

# IPCRG workshops on respiratory diseases

## Spirometry technique

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# Objectives

- To know the important spirometry parameters
- To identify a “good quality” spirometry
- To identify the different spirometry patterns
- To accurately “read” the results of the test



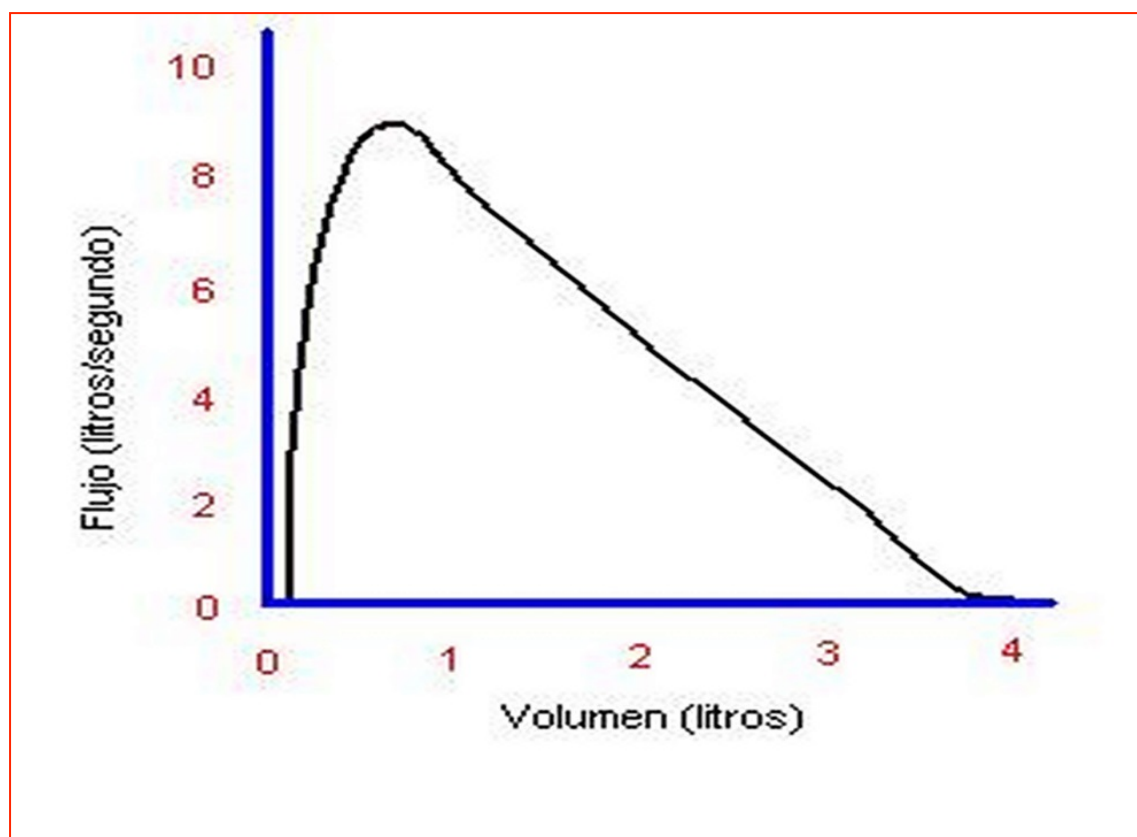
# Forced spirometry

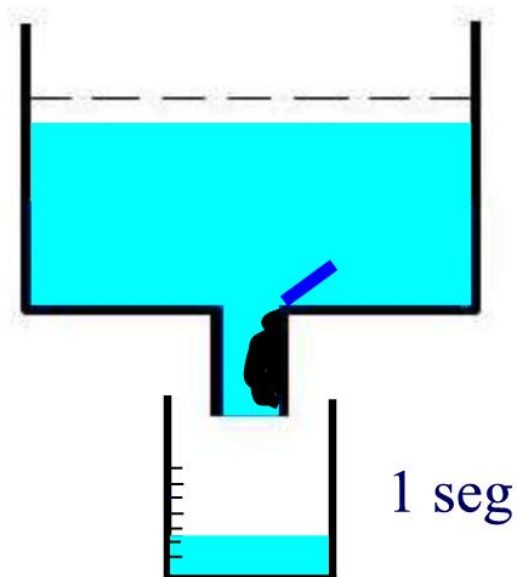
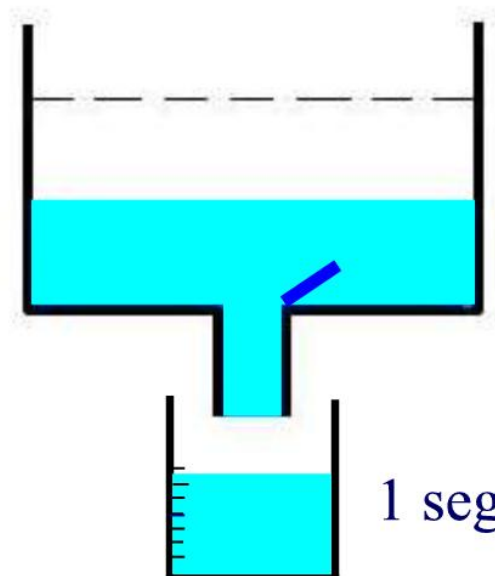
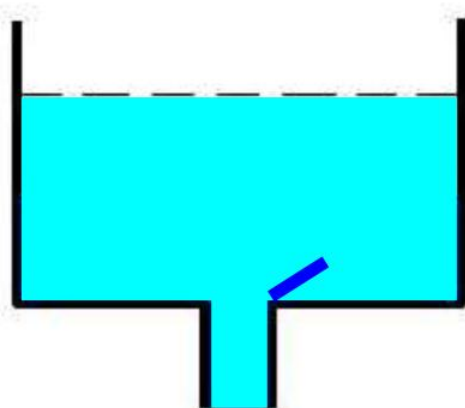
- Spirometry measures airflow and lung volumes, and is the preferred lung function test for COPD and asthma in primary care
- **Forced** exhalation from a **maximal** inspiration

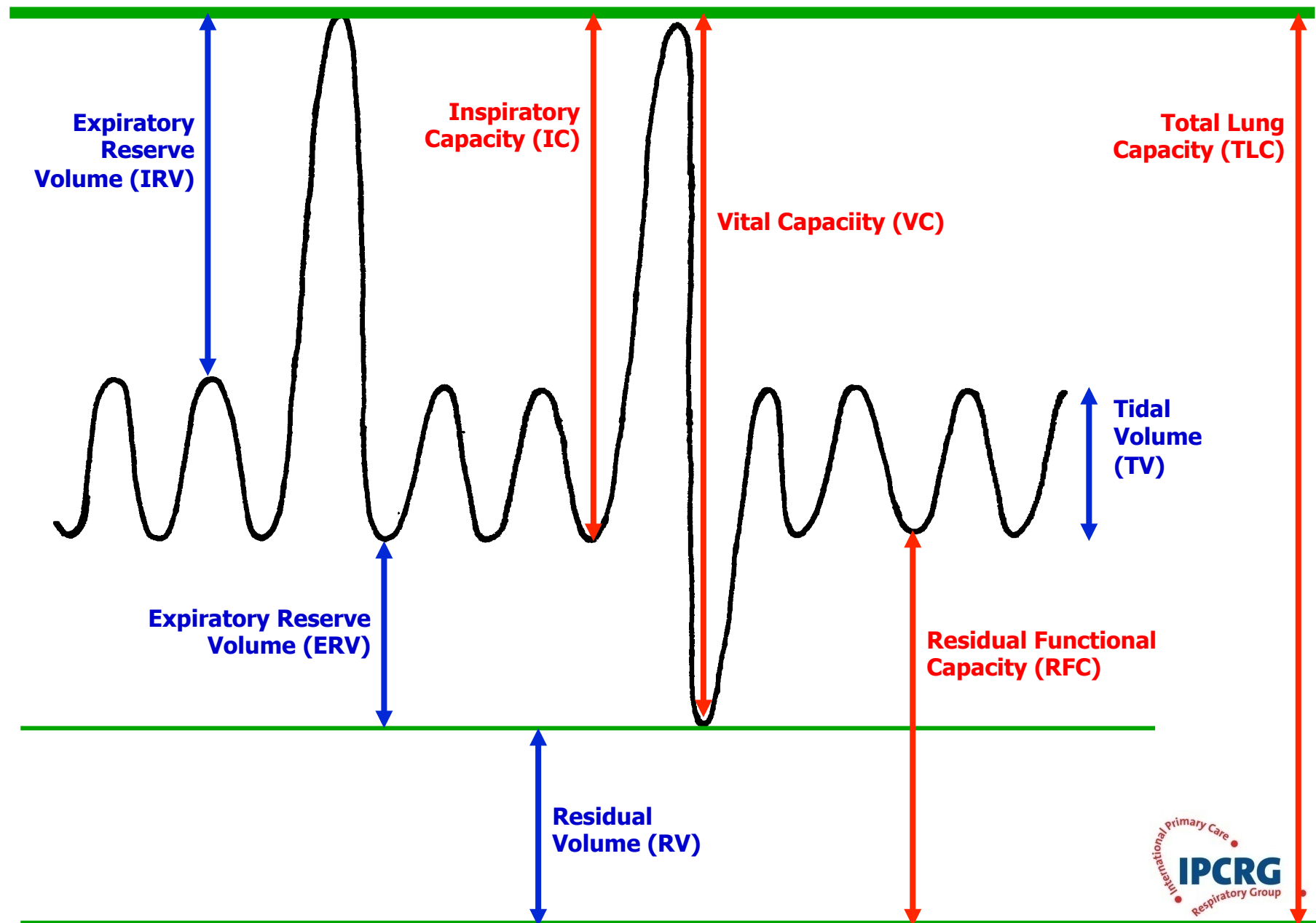




# To understand the concept



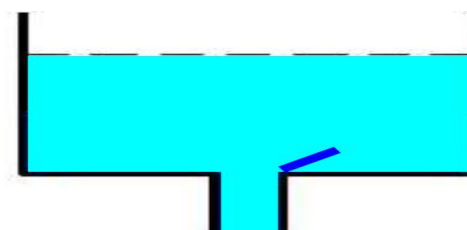
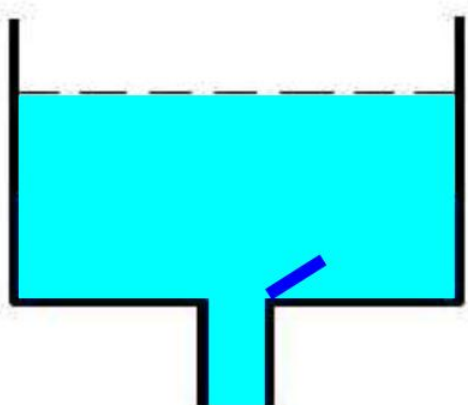






# Important measurements

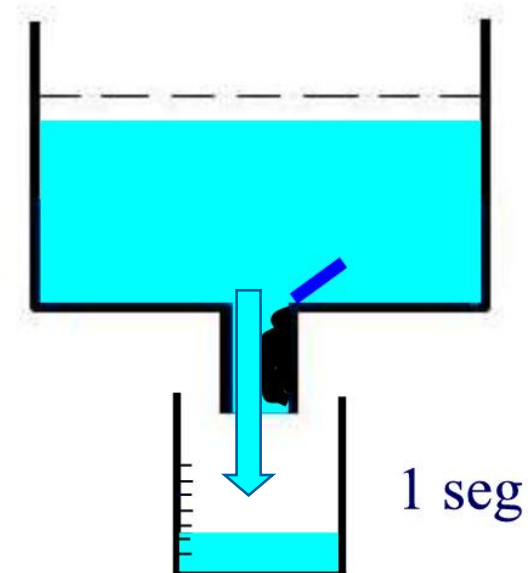
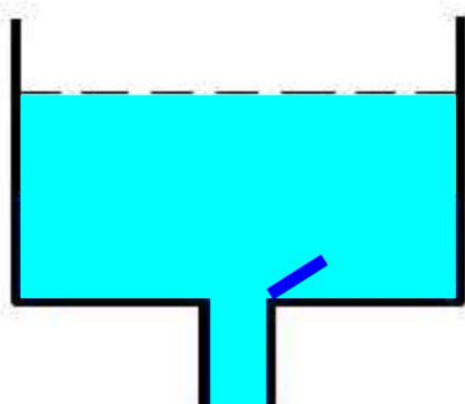
- **FVC:** FORCED VITAL CAPACITY Volume of air exhaled after full inspiration and full exhalation
- **FEV1:** FORCED EXPIRATORY VOLUME IN 1 SECOND Volume of air exhaled in the first second of forced exhalation.
- **FEV1 / FVC:** Ratio of vital capacity exhaled in 1 second expressed as a percentage



# FVC

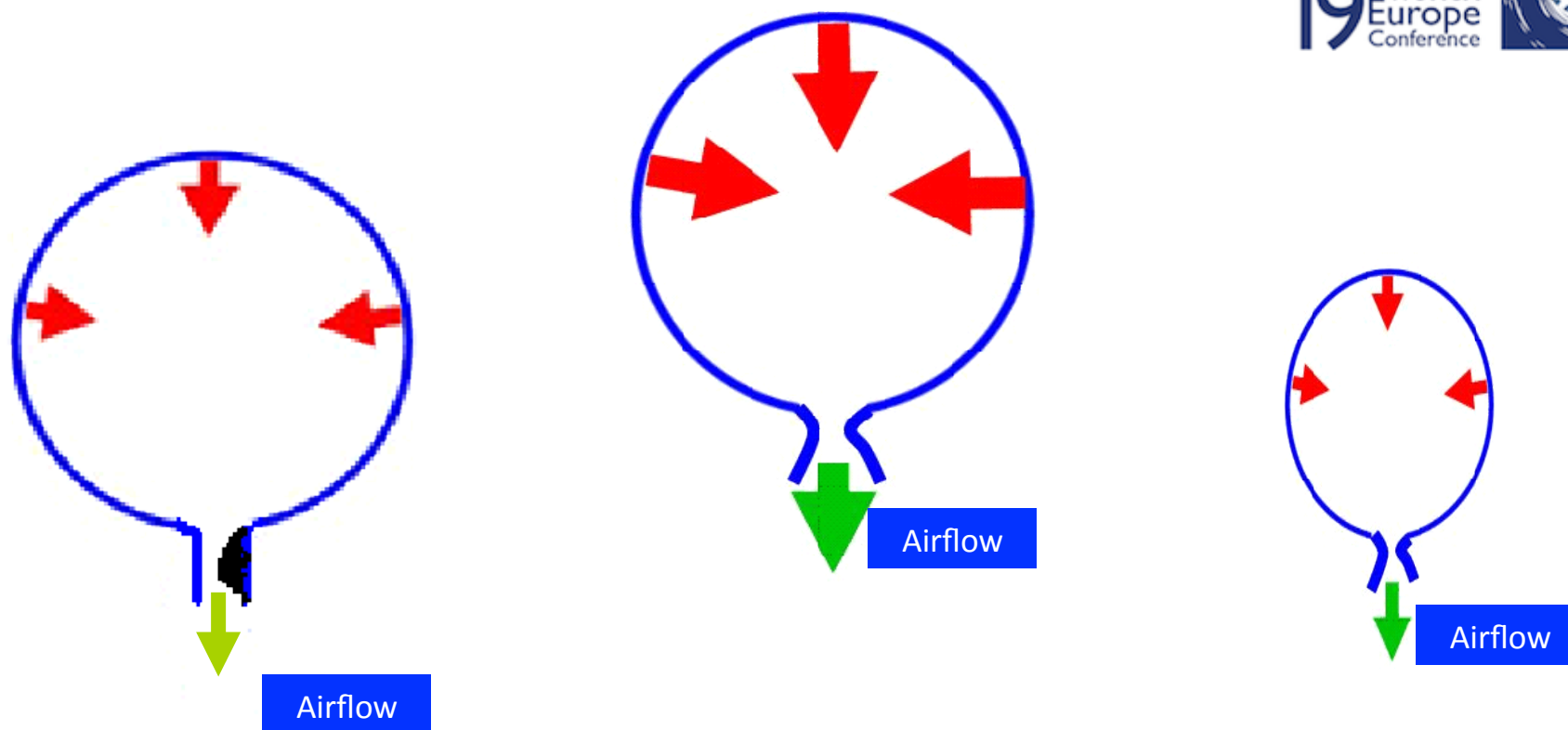
The less total volume /capacity the less FVC





# FEV1

Bronchial obstruction generates less volume in the first second



# FEV1 / FVC

Best obstruction measurement

# Factors that influence normal values

- **Height - tall people have larger lungs**
- **Age - Respiratory function declines with age**
- **Sex - Lung volumes smaller in females**
- **Race - Peculiarly studies show Black and Asian people as a whole, have smaller lung volumes (-12-20 %) No studies for Pacific People.**
- **Posture - little difference between sitting and standing. Reduced in supine position.**

# Important messages

19<sup>TH</sup> WONCA  
Europe  
Conference



International Primary Care  
**IPCRG**  
Respiratory Group



# When to perform an spirometry

ASTHMA AND COPD DIAGNOSIS AND FOLLOW UP

TO ASSES CHRONIC RESPIRATORY SYMPTOMS

TO IDENTIFY SMOKERS AT RISK OF COPD



# When not to perform spirometry

## Absolute contraindications

- ✓ Recent pneumotórax
- ✓ Pulmonary Embolism (before anticoagulation)
- ✓ Active respiratory infection
- ✓ Recent myocardical infartcion or Unstable angor pectoris
- ✓ Retinal detachment
- ✓ Aortic Aneurisms
- ✓ Recent abdominal surgery
- ✓ Intracranial hypertension

## Relative contraindications

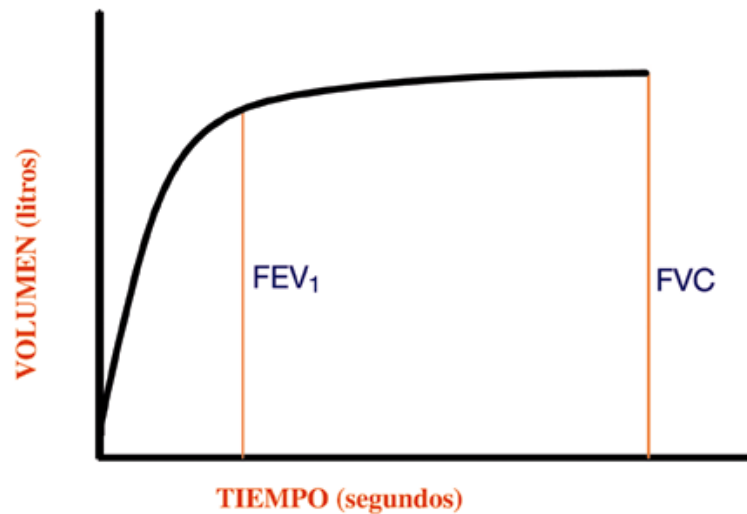
- Traqueostomy
- Problems to hold the mouthpiece
- Facial hemiparesis
- Poor mental condition.

# The most important issue

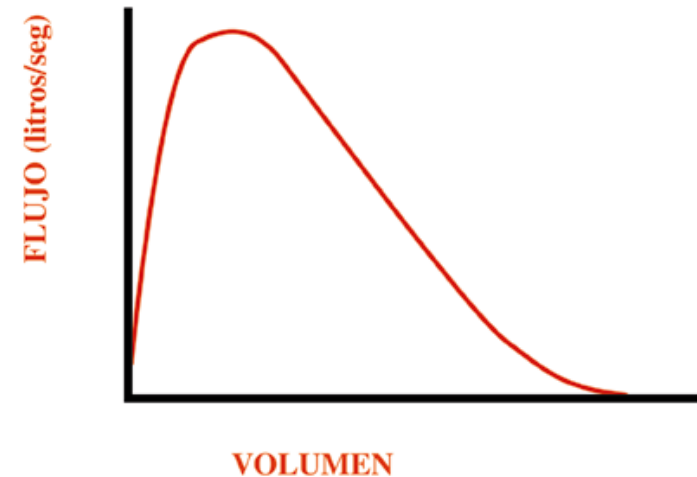
## TRACES:

Any test is only as good as its accuracy

### Time/volume



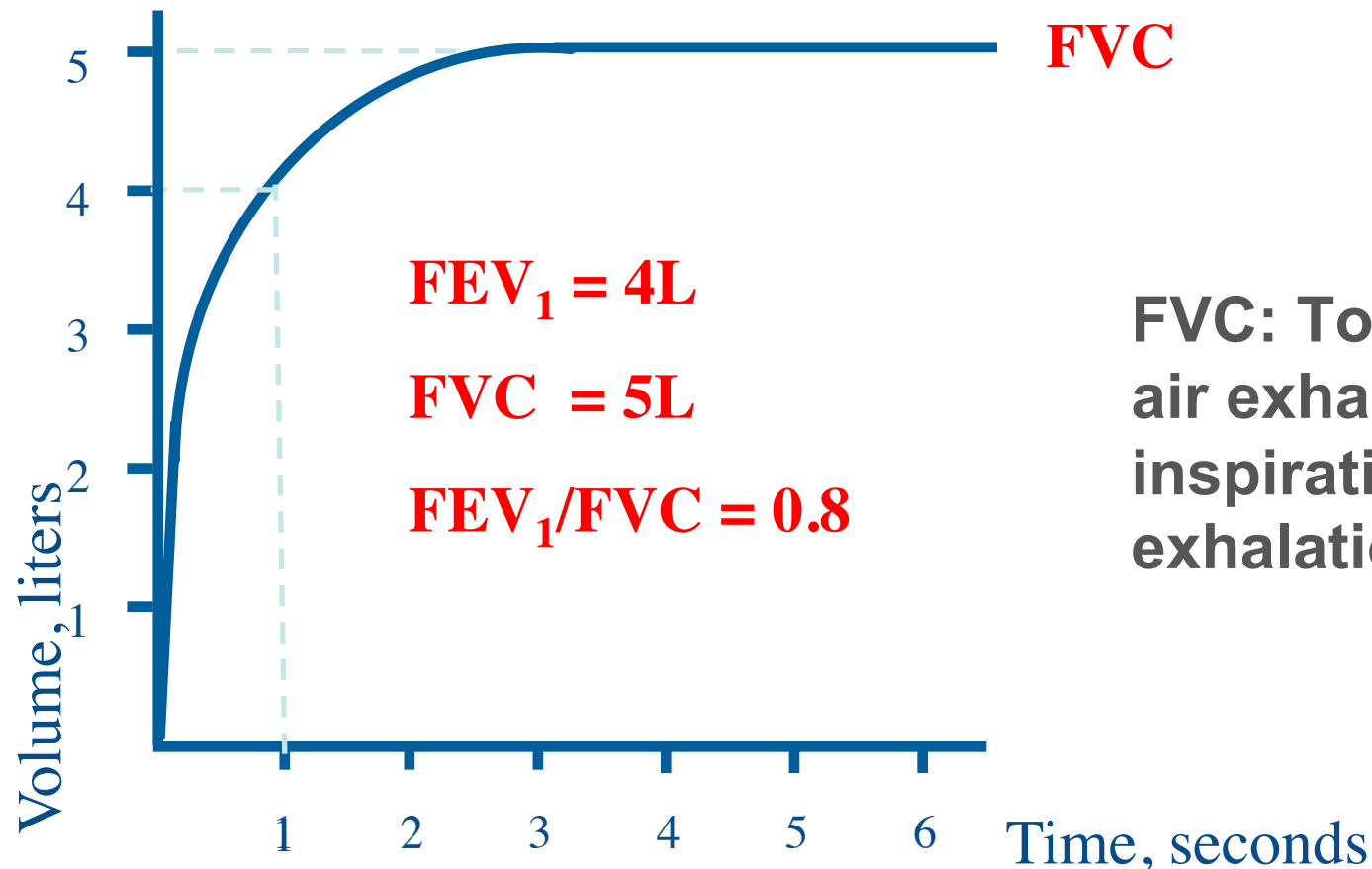
### Flow/volume



# The most important issue



**FEV<sub>1</sub>: Volume of air exhaled in the first second of a forced exhalation after complete inspiration**

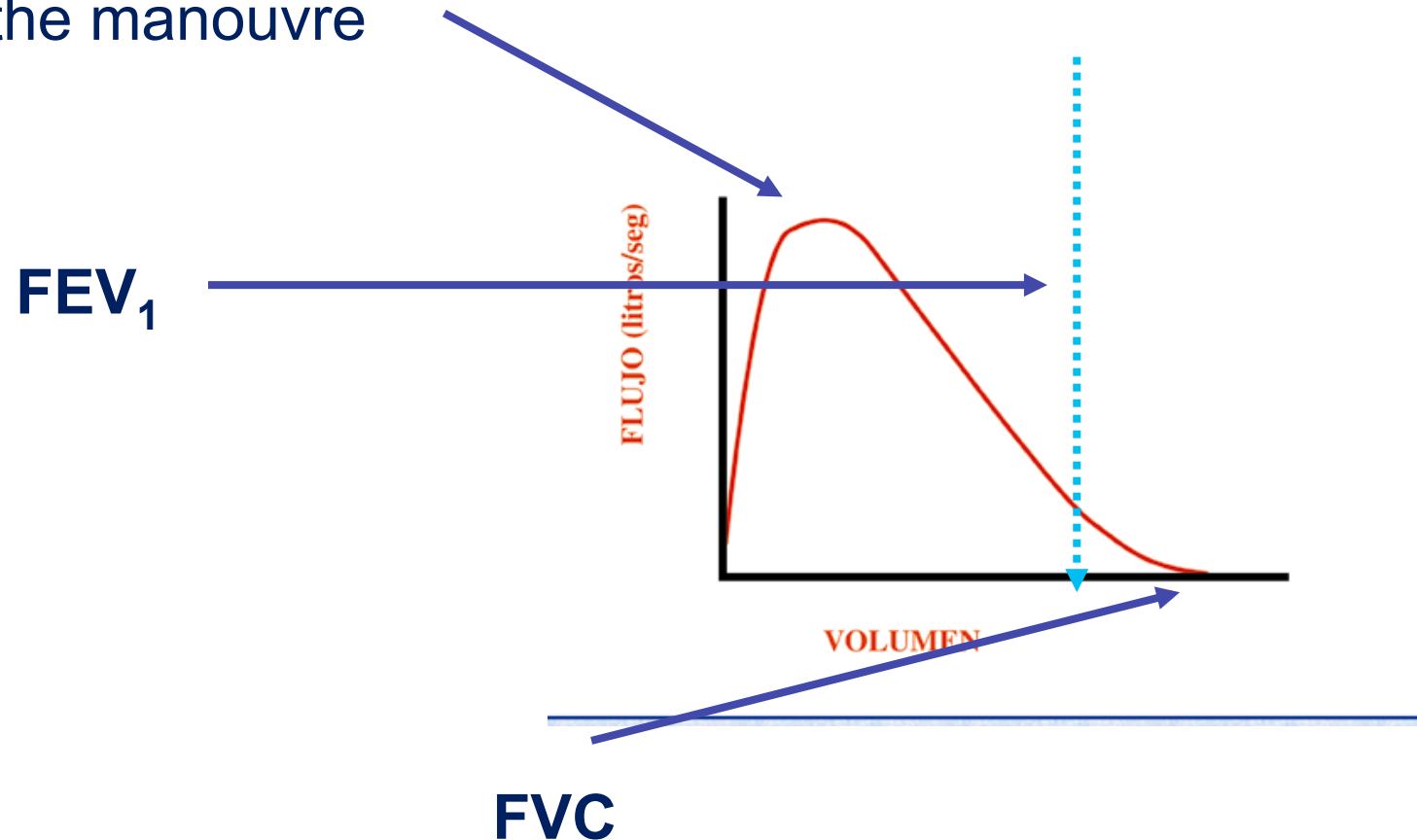


**FVC: Total volume of air exhaled after full inspiration and full exhalation**



# The most important issue

**Peak-flow:** Maximum airflow during the manouvre



# Spirometry Interpretation



C. SALUD SON PIZA  
PRUEBAS DE FUNCION PULMONAR

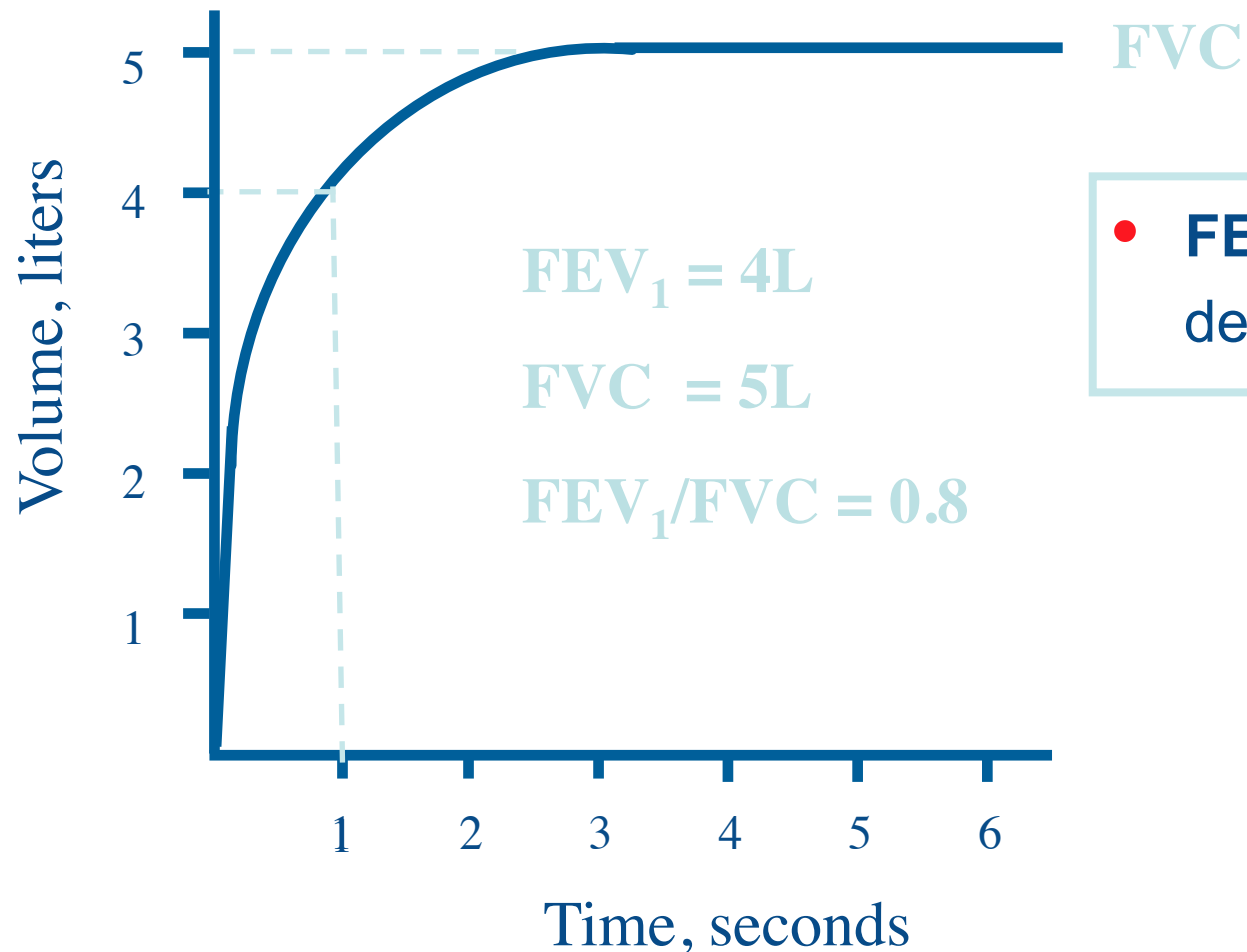
DATOSPIR 120 - SIBELMED

Codigo: 870318 Fecha: 08.11.2001  
Nombre: [REDACTED]  
Sexo: Hombre Edad(a): 14  
Talla(cm): 175 Peso(Kg): 70  
Temp(°C): 22 Humedad(%): 50  
Pres(mmHg): 746 I. Fuma: 0  
Referencias: MORRIS F. Etnico(%): 100  
Motivo:  
Procedencia:  
Técnico:  
Transductor: Fleisch F. Cal: 08.11.2001

INFORME DE FVC MANIOBRA Nº: 1/4

PARAMETRO		OBS	REF	(%)
Mejor FVC	(l)	5.21	4.33	120
Mejor FEV1	(l)	4.77	3.87	123
FVC	(l)	4.90	4.33	113
FEV1	(l)	4.77	3.87	123
FEV1/FVC	(%)	97.17	82.19	118
PEF	(l/s)	9.92	7.91	125
FEF25%-75%	(l/s)	5.72	4.99	115

# Is there an obstruction?



- **FEV<sub>1</sub>/FVC:** > 0.7- 0.8, depending on age

# Spirometry Interpretation

- Is it acceptable and repeatable?
- The traces' shape
- Measurements assessment

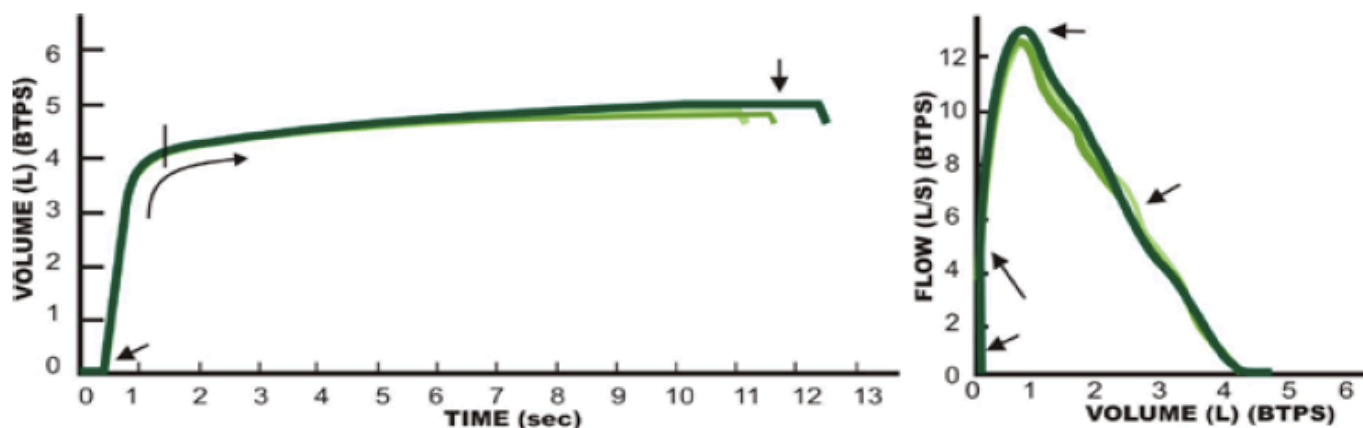
# Recognizing unacceptable / unreliable readings :



## Valid Normal Test

Trial	FVC (L)	FEV <sub>1</sub> (L)	PEF (L/sec)
1	4.81	4.09	12.1
2	4.74	4.07	12.0
3	<b>4.87</b>	<b>4.14</b>	<b>12.5</b>
Repeatability	0.06	0.05	

$$4.87 - 4.81 = 0.06 \quad 4.14 - 4.09 = 0.05$$



2012 NIOSH Spirometry Quality Assurance: Common Errors and Their Impact on Test Results 8

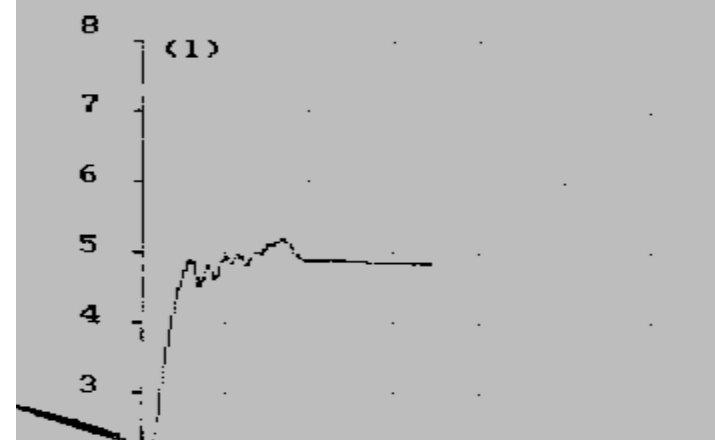
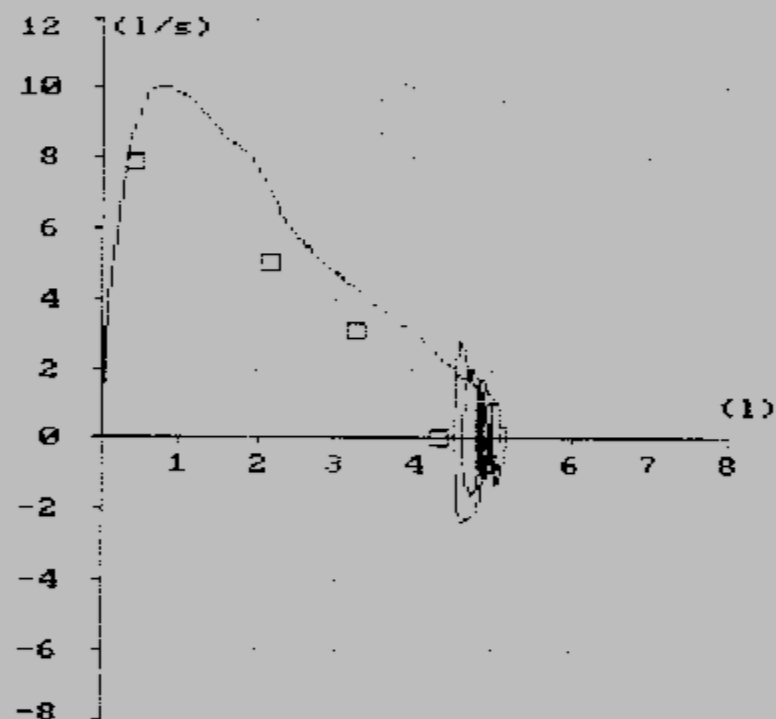
C. SALUD SON PIZA  
PRUEBAS DE FUNCION PULMONAR

DATOSPIR 120 - SIBELMED

Codigo: 870318 Fecha: 08.11.2001  
Nombre: XXXXXXXXXX  
Sexo: Hombre Edad(a): 14  
Talla(cm): 175 Peso(Kg): 70  
Temp(°C): 22 Humedad(%): 50  
Pres(mmHg): 746 I. Fuma: 0  
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Motivo:  
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FEV1/FVC (%)	97.17	82.19	118
PEF (l/s)	9.92	7.91	125
FEF25%-75% (l/s)	5.72	4.99	115



# Reasons for unacceptable / unreliable readings:



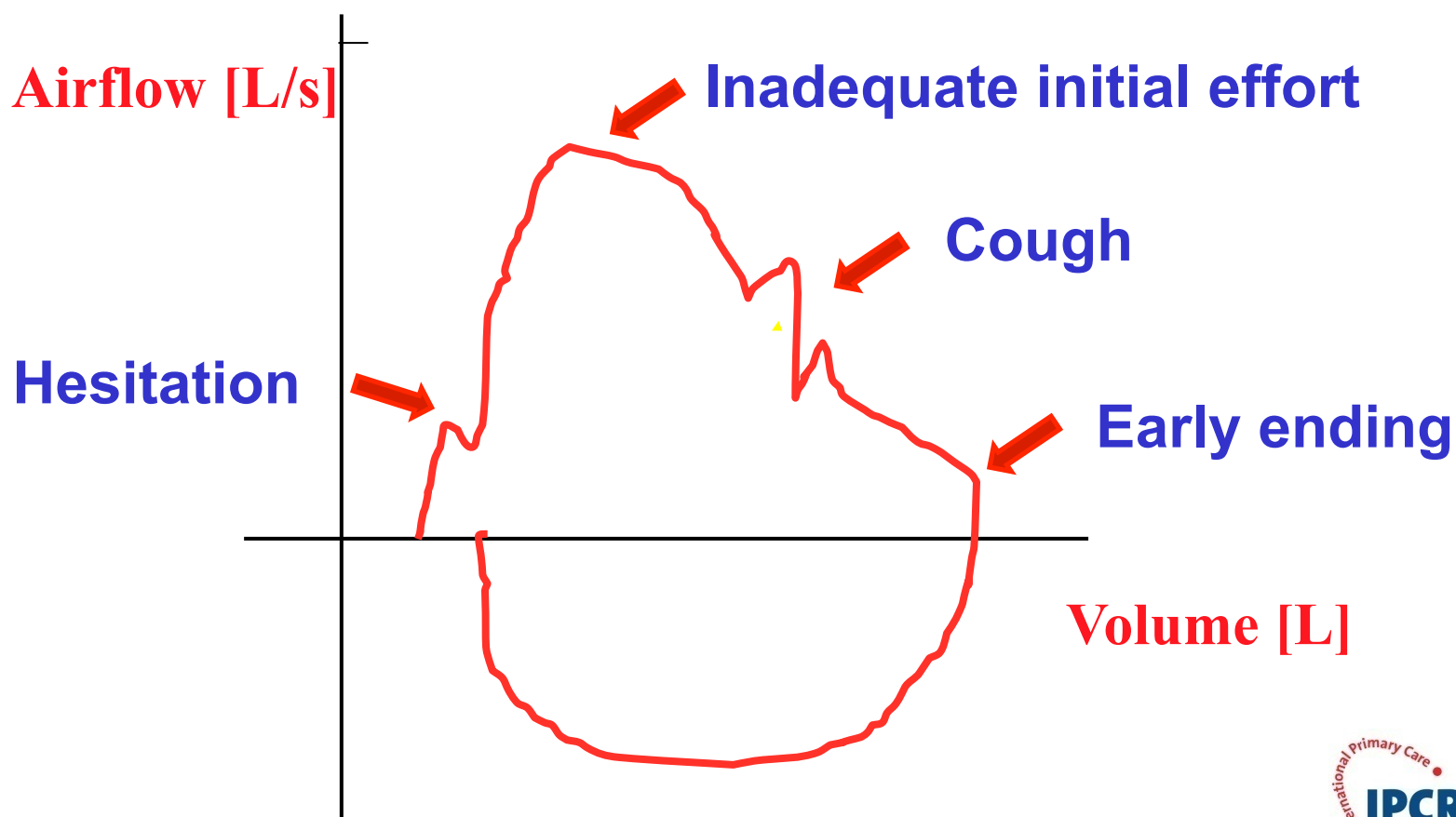
- Inadequate or incomplete inhalation
- Slow start to the forced exhalation
- Lack of blast effort during exhalation
- Coughing.
- Additional breath taken during manoeuvre
- Lips not tight around the mouthpiece
- Exhalation stops before complete expiration





# Reasons for unacceptable / unreliable readings:

19<sup>TH</sup> WONCA Europe Conference



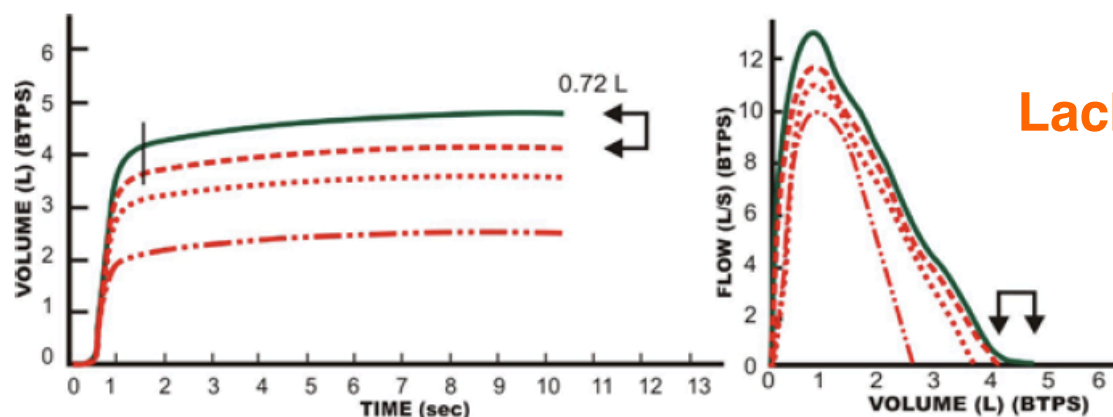
# Recognizing unacceptable / unreliable readings :



## Error #1: Sub-maximal Inhalation

	FVC (L)	FVC % Pred	FVC LLN (L)	FEV <sub>1</sub> (L)	FEV <sub>1</sub> % Pred	FEV <sub>1</sub> LLN (L)
Good Effort	4.90	96	4.17	4.17	103	3.29
Error	4.18	82	4.17	3.60	88	3.29

$$4.90 - 4.18 = 0.72$$



Lack of repeatability

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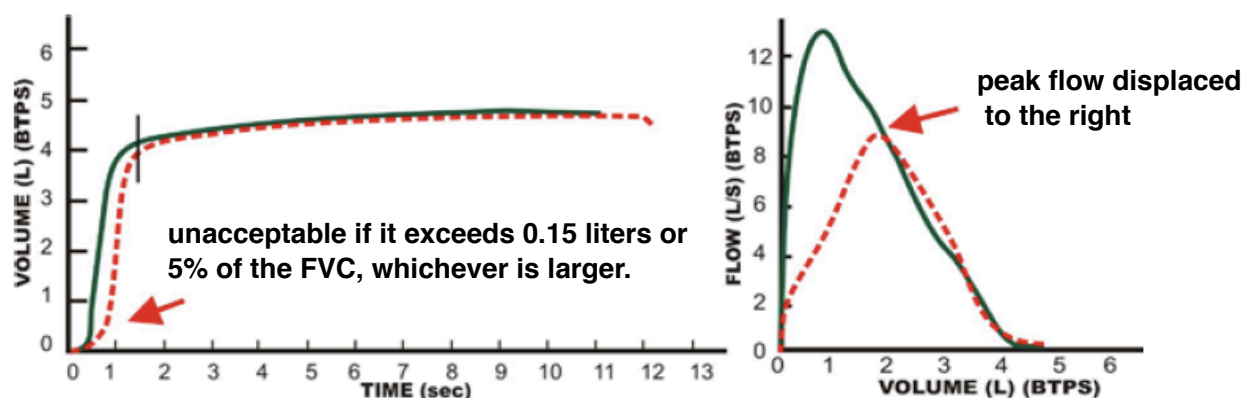
Falsely reduced FVC can be misinterpreted as indicating a “restrictive impairment.”

# Recognizing unacceptable / unreliable readings :



## Error #2: Excessive Extrapolated Volume

	FVC (L)	FEV <sub>1</sub> (L)	FEV <sub>1</sub> % Pred	PEF (L/sec)	Vext (L)	Vext (%)
Good Effort	4.79	4.12	86	12.2	0.12	2.5
Error	4.78	3.95	82	8.5	0.55	11.5



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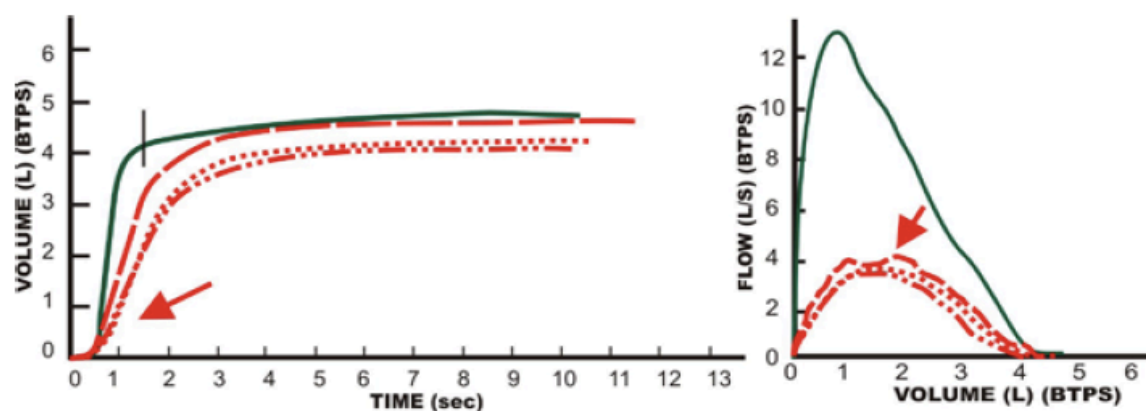
**Spirometer Error Messages: Most spirometers label this error with “Hesitation,” “Large extrapolated volume,” or “Start faster.”**

# Recognizing unacceptable / unreliable readings :



## Error #3: Sub-maximal Blast

	FVC (L)	FEV <sub>1</sub> (L)	FEV <sub>1</sub> % Pred	PEF (L/sec)
Good Effort	4.69	4.08	86	12.6
Error	4.57	3.36	71	4.1



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The peak on the curve is reduced, indicating insufficient subject effort

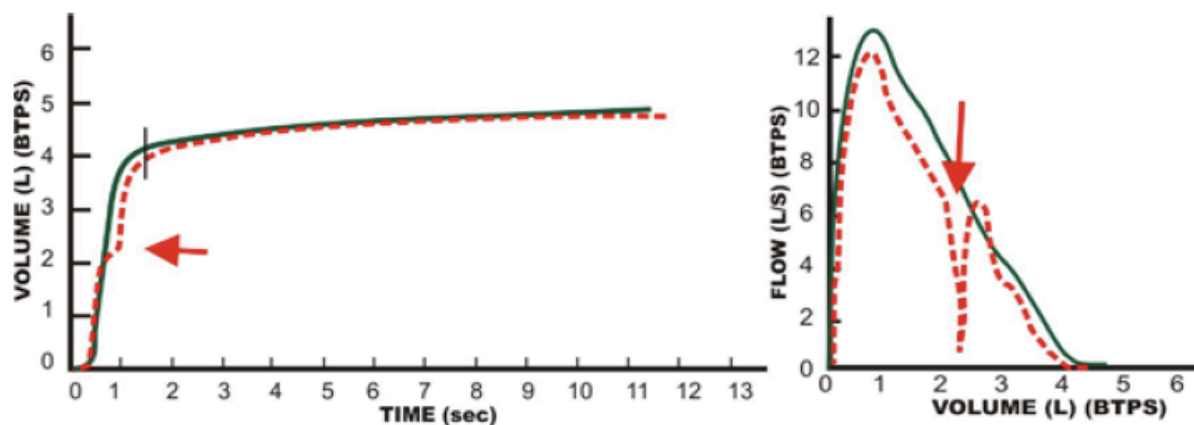
**Coach the subject to blast the air out HARDER**

# Recognizing unacceptable / unreliable readings:



## Error #4: Cough in First Second

	FEV <sub>1</sub> (L)	FEV <sub>1</sub> % Pred
Good Effort	4.12	88
Error	3.96	84



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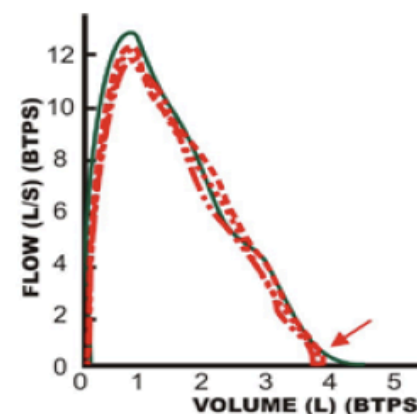
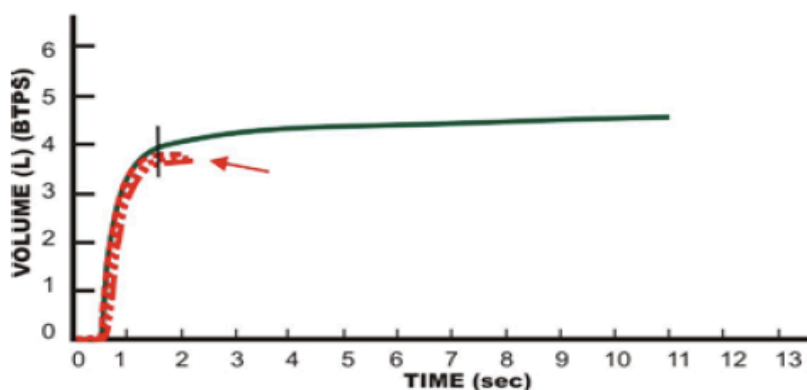
A cough can cause either a falsely reduced or falsely elevated FEV<sub>1</sub>

# Recognizing unacceptable / unreliable readings:



## Error #5: Early Termination

	FVC (L)	FVC % Pred	FEV <sub>1</sub> (L)	FEV <sub>1</sub> % Pred	FEV <sub>1</sub> /FVC%
Good Effort	4.54	83	3.91	87	86
Error	3.81	67	3.76	84	98

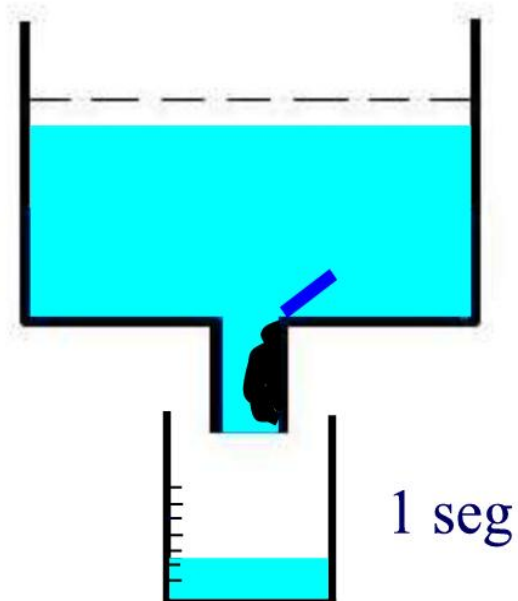


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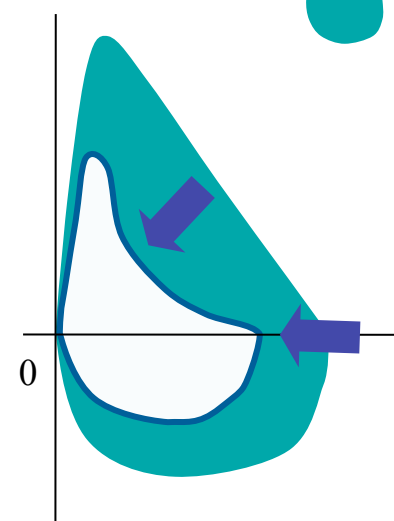
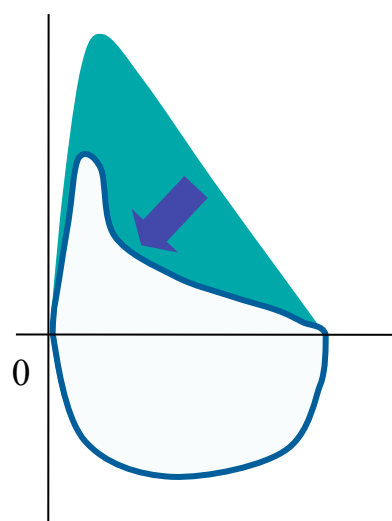
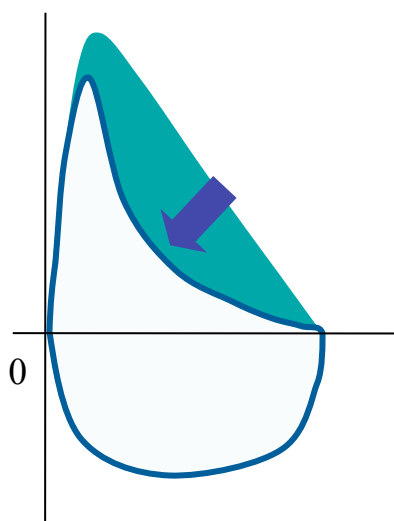
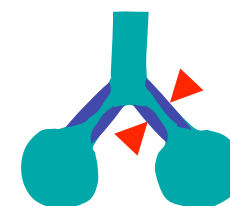
Falsely reduced FVC may be misinterpreted as indicating a “restrictive impairment.” The falsely increased FEV<sub>1</sub>/FVC ratio may cause a true “obstructive impairment” to be missed.

# Spirometric patterns

- **Normal**
- **Obstructive**
- **Restrictive**
- **Mixed**



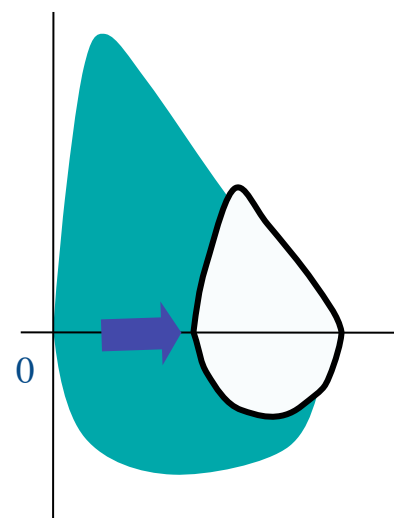
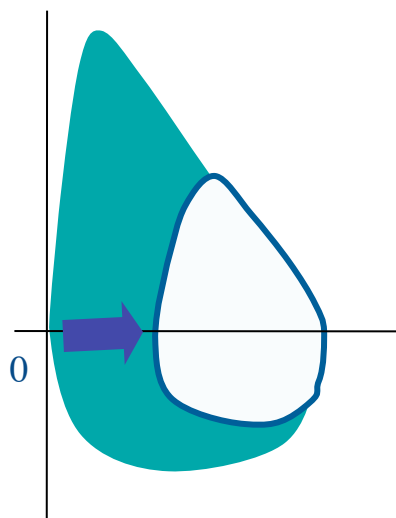
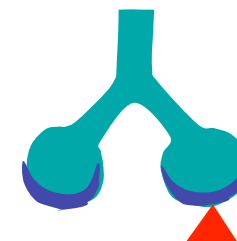
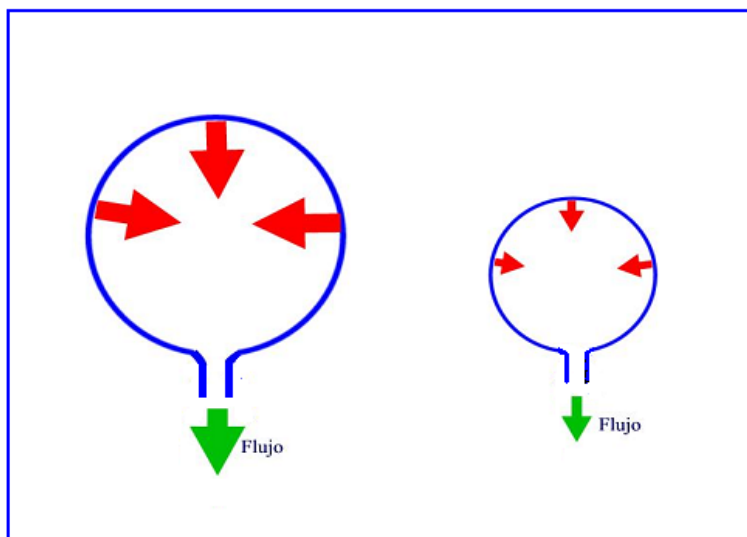
# OBSTRUCTION

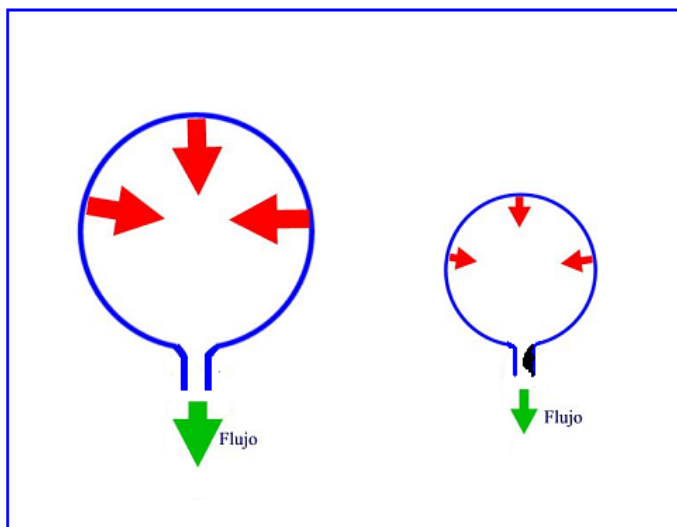




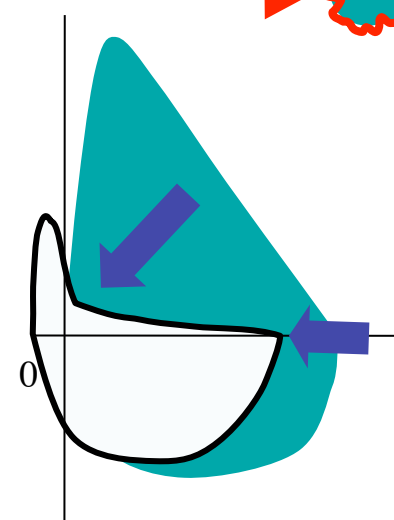
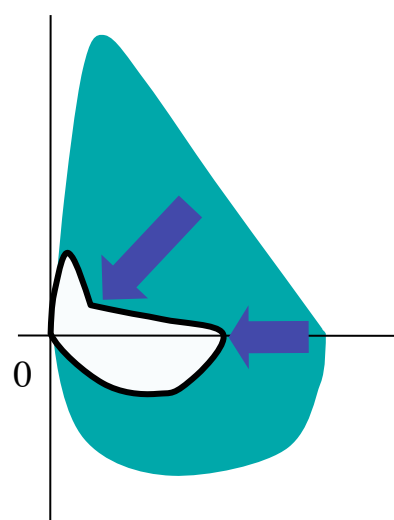
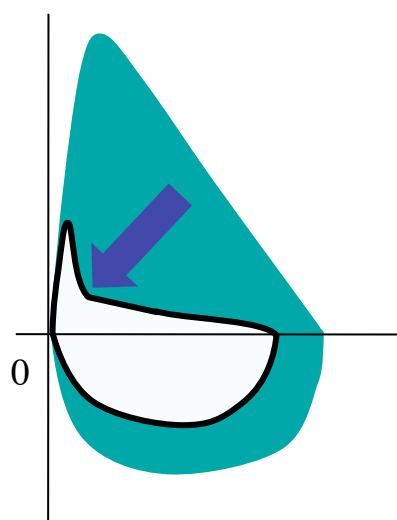
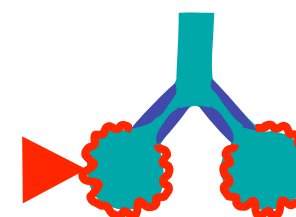


# RESTRICTION





# MIXED






# Spirometric patterns



	FEV <sub>1</sub> /FVC	FVC	FEV <sub>1</sub>	
Obstruction	↓	<i>N</i>	↓	
Restriction	<i>N</i>	↓	<i>N</i> ↓	
Mixed Obstruction and hyperinflation	↓	↓	↓	
Pletismography and lung volumes studies are needed				

# Spirometric patterns

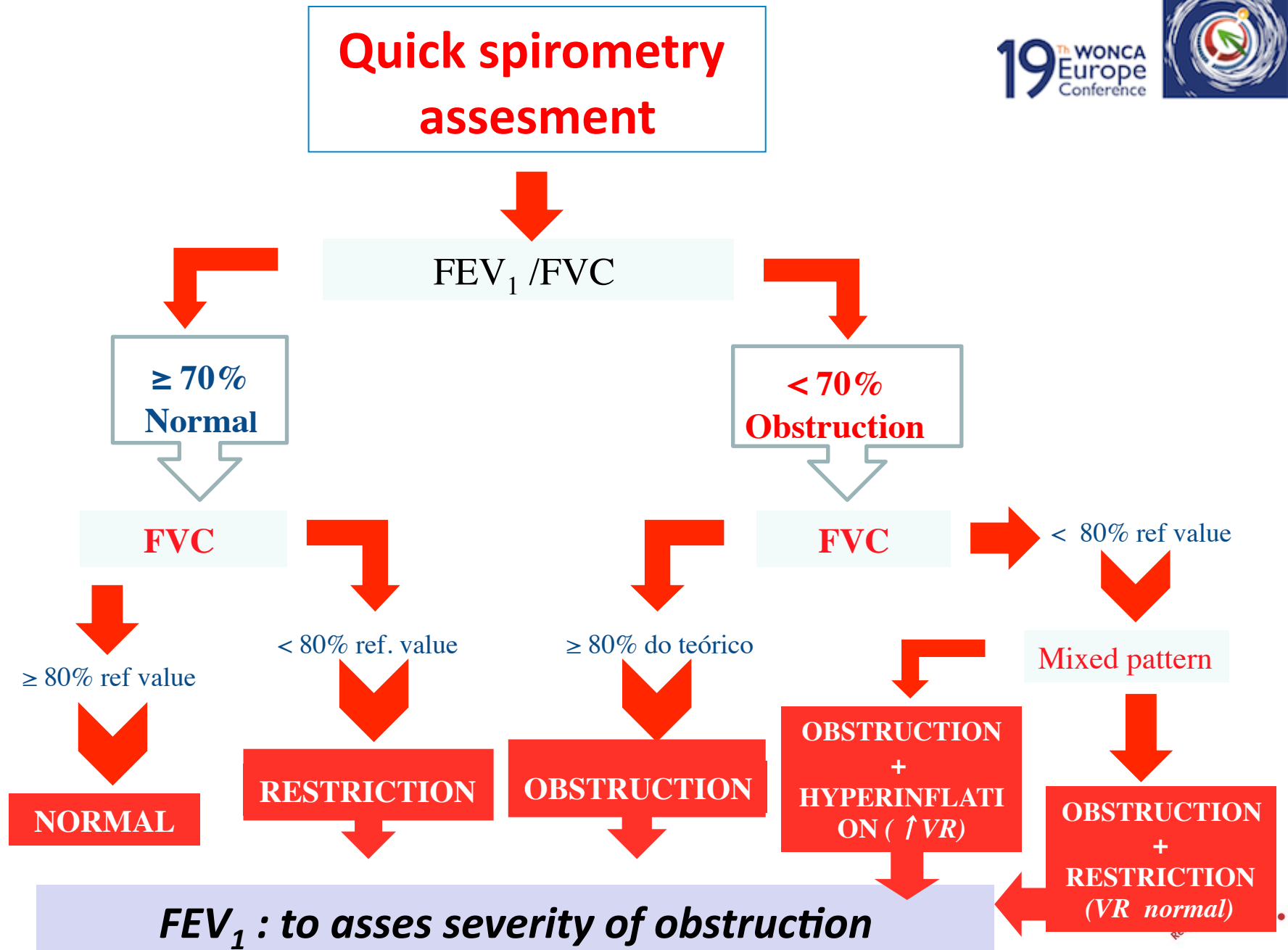
	FEV <sub>1</sub> /FVC	FVC	
Obstruction	↓	<i>N</i>	
Restriction	<i>N</i>	↓	
Mixed Obstruction and hyperinflation	↓	↓	

# Any other assesment?



## Severity of obstruction

Mild Obstruction	$FEV_1 \geq 80\%$
Moderate Obstruction	$FEV_1 < 80\% \geq 50\%$
Severe Obstruction	$FEV_1 < 50\% \geq 35\%$
Very Severe Obstruction	$FEV_1 < 35\%$



ID: <Pantalla> Fecha prueba: 19/02/2001 Hora: 12:22:54  
Edad: 40 Talla: 174 cm Peso: 64 Kgs Sexo: M  
Origen étnico: Caucasica  
ID unidad: 04402

**Inform. de calidad en prueba:**

Variabilidad - FVC: -- FEV1: --

No. de pruebas: 3

Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

<u>Indice</u>	<u>Teór</u>	<u>Medid</u>	<u>%</u>
FVC	5.16	3.64	70
FEV1	4.00	2.77	69
FEV1%	77	76	99
FEF25-75%	3.94	1.95	50

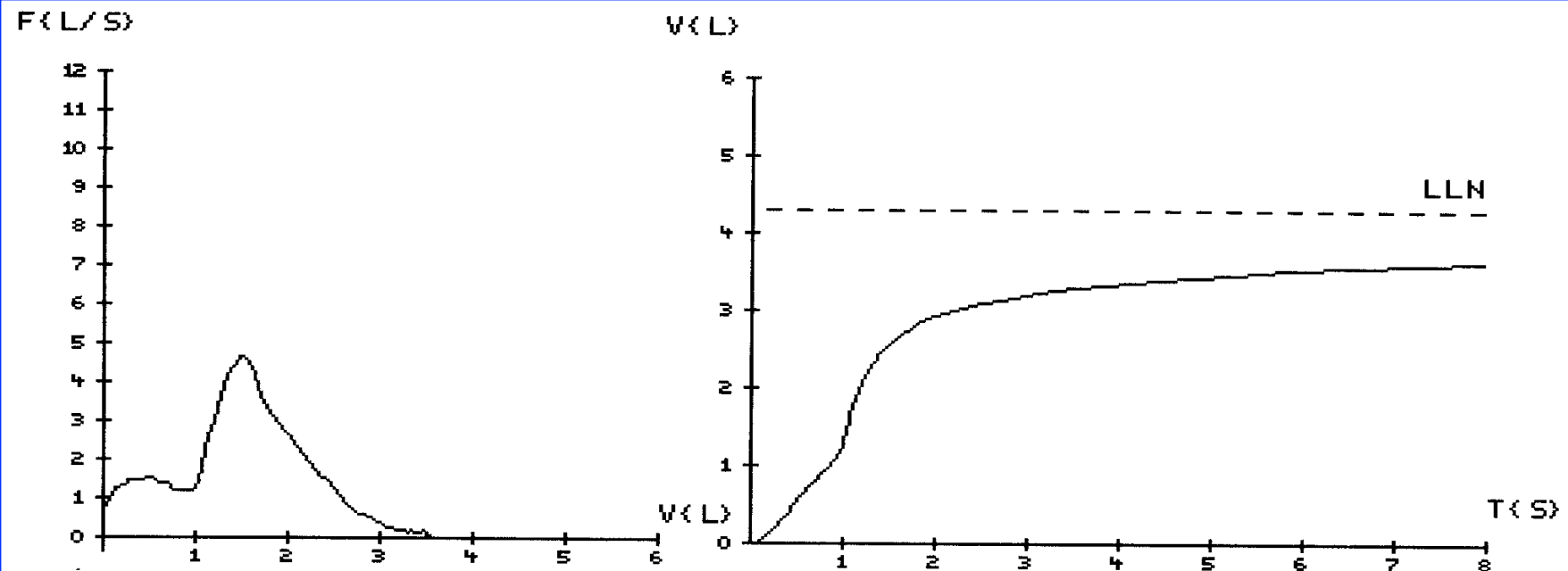
ID: <Pantalla> Fecha prueba: 19/02/2001 Hora: 12:22:54  
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**Inform. de calidad en prueba:**

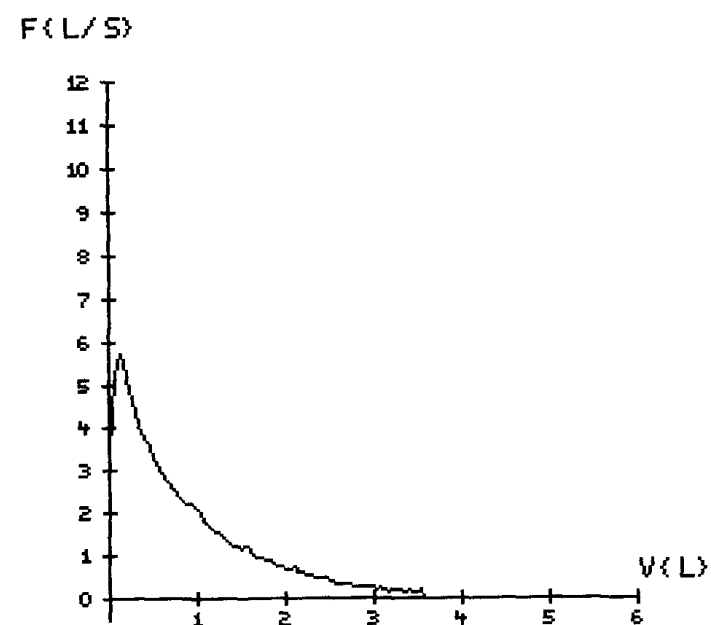
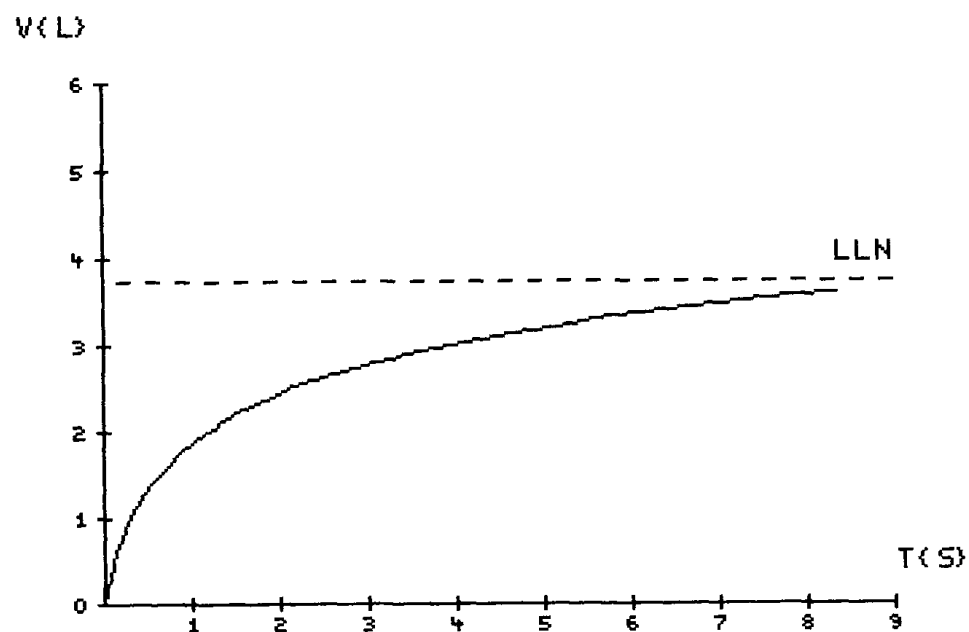
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**Inform. de calidad en prueba:**

Variabilidad - FVC: -- FEV1: --

No. de pruebas: 3

Mejor valores ERS B.T.P.S - Teóricos: Separ

<u>Indice</u>	<u>Teór</u>	<u>Medid</u>	<u>%</u>
FVC	4.57	3.63	79
FEV1	3.30	1.88	57
FEV1%	72	51	71
FEF25-75%	2.70	0.69	26

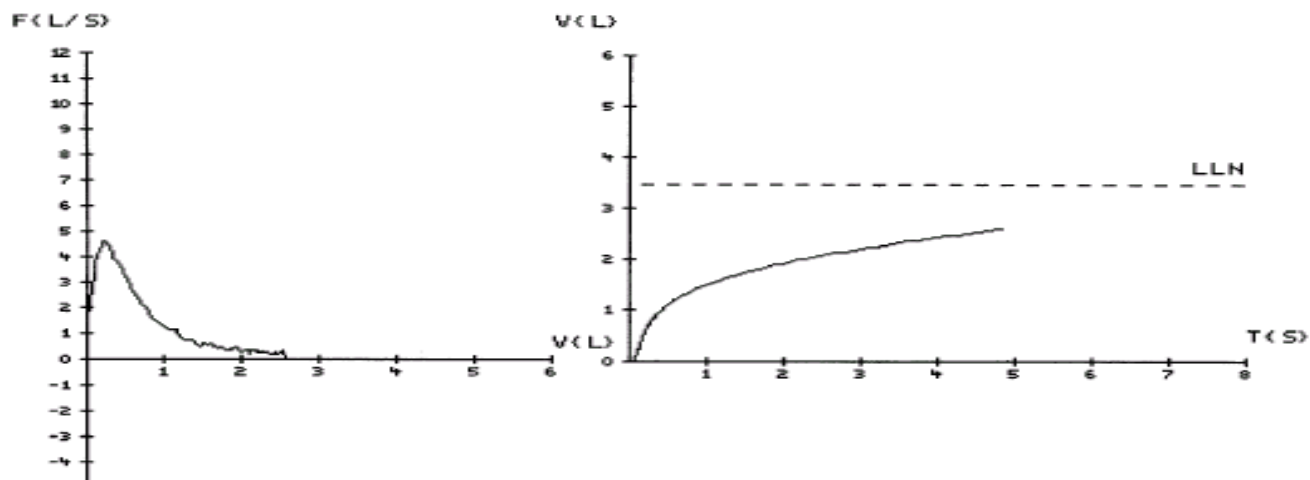
# Vitalograph 2120

ID: 04402\_240101P02 Fecha prueba: 24/01/2001 Hora: 15:58:26  
 Edad: 69 Talla: 168 cm Peso: 62 Kgs Sexo: M  
 Origen étnico: Europea  
 ID unidad: 04402  
Inform. de calidad en prueba:  
 Variabilidad - FVC: 3 FEV1: 1  
 No. de pruebas: 5

Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

Indice	Teór	Medid	%
FVC	4.33	2.60	60
FEV1	3.09	1.61	52
FEV1%	71	61	86
FEF25-75%	2.46	0.68	28

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## Vitalograph 2120

ID: 04402\_161101P02 Fecha prueba: 16/11/2001 Hora: 09:58:38

Edad: 36 Talla: 176 cm Peso: 87 Kgs Sexo: M

Origen étnico: Europea

ID unidad: 04402 Fecha Revis. cal: 16/11/2001

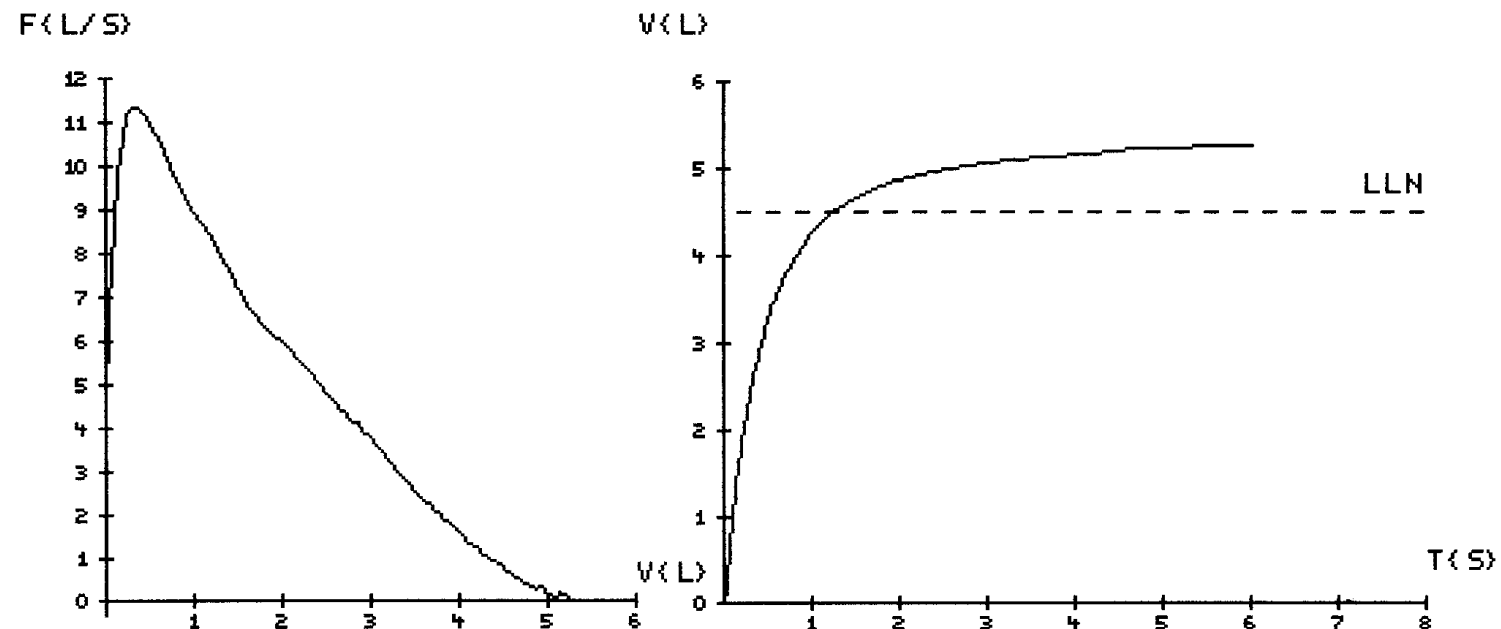
### Inform. de calidad en prueba:

Variabilidad - FVC: 4 FEV1: 3

No. de pruebas: 6

Mejor valores ERS B.T.P.S - Teóricos: Separados

Indice	Teór	Medid	%
FVC	5.35	5.32	99
FEV1	4.18	4.27	102
FEV1%	78	80	103
FEF25-75%	4.19	3.76	90





## Vitalograph 2120

ID: 04402\_230101P01 Fecha prueba: 23/01/2001 Hora: 11:03:00

Edad: 31 Talla: 167 cm Peso: 64 Kgs Sexo: M

Origen étnico: Europea

ID unidad: 04402

### Inform. de calidad en prueba:

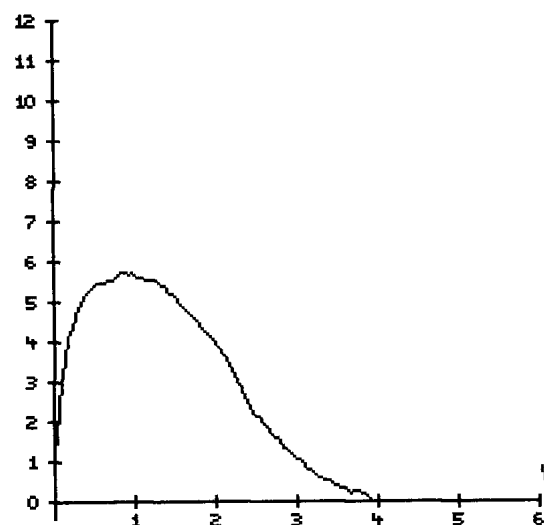
Variabilidad - FVC: 13 FEV1: 8

No. de pruebas: 3

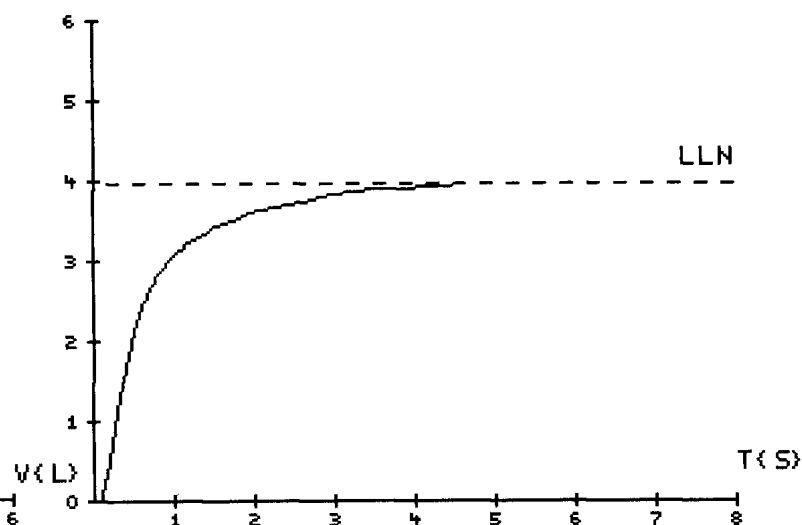
Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

Indice	Teór	Medid	%
FVC	4.82	3.97	82
FEV1	3.84	3.16	82
FEV1%	79	79	100
FEF25-75%	4.05	2.94	72

F(L/S)



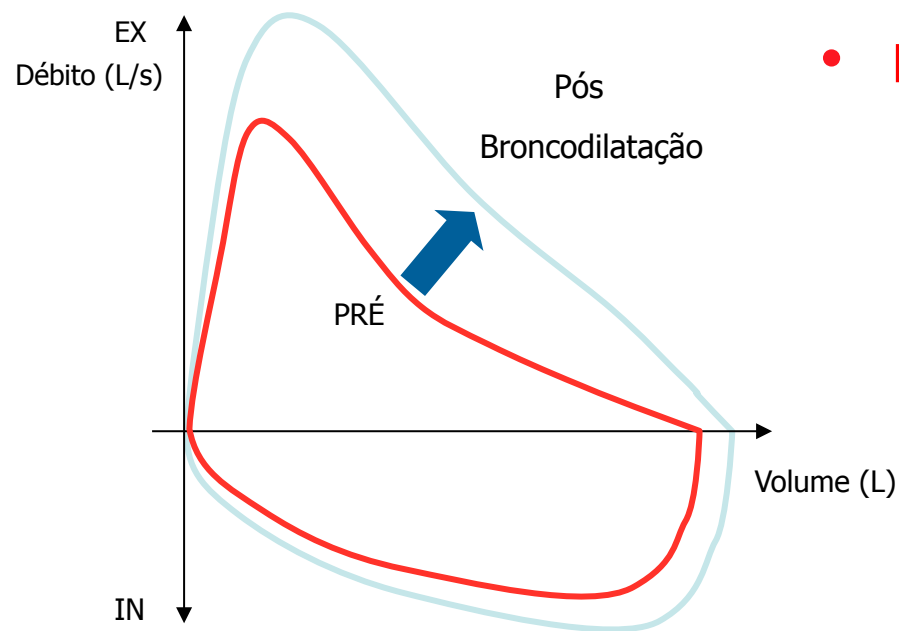
V(L)



# Reversibility Test



- Second full spirometry 15 minutes after inhalation of 400µg of salbutamol or equivalent
- Essential for the diagnosis of respiratory diseases



- **Positive if:**

- **Increase in FEV<sub>1</sub> ≥ 12% and 200 ml from basal values**

## Vitalograph 2120

ID: 04402\_210102P01 Fecha prueba: 21/01/2002 Hora: 11:18:44

Edad: 78 Talla: 165 cm Peso: 98 Kgs Sexo: M

Origen étnico: Europea

ID unidad: 04402 Fecha Revis. cal: 21/01/2002

Inform. de calidad pre-prueba Inform. de calidad post-prueba

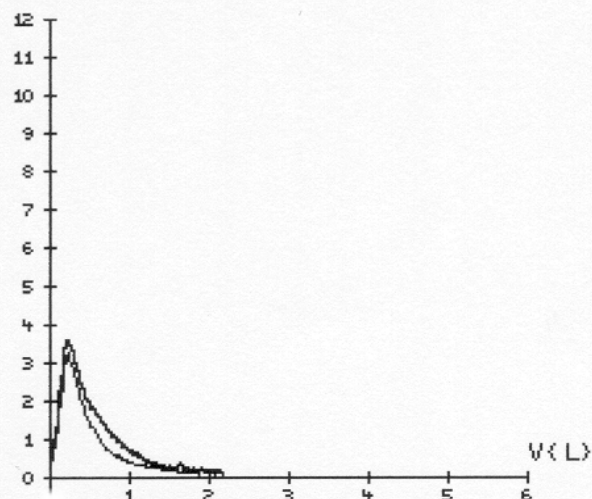
Variabilidad - FVC: 1 FEV1: -- Variabilidad - FVC: 3 FEV1: 1

No. de pruebas: 3 No. de pruebas: 3

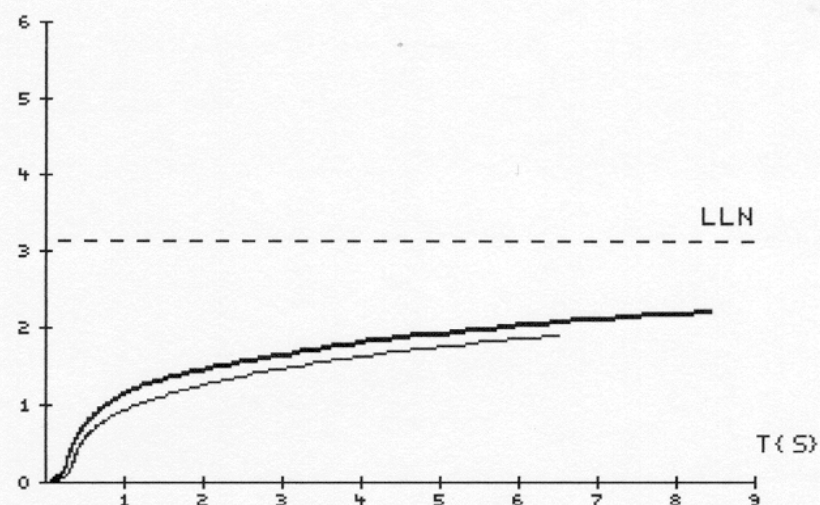
Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

Indice	Teór	Pre	%	Post	%	Cambio
FVC	3.99	1.90	48	2.20	55	15
FEV1	2.75	1.04	38	1.24	45	18
FEV1%	68	54	79	56	82	2
FEF25-75%	1.95	0.40	21	0.39	20	-2

F(L/S)



V(L)



## Vitalograph 2120

ID: 04402\_080201P02 Fecha prueba: 08/02/2001 Hora: 16:32:11

Edad: 55 Talla: 147 cm Peso: 68 Kgs Sexo: F

Origen étnico: Europea

ID unidad: 04402

### Inform. de calidad pre-prueba

Variabilidad - FVC: 2 FEV1: 5

No. de pruebas: 3

### Inform. de calidad post-prueba

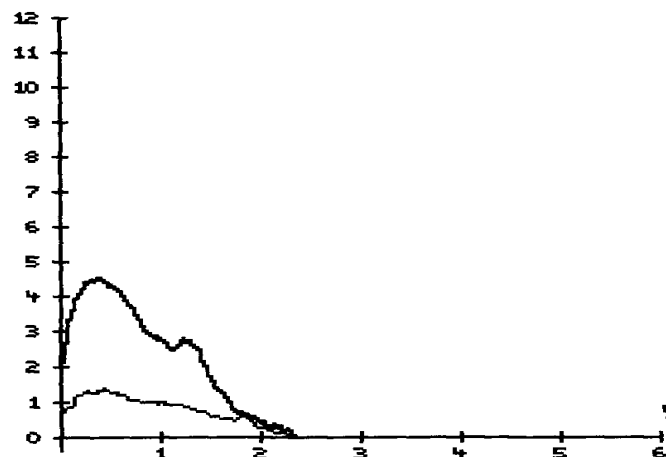
Variabilidad - FVC: 4 FEV1: --

No. de pruebas: 4

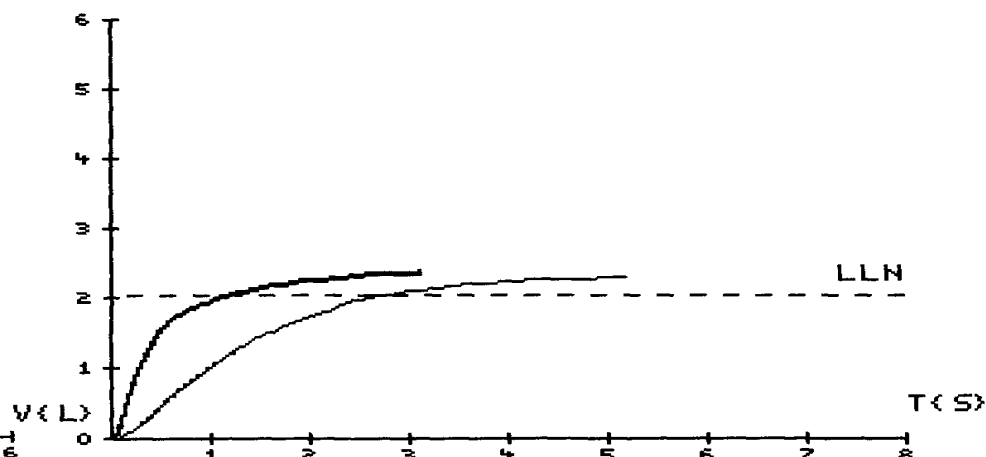
Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

Indice	Teór	Pre	%	Post	%	Cambio
FVC	2.68	2.31	86	2.37	88	3
FEV1	2.05	1.14	56	1.96	95	52
FEV1%	76	49	64	82	108	33
FEF25-75%	1.98	0.79	40	1.98	100	86

F(L/S)



V(L)



— PRE  
— POST



## Vitalograph 2120

ID: 04402\_230101P05 Fecha prueba: 23/01/2001 Hora: 14:06:24

Edad: 48 Talla: 161 cm Peso: 71 Kgs Sexo: F

Origen étnico: Europea

ID unidad: 04402

Inform. de calidad pre-prueba Inform. de calidad post-prueba

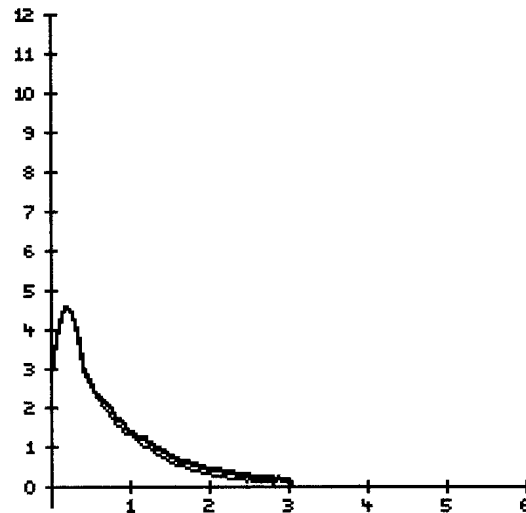
Variabilidad - FVC: 2 FEV1: 1 Variabilidad - FVC: 1 FEV1: --

No. de pruebas: 3 No. de pruebas: 3

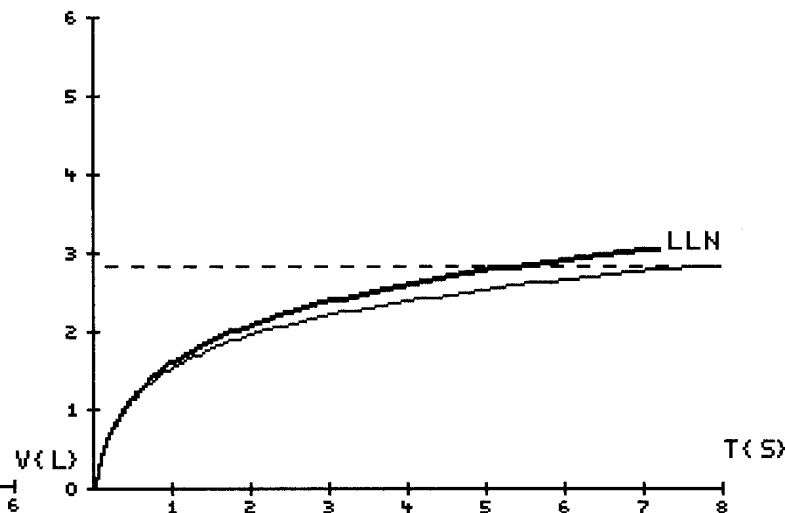
Mejor valores ERS B.T.P.S - Teóricos: Separ.

Indice	Teór	Pre	%	Post	%	Cambio
FVC	3.47	2.83	82	3.08	89	8
FEV1	2.67	1.54	58	1.60	60	4
FEV1%	77	54	70	52	68	-2
FEF25-75%	2.62	0.57	22	0.60	23	5

F(L/S)



V(L)



— PRE  
— POST



# Vitalograph 2120

ID: 04402\_170902P01 Fecha prueba: 17/09/2002 Hora: 10:42:15

Edad: 54 Talla: 146 cm Peso: 41 Kgs Sexo: F

Origen étnico: Europea

ID unidad: 04402 Fecha Revis. cal: 17/09/2002

Inform. de calidad pre-prueba Inform. de calidad post-prueba

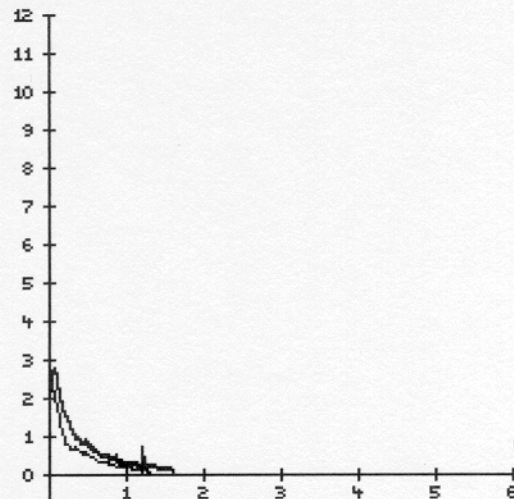
Variabilidad - FVC: 4 FEV1: 1 Variabilidad - FVC: 2 FEV1: 4

No. de pruebas: 8 No. de pruebas: 8

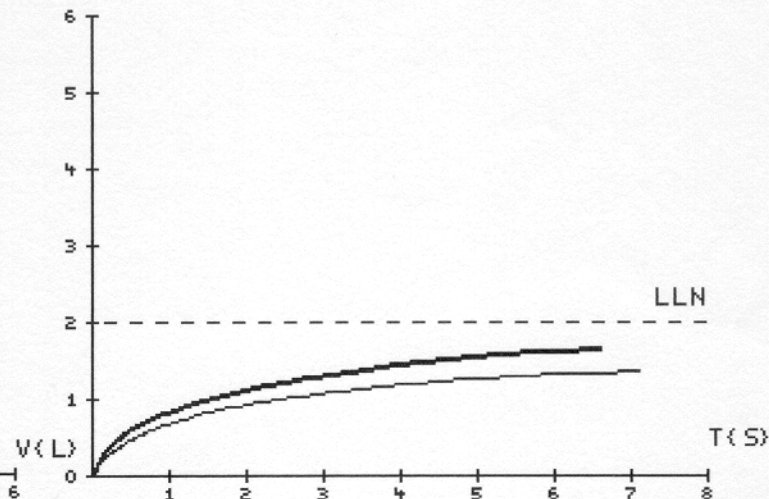
Mejor valores ERS B.T.P.S - Teóricos: Separ(S/W 74335/2.02)

Indice	Teór	Pre	%	Post	%	Cambio
FVC	2.66	1.36	51	1.63	61	18
FEV1	2.05	0.70	34	0.82	40	15
FEV1%	77	51	66	50	65	-1
FEF25-75%	2.01	0.29	14	0.34	17	16
FET	6.00	7.11	119	6.60	110	-8

F(L/S)



V(L)



PRE  
POST

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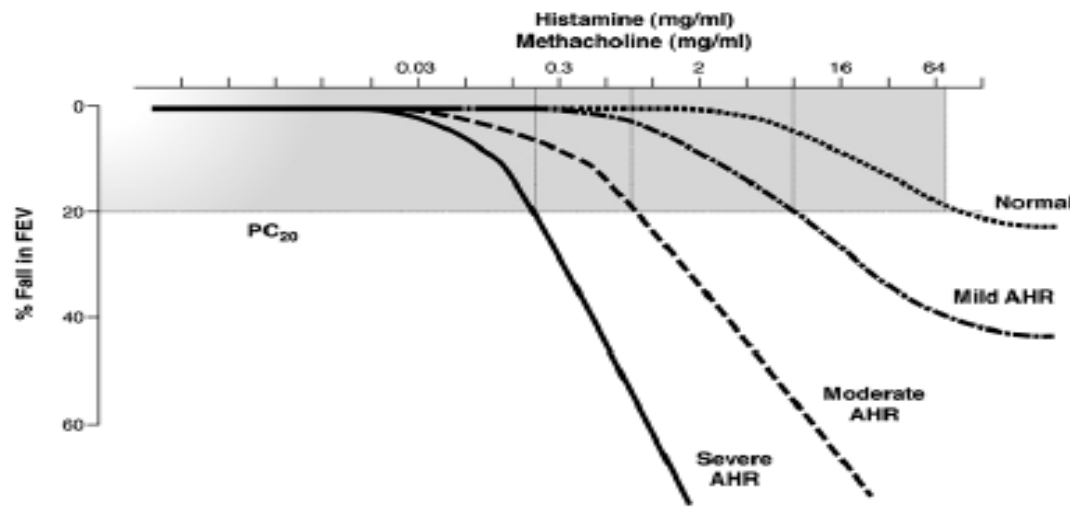
International Primary Care  
IPCRG  
Respiratory Group

# Bronchial provocation test

19<sup>TH</sup> WONCA Europe Conference



- Useful to identify bronchial hyperreactivity
- Useful when asthma is suspected and normal spirometry
- Progressive increasing inhalation doses of Histamine, metacoline, allergens, hypertonic solution, or exercise
- **Positive test: 20% decrease in FEV<sub>1</sub> or more**





Now...you are ready for that...  
Go home and try

19<sup>TH</sup> WONCA  
Europe  
Conference



*Thanks you for your attention!*

International Primary Care  
**IPCRG**  
Respiratory Group