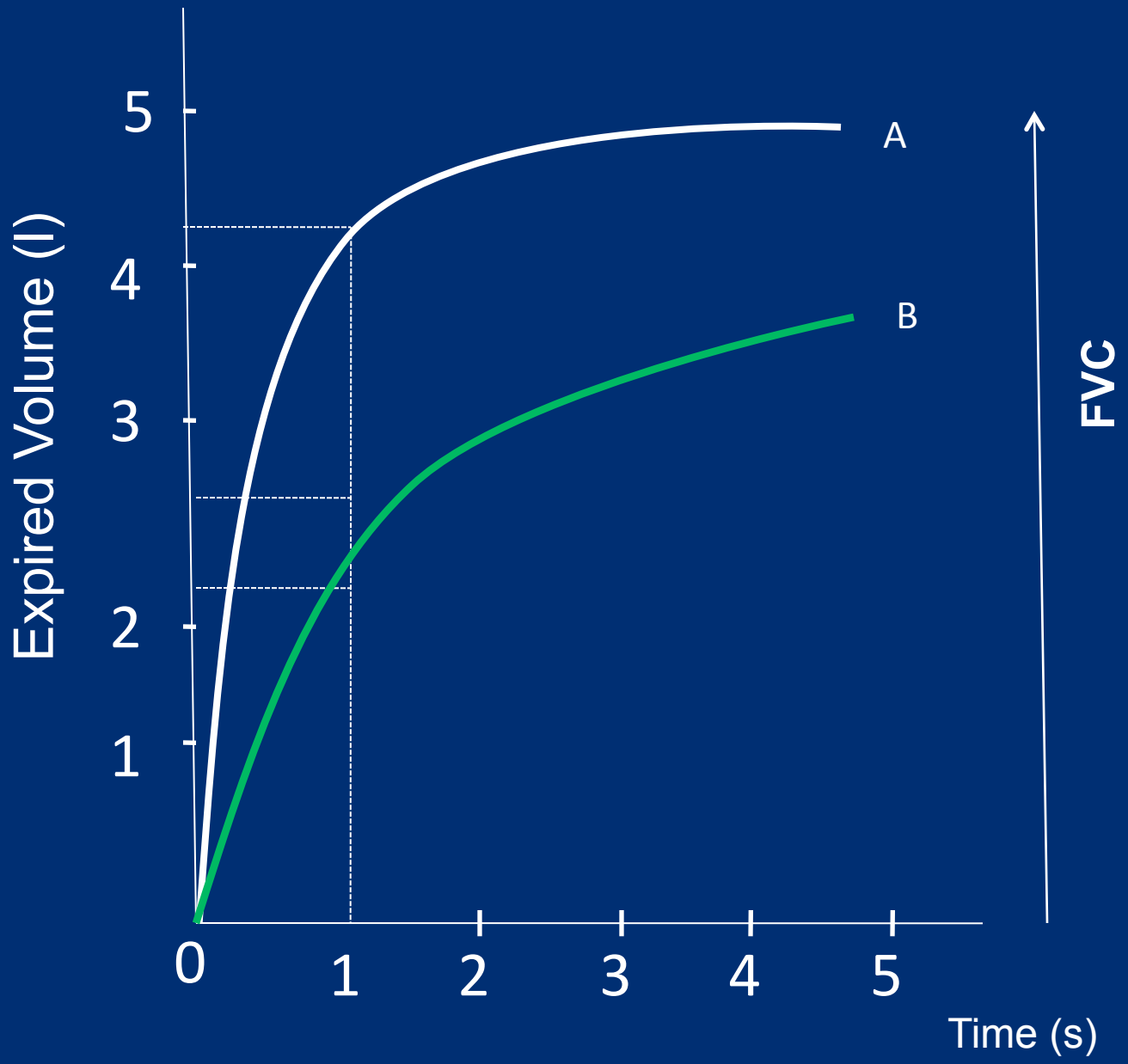
Fraction of the VC expired during the 1st sec of a forced expiration (NL 70%-80%)

Normal Trace Showing FEV_1 and FVC

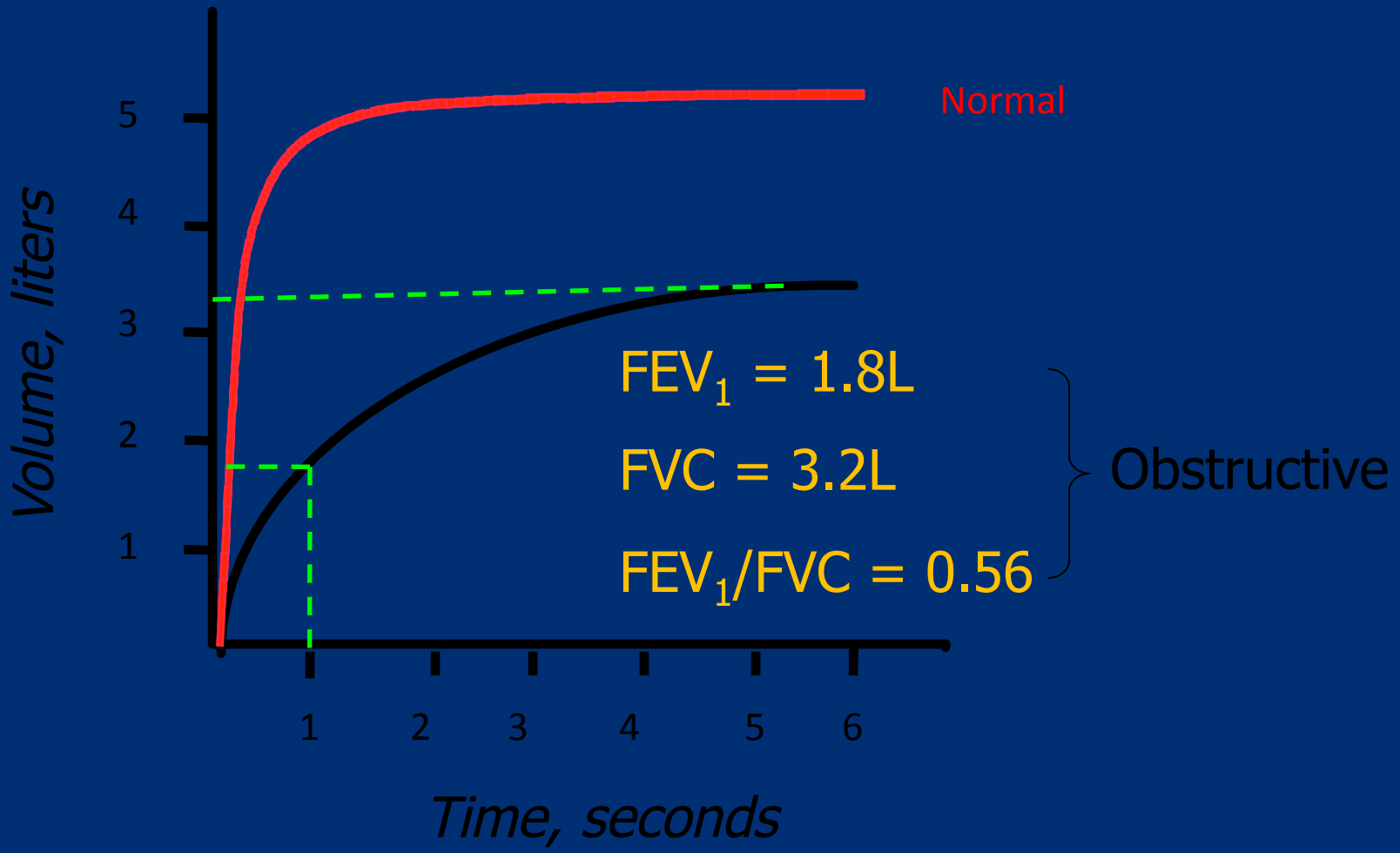



The curve helps ≠
obstructive LD
Restrictive LD

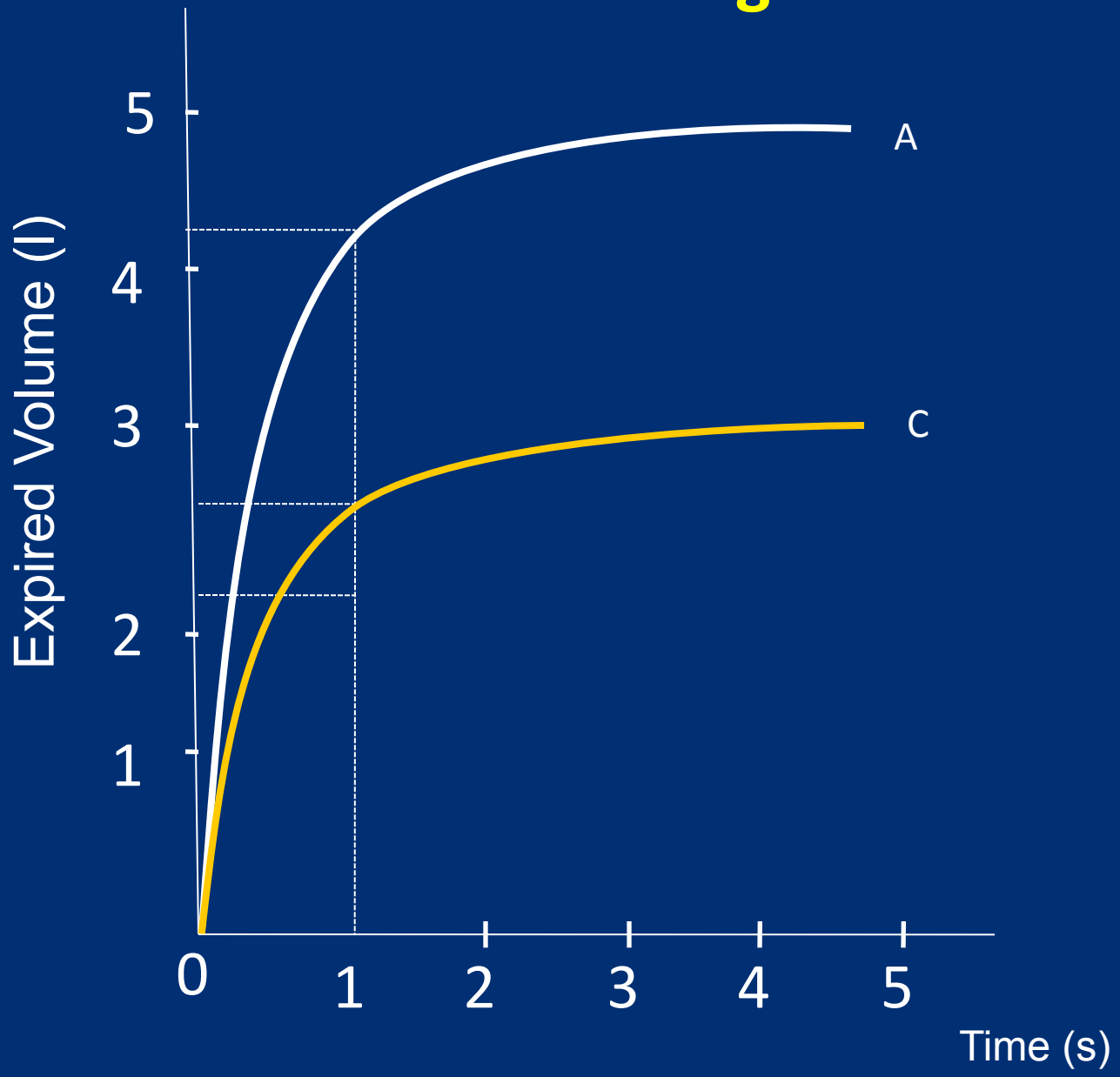
Obstructive lung disease



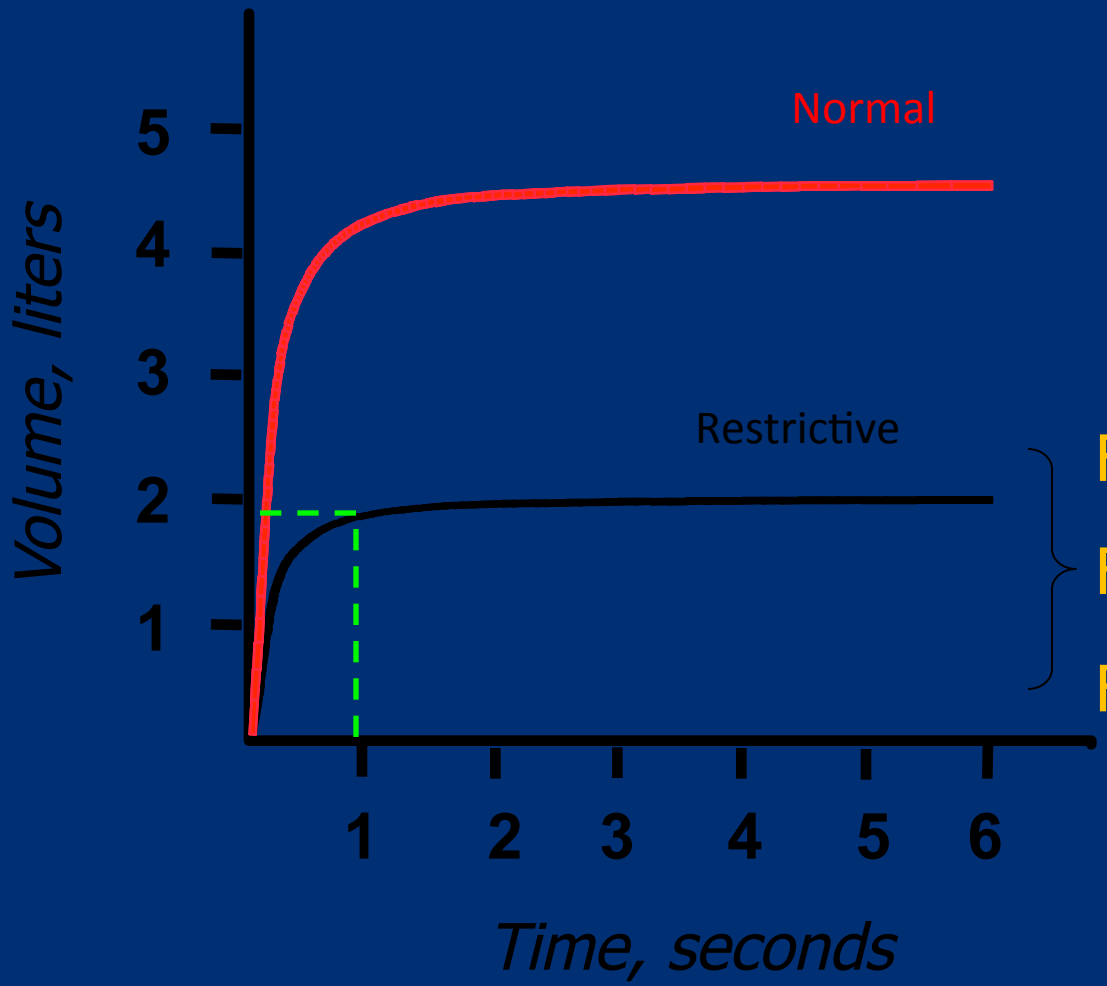
Obstructive Disease



Restrictive lung disease



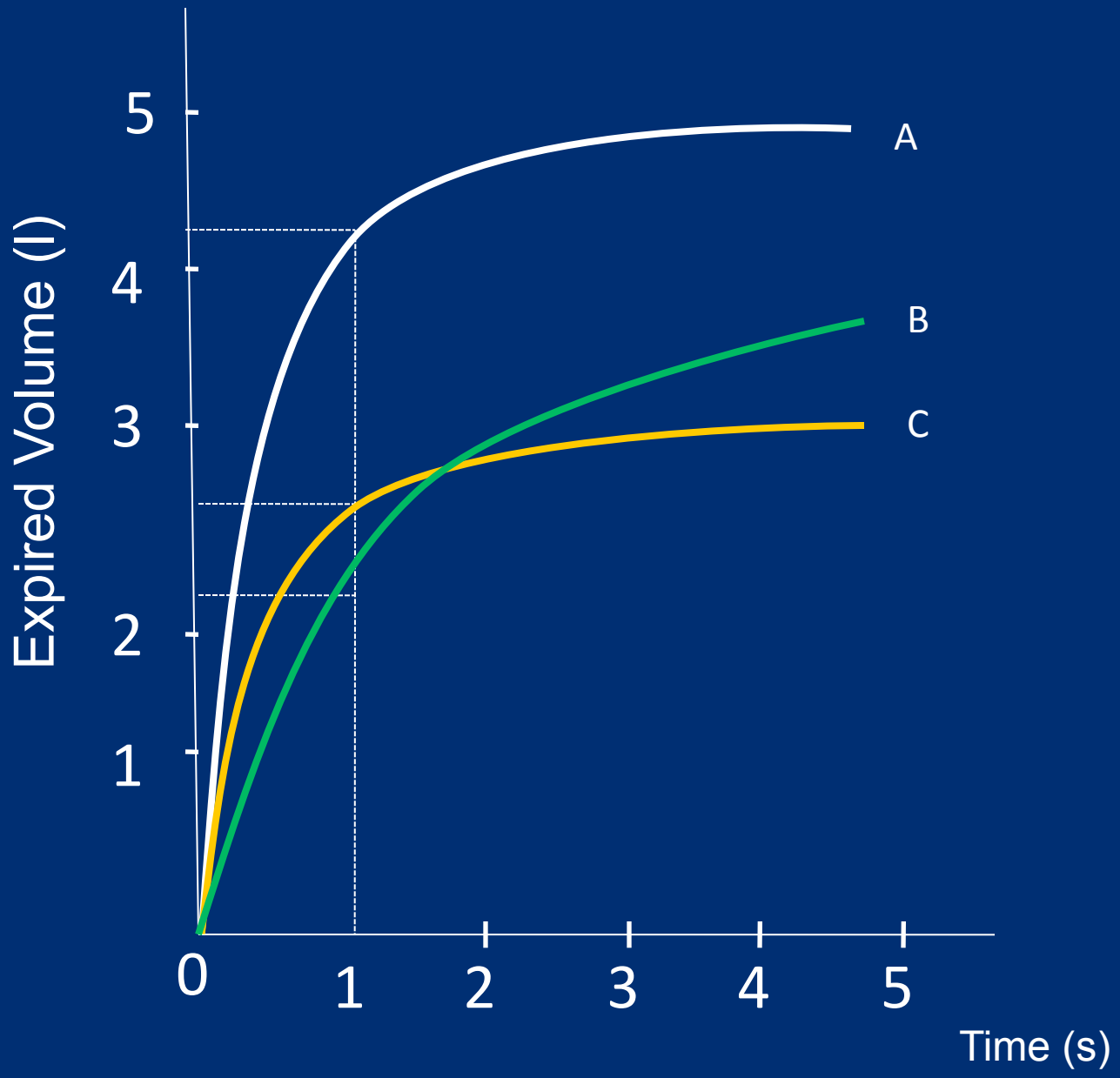
Restrictive Disease

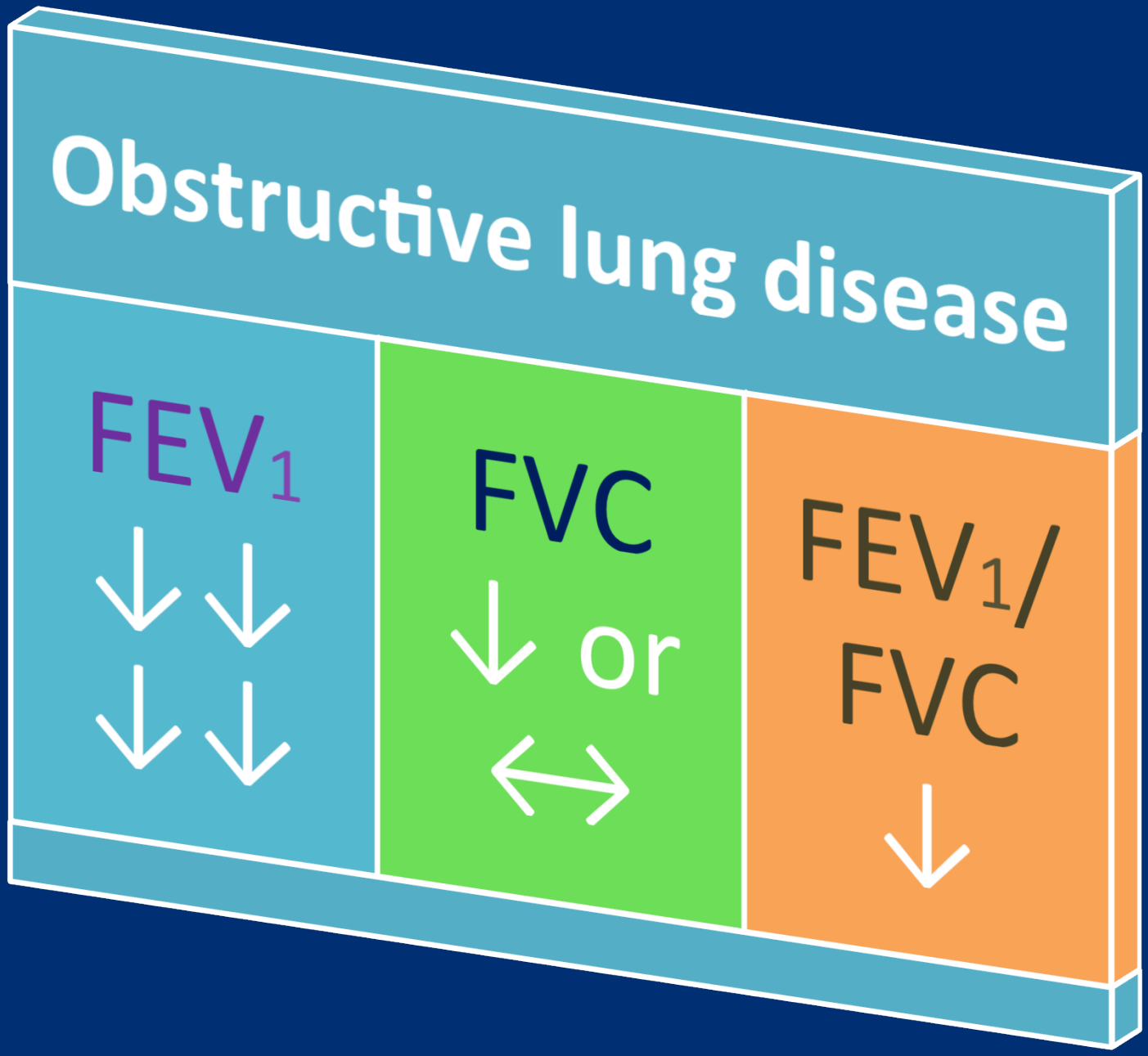


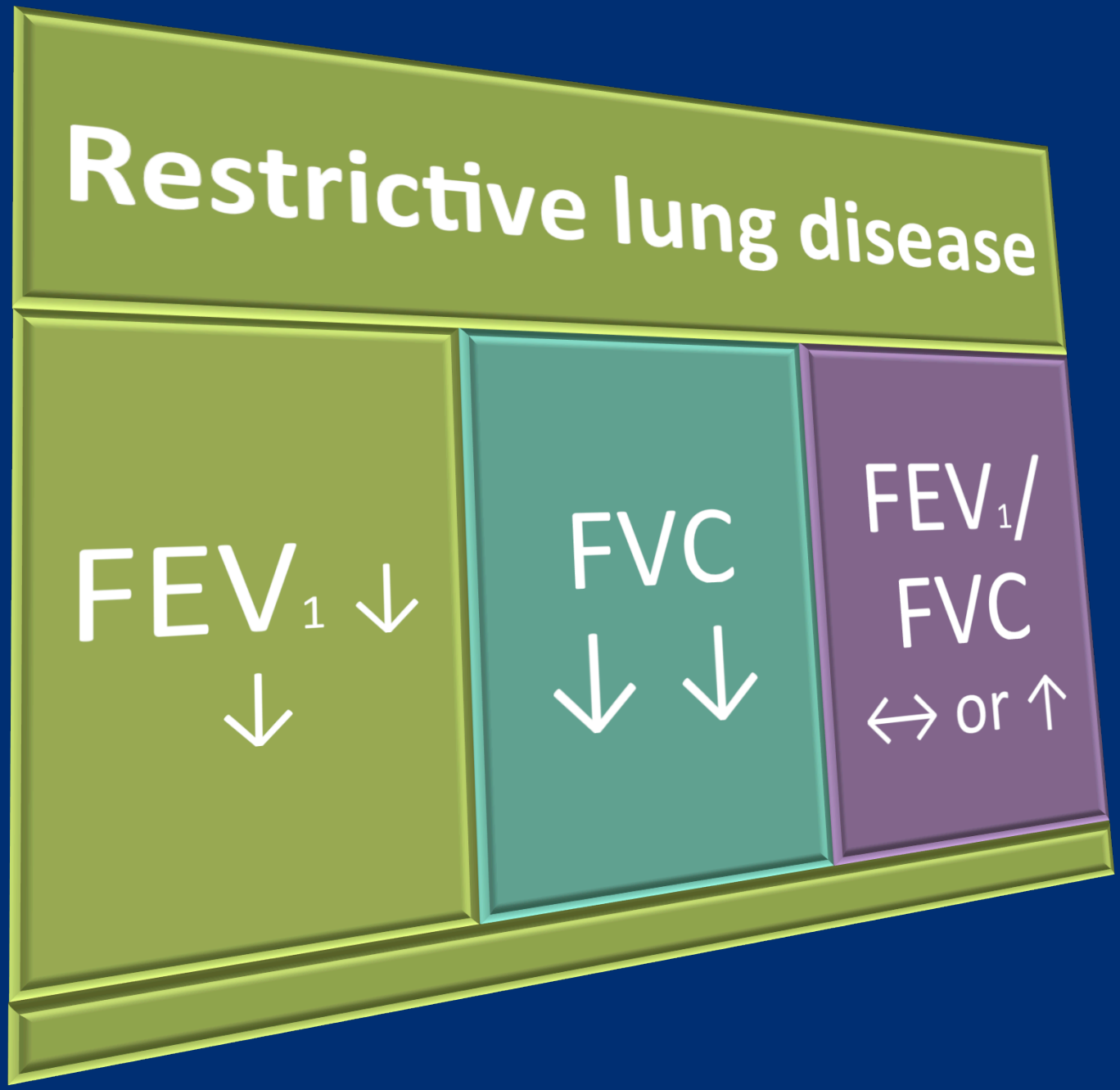
FEV_1 = 1.9L

FVC = 2.0L

FEV_1/FVC = 0.95


Expired Volume (l)
5
4
3
2
1
0
1
2
3
4
5
Time (s)
A
B
C


Obstructive lung disease
FEV1
↓ ↓
↓ ↓
FVC
↓ or
↔
FEV1/
FVC
↓


Restrictive lung disease
FEV1 ↓
↓
FVC
↓ ↓
FEV1/
FVC
↔ or ↑

Volume	Normal	Obstructive	Restrictive
FVC	5	↓ or ↔ (5)	↓ (3)
FEV_1	4	↓↓↓ (2)	↓ (2.7)
$FEV_1\%$	80%	↓ (40%)	↔ or ↑ (90)

Results interpretation

- Results are reported as absolute values (litre) ,and as percentages of predicted values based on age, height, sex, ethnicity.

- Normal: Both FVC and FEV1 ≥ 75% of predicted

- If one or both of the parameters is < 75% predicted, calculate FEV_1 ratio:
- $FEV_1\% \geq 80\%$ ------→ Restrictive
- $FEV_1\% < 70\%$ ------→ Obstructive

Calculating percentage of predicted values

Patient: 45 year old woman, height 5'3"

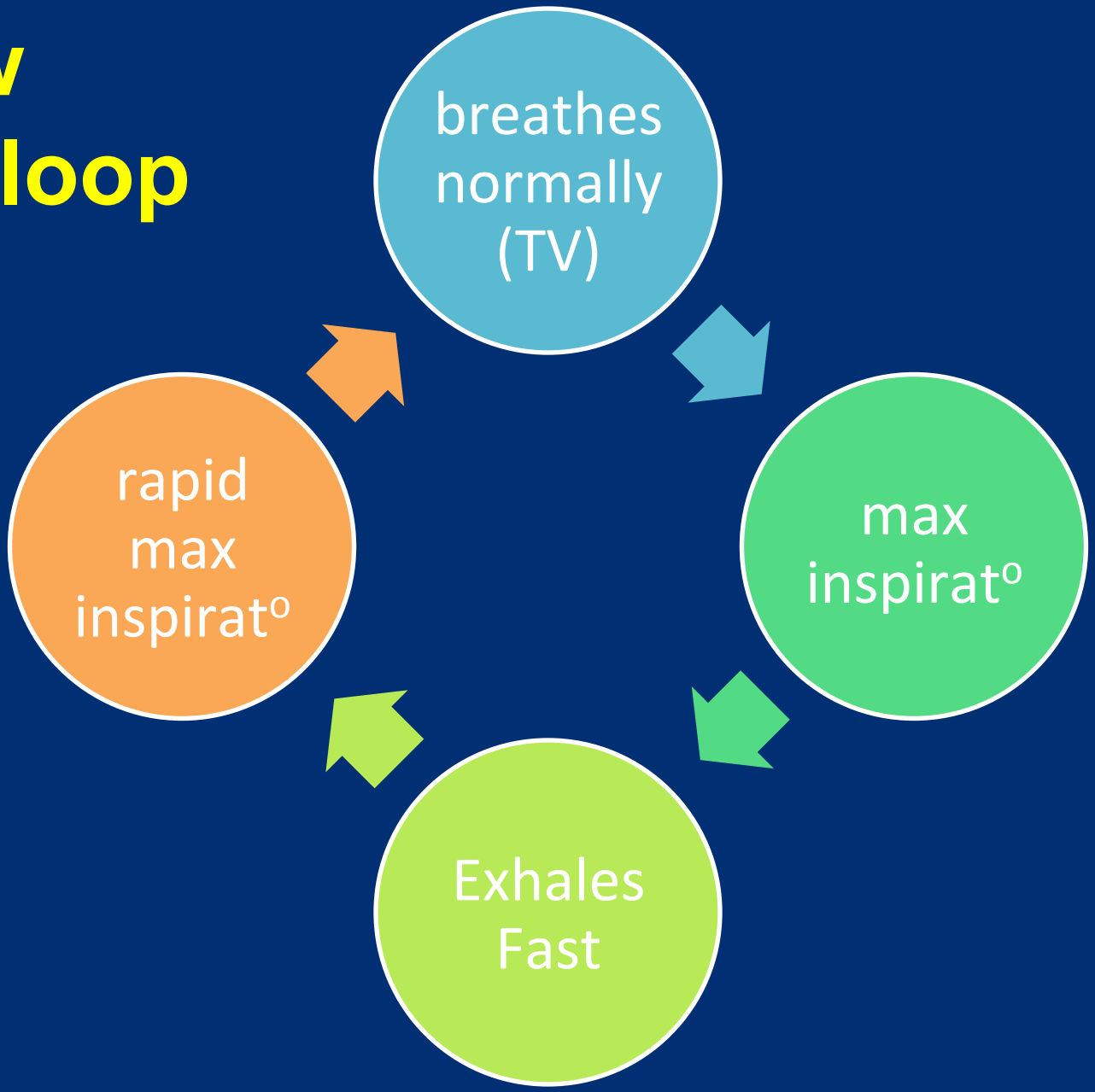
$$FEV_1 \quad \frac{\text{Reading } 1.43}{\text{Predicted value } 2.60} \times 100\% = 55\% \text{ of predicted normal}$$

$$FVC \quad \frac{\text{Reading } 2.5}{\text{Predicted value } 3.03} \times 100\% = 82.5\% \text{ of predicted normal}$$

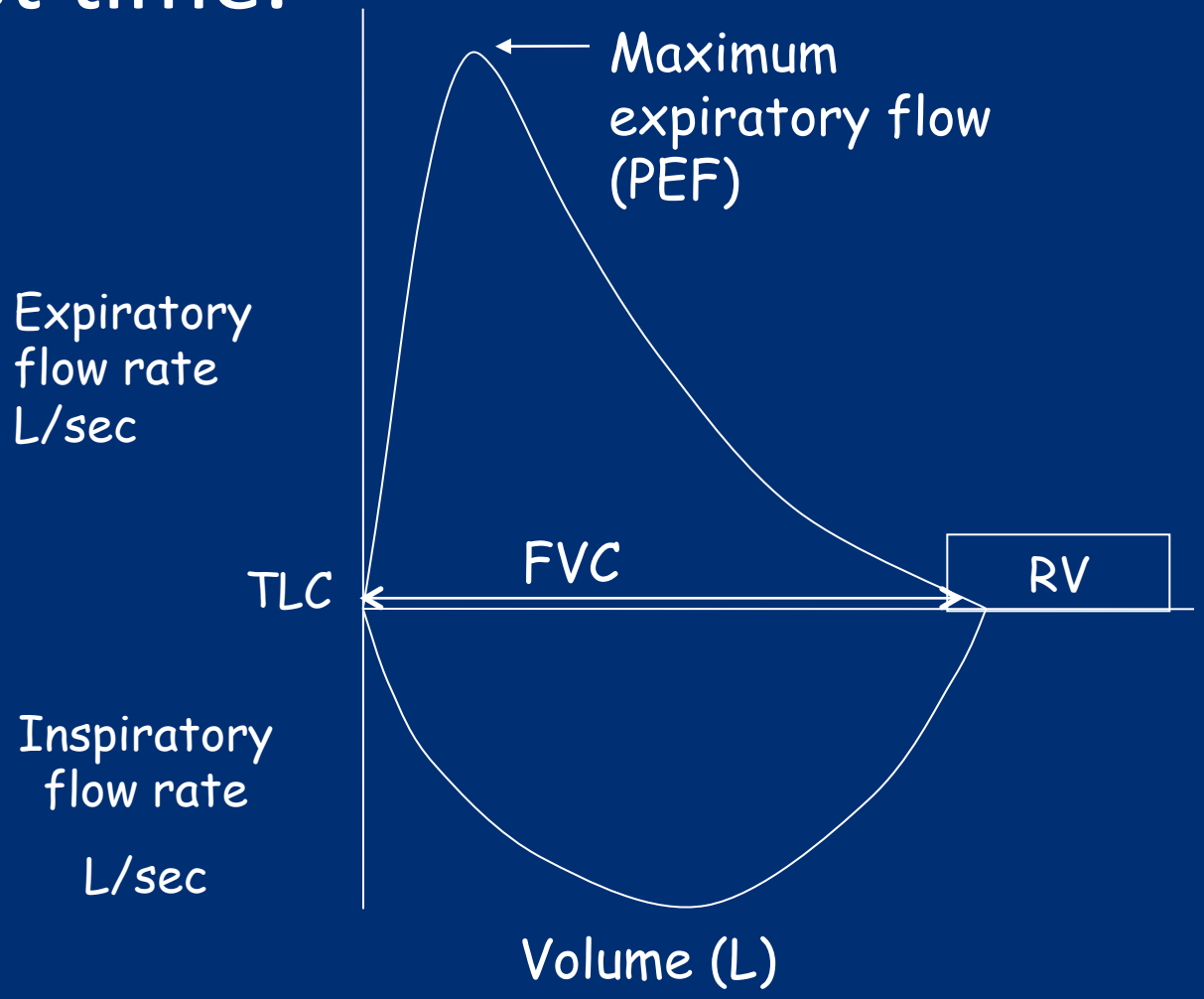
$$\frac{FEV_1}{FVC} \quad \frac{\text{Reading } 1.43}{\text{Reading } 2.5} = 0.57$$

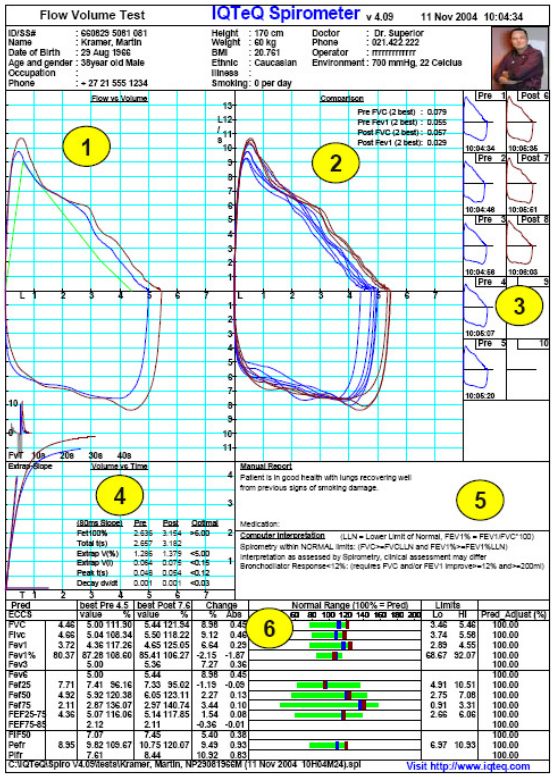
Interpretation: patient has mild airflow obstruction as FEV_1 is between 50% and 80% of predicted normal and FEV_1/FVC is <0.7.

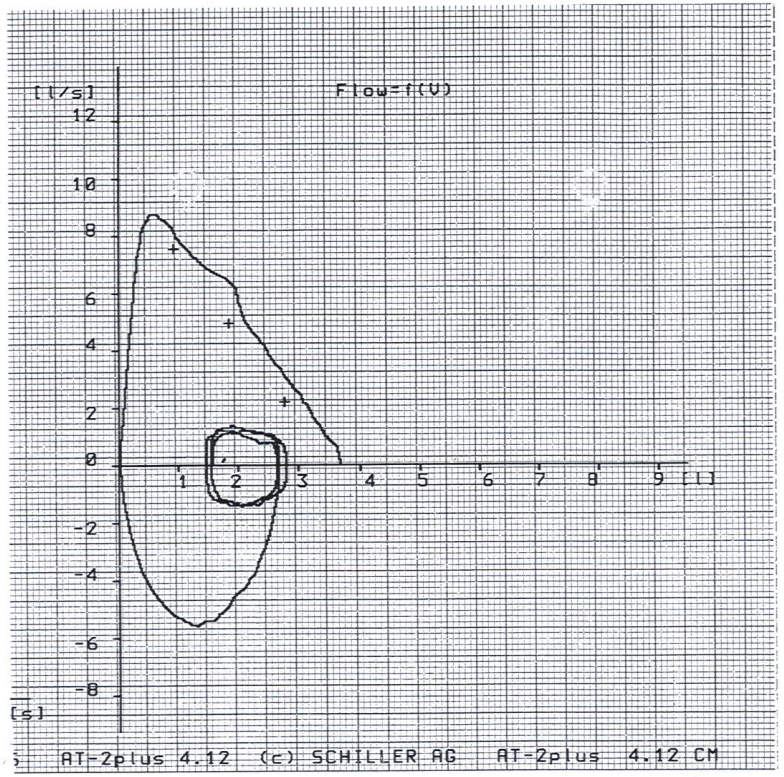
Flow Volume loop



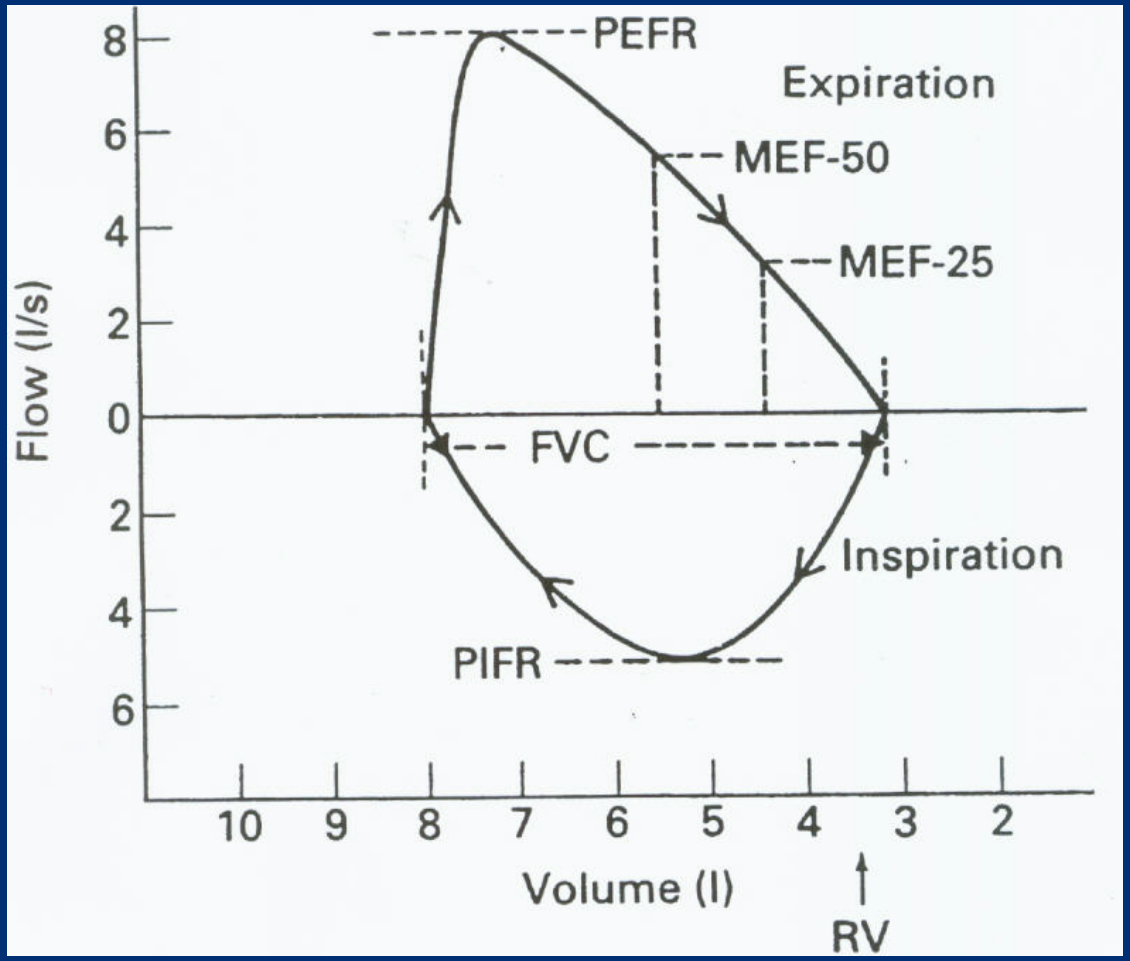
This measures exp & insp flow as a function of exhaled volume rather then against time.




Flow Volume Test
IQTeQ Spirometer v 4.09
11 Nov 2004 10:04:34
ID/SS# : 660829 5081 081
Name : Kramer, Martin
Date of Birth : 29 Aug 1966
Age and gender : 38year old Male
Occupation :
Phone : + 27 21 555 1234
Height : 170 cm
Weight : 60 kg
BMI : 20.761
Ethnic : Caucasian
Illness :
Smoking : 0 per day
Doctor : Dr. Superior
Phone : 021.422.222
Operator : rrrrrrrrrrrrr
Environment : 700 mmHg, 22 Celcius
Flow vs Volume
Comparison
Pre FVC (2 best) : 0.079
Pre Fev1 (2 best) : 0.055
Post FVC (2 best) : 0.057
Post Fev1 (2 best) : 0.029
Pre 1
Post 6
Pre 2
Post 7
Pre 3
Post 8
Pre 4
Pre 5
Extrap Slope
Volume vs Time
(80ms Slope) Pre Post Optimal
Fet100% 2.636 3.154 >6.00
Total t(s) 2.657 3.182
Extrap V(%) 1.286 1.379 <5.00
Extrap V(l) 0.064 0.079 <0.15
Peak t(s) 0.048 0.054 <0.12
Decay dv/dt 0.001 0.001 <0.03
Manual Report
Patient is in good health with lungs recovering well from previous signs of smoking damage.
Medication:
Computer Interpretation (LLN = Lower Limit of Normal, FEV1% = FEV1/FVC*100)
Spirometry within NORMAL limits: (FVC>=FVCLLN and FEV1%>=FEV1%LLN)
Interpretation as assessed by Spirometry, clinical assessment may differ
Bronchodilator Response<12%: (requires FVC and/or FEV1 improve>=12% and>=200ml)
Pred best Pre 4.5 best Post 7.6 Change Normal Range (100% = Pred) Limits
ECCS Value % Value % % Abs Lo Hi Pred_Adjust (%)
FVC 4.46 5.00 111.90 5.44 121.94 8.98 0.45 3.46 5.46 100.00
FIvc 4.66 5.04 108.34 5.50 118.22 9.12 0.46 3.74 5.58 100.00
Fev1 3.72 4.36 117.26 4.65 125.05 6.64 0.29 2.89 4.55 100.00
Fev1% 80.37 87.28 108.60 85.41 106.27 -2.15 -1.87 68.67 92.07 100.00
Fev3 5.00 5.36 7.27 0.36 100.00
Fev6 5.00 5.44 8.98 0.45 100.00
Fef25 7.71 7.41 96.16 7.33 95.02 -1.19 -0.09 4.91 10.51 100.00
Fef50 4.92 5.92 120.38 6.05 123.11 2.27 0.13 2.75 7.08 100.00
Fef75 2.11 2.87 136.07 2.97 140.74 3.44 0.10 0.91 3.31 100.00
FEF25-75 4.36 5.07 116.06 5.14 117.85 1.54 0.08 2.66 6.06 100.00
FEF75-85 2.12 2.11 -0.36 -0.01 100.00
FIF50 7.07 7.45 5.40 0.38 100.00
Pefr 8.95 9.82 109.67 10.75 120.07 9.49 0.93 6.97 10.93 100.00
Pifr 7.61 8.44 10.92 0.83 100.00
C:\IQTeQ\Spiro V4.09\tests\Kramer, Martin, NP29081966M (11 Nov 2004 10H04M24).spl
Visit http://www.iqteq.com
1
2
3
4
5
6


[l/s]
Flow=f(V)
[l]
[s]
AT-2plus 4.12 (c) SCHILLER AG AT-2plus 4.12 CM

Flow Volume loop



• Measurements on flow V loop

- **PEFR** : Greatest flow achieved during the maneuvre = 6- 12l/sec
- **PIFR** = max flow speed achieved during forceful inspiratory effort=6l/sec

- **MEF50**: max expiratory flow at 50% of FVC = 4- 6 l
- **FVC** measured over the X-axis

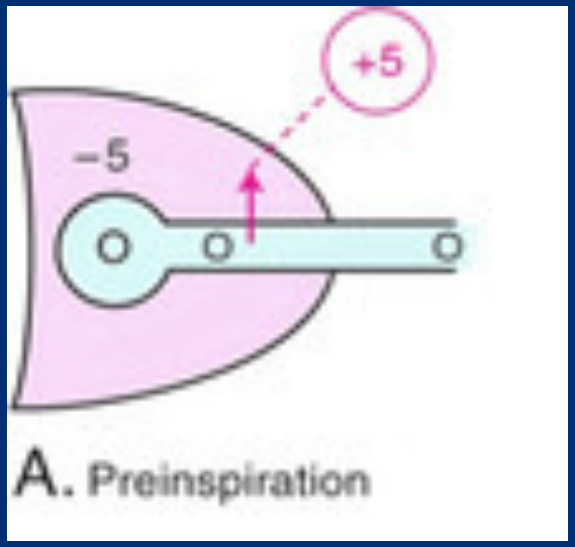
Maximal Expiratory Flow

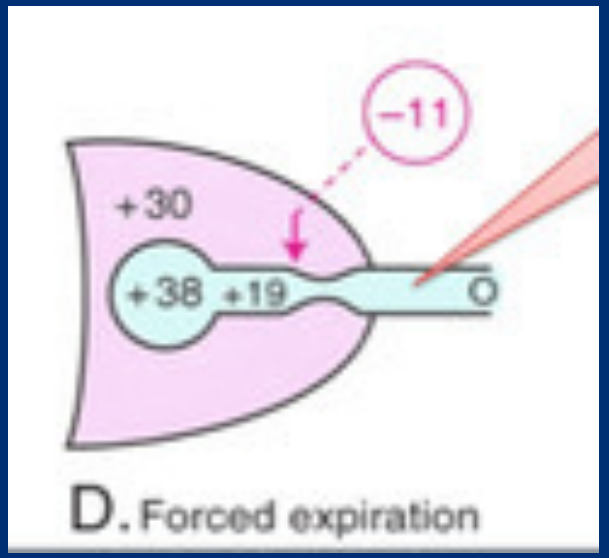
- The inspiratory and the 1st early flow rates of the expiratory curve : (flows generated near the TLC) are effort (muscle) dependent :

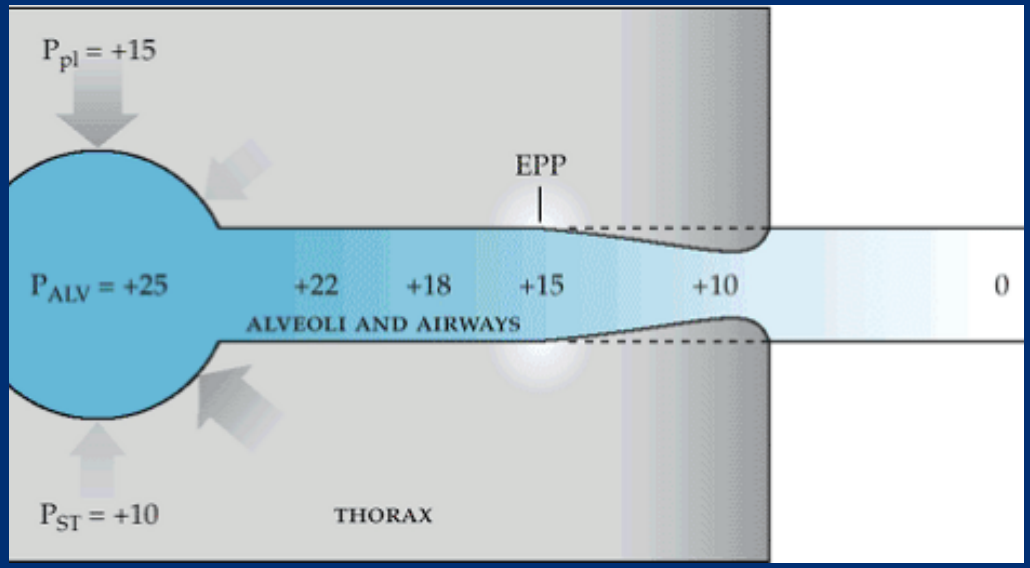
- The greater one can raise pleural pressure (the harder one forces the air out), the greater the resulting air flow

Flow Volume Loop and Flow Limitation

- At low lung Volume , as RV is approached, after a certain pleural pressure (Pip) is reached, flow rate is effort independent (it depends on the size of the bronchi)
- Harder effort generates higher Pip but no greater airflow, this is because the positive Pip that tends to collapse the airway exceeds the airway pressure that tends to keep the airways open: the airways narrow, preventing any further increase in airflow despite greater effort.


+5
−5
A. Preinspiration


−11
+30
+38
+19
D. Forced expiration


P_{pl} = +15
EPP
P_{ALV} = +25
+22
+18
+15
+10
0
ALVEOLI AND AIRWAYS
P_{ST} = +10
THORAX

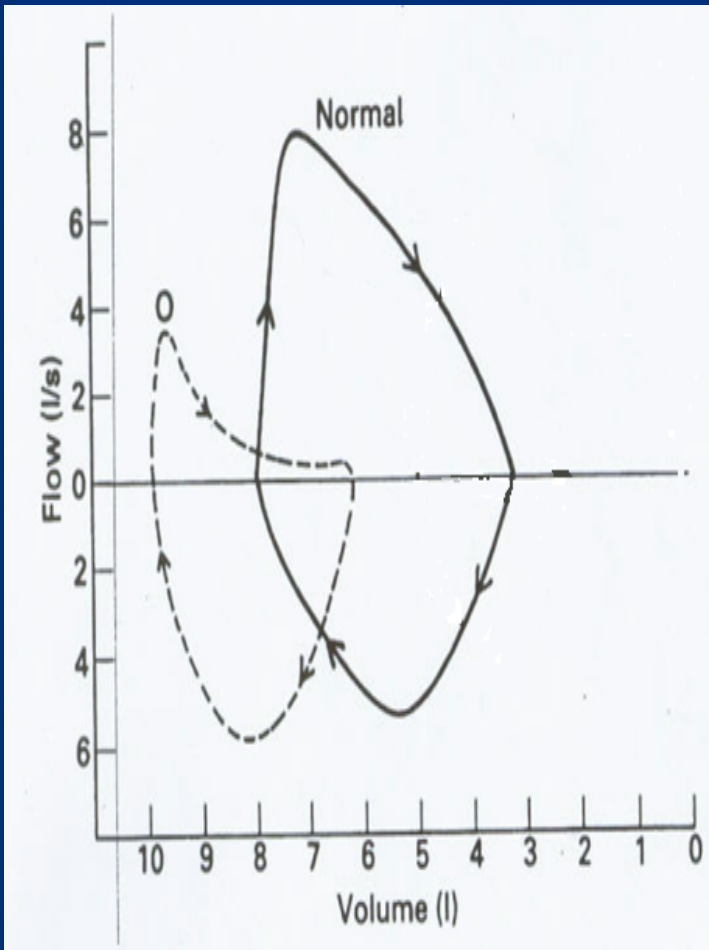
Obstructive LD

MEF50↓

Effort independent part of curve: concave

PEFR↓

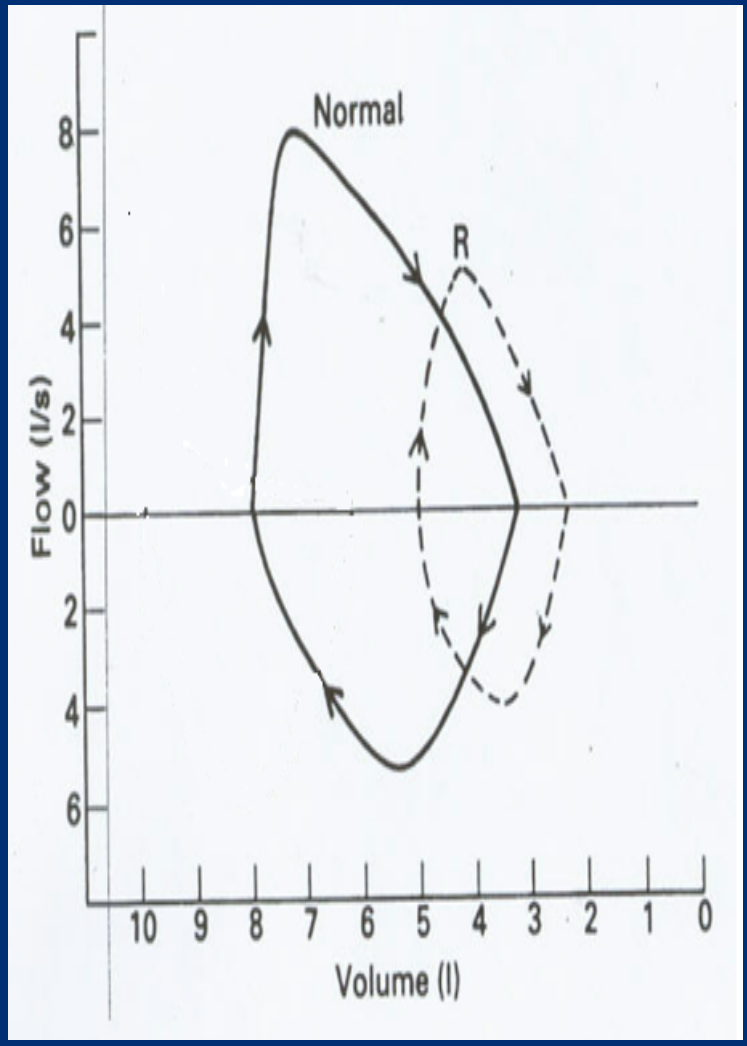
Inspiratory loop Normal

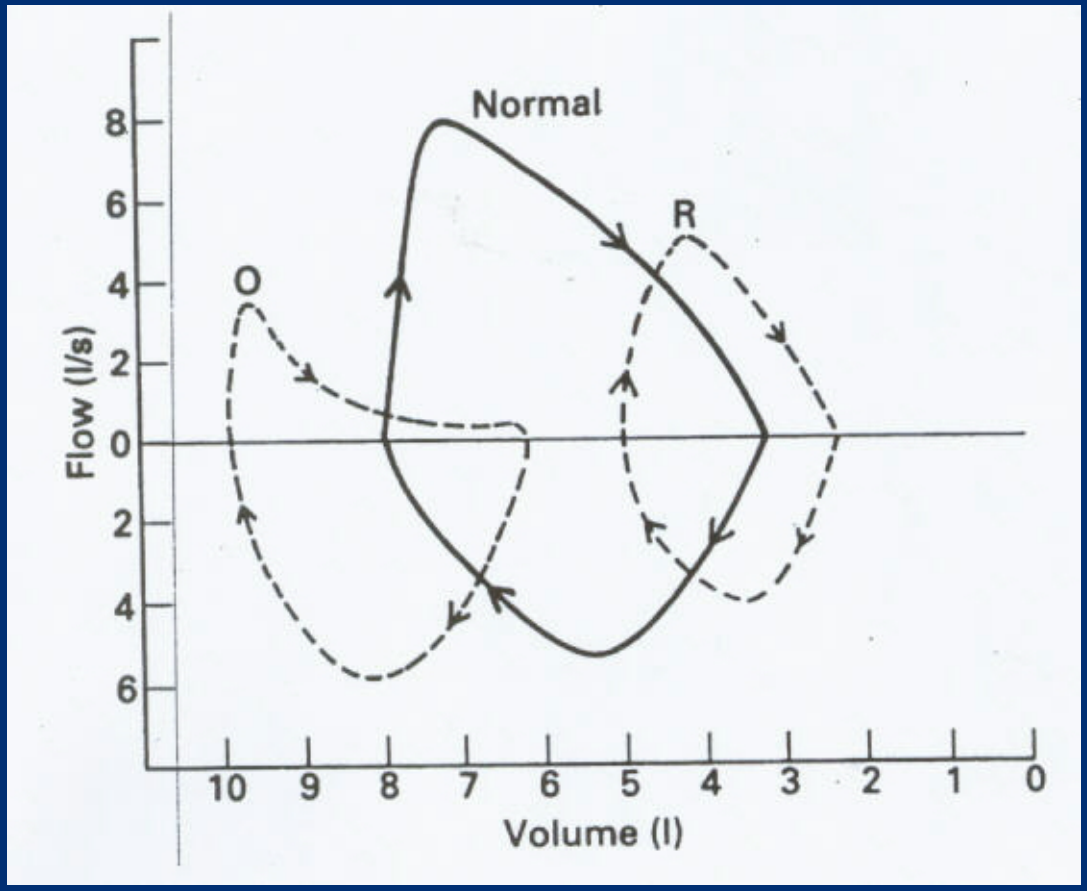


Restrictive LD

Miniature loop (elliptical)

All flow parameters ↓




Normal
R
O
Flow (l/s)
8
6
4
2
0
2
4
6
10
9
8
7
6
5
4
3
2
1
0
Volume (l)

Importance of spirometry

Assess physical fitness .

Helps in the diagnosis of certain pulmonary diseases (obstructive & restrictive).

Follow disease progression.

Thank You