Peak Flow and Spirometry: The Good, The Bad & The Ugly

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To be discussed

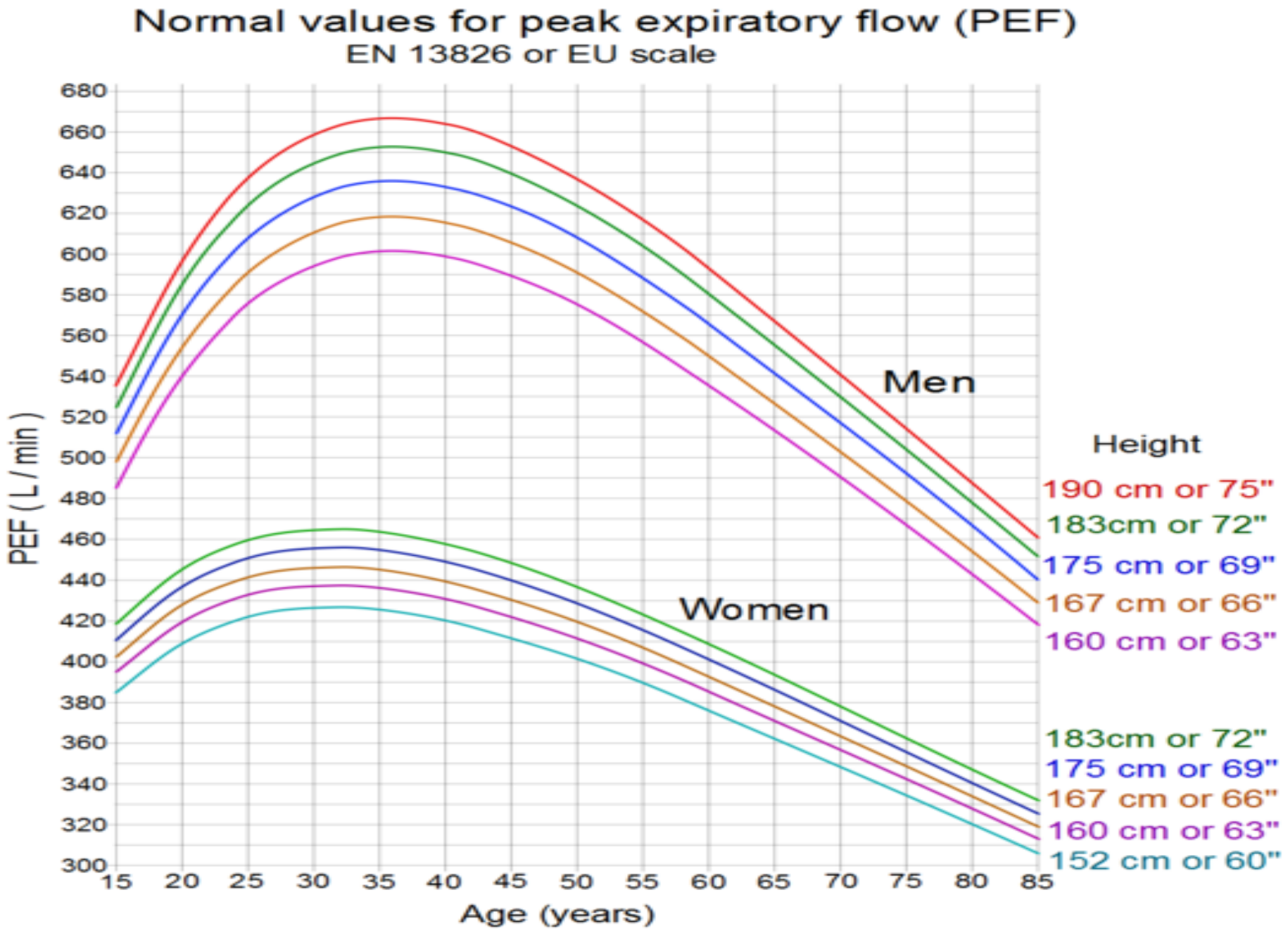
- Peak Flow Meters
  - Why use
  - How to use PF meters
  - Various uses
- Spirometry:
  - Why perform
  - How to perform
  - Introduction to pattern recognition and interpretation

History of Peak Flow

- First used in 1942
- 1978 Mini Wright introduced
- 2004 A new standard scale (EN 13826) is introduced arcoss Europe
- 2014 Digital peak flows widely available

Performance of Peak Flow

- Ensure peak flow meter is clean and working
- Insert new/clean mouthpiece
- Ask patient to sit/stand straight (standing preferable)
- Explain test and ensure patients hands do not cover the vents/path of pointer on scale
- Ask patient to take a full inspiration through the mouth and immediately place teeth and lips around the mouthpiece to make tight seal
- The patient should then make a short, sharp, hard blow with an empty glottis (can stop after one second)
- Return pointer to zero
- Highest reading of at least three acceptable blows should be recorded (these should be within 20L.min-1 of each other)


Normal values for peak expiratory flow (PEF)
EN 13826 or EU scale
PEF (L / min)
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Age (years)
Men
Women
Height
190 cm or 75"
183cm or 72"
175 cm or 69"
167 cm or 66"
160 cm or 63"
183cm or 72"
175 cm or 69"
167 cm or 66"
160 cm or 63"
152 cm or 60"

Name _____ Week Begining (Date) _____

Peak Flow Zones: Green Zone _____ Yellow Zone _____ Red Zone _____

Prescribed Medications (include dose and frequency) _____

Peak Flow Recording Times: _____ AM _____ PM

Day	Sunday		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday	
Time	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Your Peak Flow Rates (liters/minute) 600														
550														
500														
450														
400														
350														
300														
250														
200														
150														
100														
Changes in Medicine														
Notes														

Possible errors

- Poor effort
  - Poor comprehension
  - Lack of motivation
  - Lack of co-ordination
  - Sub-max inspiration

- Leak at mouthpiece
  - Lips not tight
  - Loose dentures
  - Teeth not over mouthpiece
  - Tongue blocking mouthpiece
  - Facial palsy

(also inadequate rest)

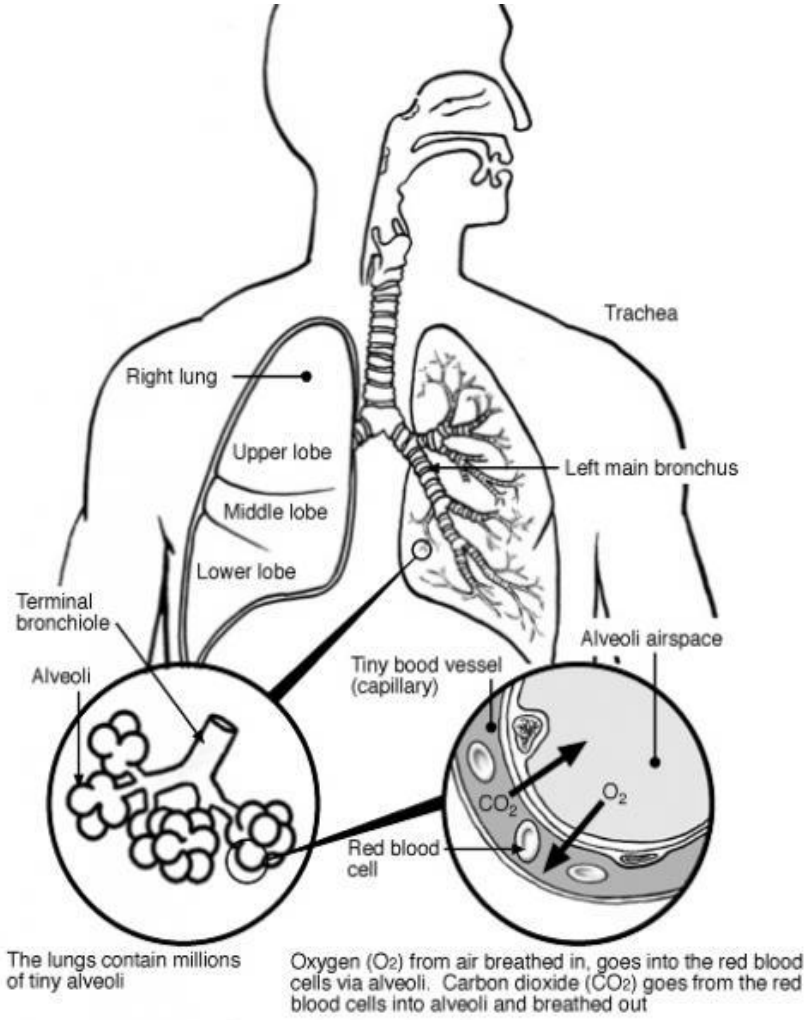
Interpretation of Peak Flow

Many respiratory abnormalities/diseases will cause a reduction in peak flow

- Obstructive airway diseases:
  - COPD
  - Asthma
- Restrictive airway diseases
  - Interstitial disease ie fibrosis
  - Chest wall deformities ie scoliosis
  - Neuromuscular diseases

Normal PF=Undiseased Lungs?

- Unfortunately not!
- Normal PF can be seen in:
  - Normal lungs
  - Controlled/stable Asthma
  - Mild COPD
  - Restrictive disease
  - Asymtomatic smokers



Lung showing alveoli

Why use a Peak Flow

- Assess peak flow and compare to normal values
- To assess diurnal variation
- Bronchodilator response
- Steroid Trial
- Management Plan
- occupational

Uses of a Peak Flow

- Assessment of diurnal variation
- Perform PF 2-4 times daily (We suggest TDS, but tailor to patients needs)
- Record best attempt on PF chart
- Use for at least 3 weeks
- Normal variation is 8%
- 20% variations indicate asthma (BTS guidelines)
- If diurnal variation does not occur, this does not exclude asthma, further testing advised

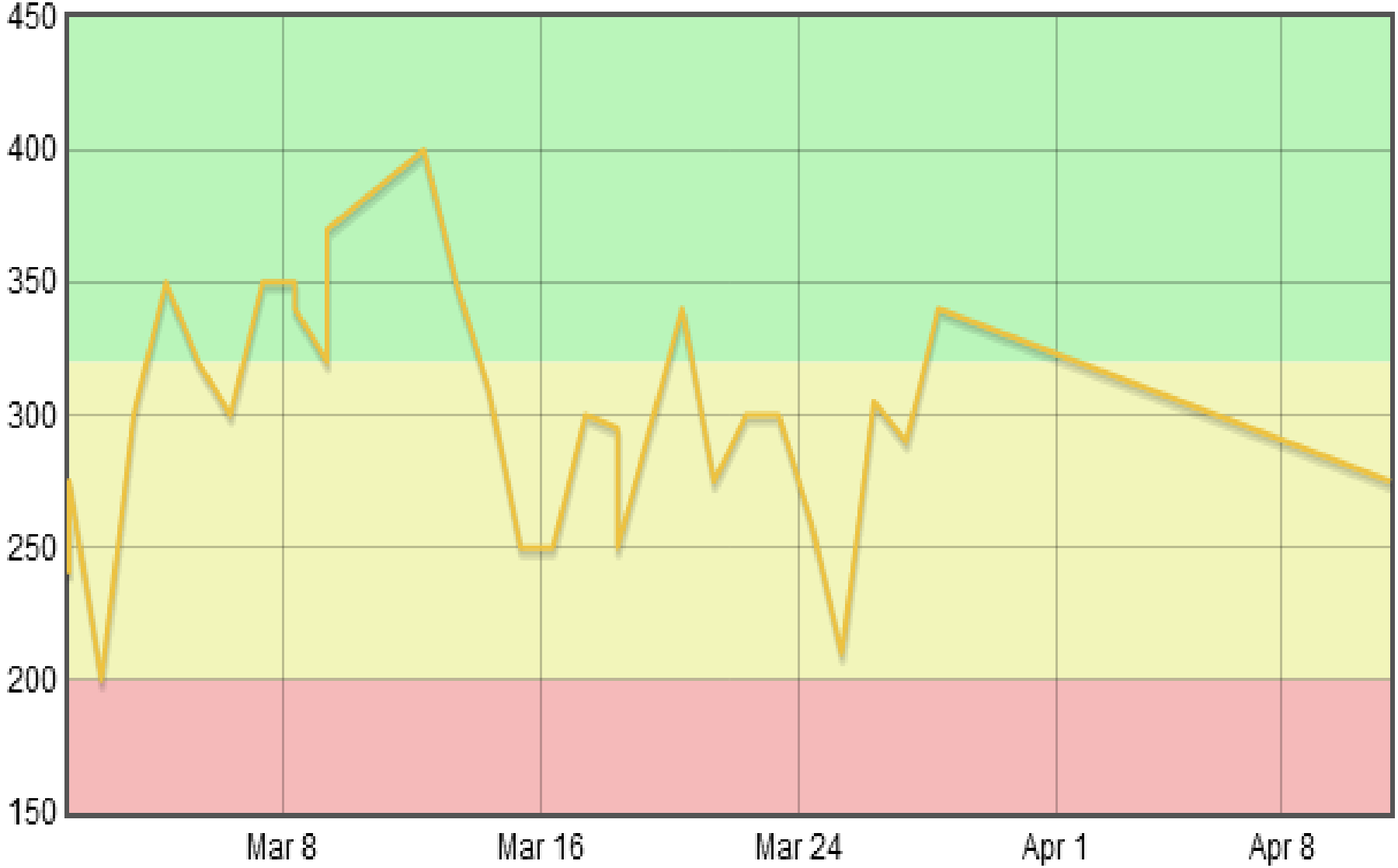
- To calculate % Change

- $\frac{\text{(Daily Max-Daily Min)}}{\text{Daily Max}} * 100$

- Ex: Daily Max=400,
  Daily Min =300

- $\frac{400-300}{400} *100 = 25\%$ Change

Diurnal variation



Uses of a Peak Flow

- Bronchodilator Response
  - Obtain baseline
  - Administer Bronchodilator (400mcg Salbutamol via spacer device)
  - Wait 12-15 minutes
  - Repeat 3 peak flow manoeuvres
  - 20% increase in peak flow is indicative of asthma

Uses of a Peak Flow

- Steroid Trial
  - Patient should use PF BD for 1/52
  - Trial of oral steroids:
    - 30mg per day for 3/52 for adults
    - 1mg/kg for children for 1/52

Change in 20% in PF after steroids indicates asthma

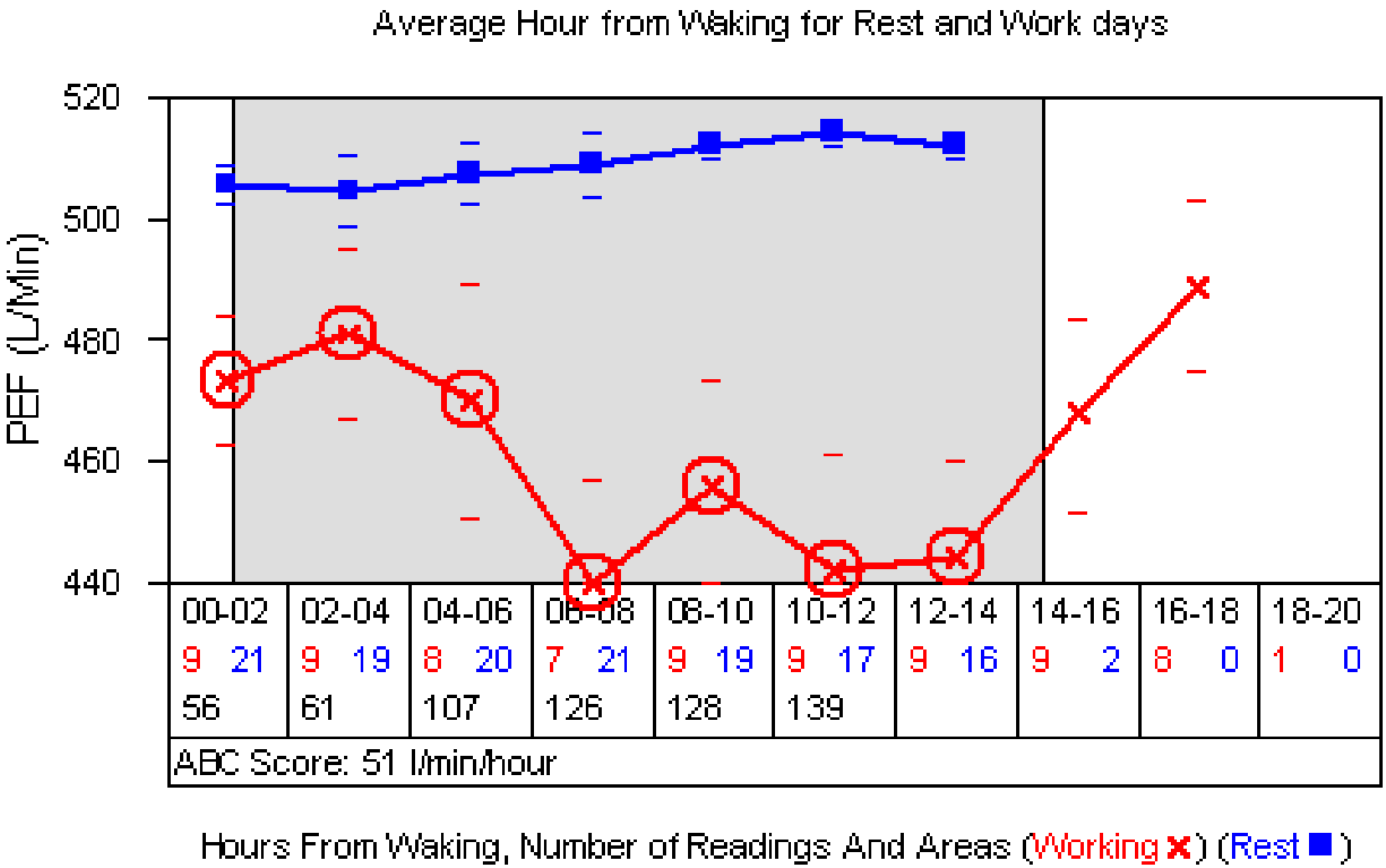
Uses of a Peak Flow

- Management plan
  - Have patients record their baseline when they are feeling well
  - Patient can then compare with when they are feeling unwell, monitor their own response to therapy
  - Puts power and reponsibility in the hands of the patient

Uses of a Peak Flow

- Occupational Asthma
  - Over a number of weeks
  - Allows patient to measure PF in work versus at home
  - Delayed “dip” in PF is possible, this may happen outside work environment
  - If no significant change is noted it is beneficial to repeat testing when patient is outside of work for longer period ie before, during and after a week of holiday

Occupational Asthma



Advantages & Disadvantages of using a Peak Flows

- Advantages
  - Readily available
  - Useful tool in diagnosis and monitoring of asthma
  - Quick to perform
  - Cheap and portable
- Disadvantages
  - Effort dependant
  - Poor compliance
  - False high readings
  - Possibility of manipulation of results

Uses of Spirometry

- The most widely utilized test of respiratory function
- Not used enough in primary care settings
- Can provide important clinical information
- Identify and quantify defects in the respiratory system
- Nessessary for the diagnosis of Asthma and COPD

Why do Spirometry?

- Diagnostic
- To evaluate symptoms, signs or abnormal laboratory tests
- To measure the effect of disease on pulmonary function
- To screen individuals at risk of having pulmonary disease
- To assess pre-operative risk
- To assess prognosis
- To assess health status before beginning strenuous physical activity
- programmes
- Monitoring
- To assess therapeutic intervention
- To describe the course of diseases that affect lung function
- To monitor people exposed to injurious agents
- To monitor for adverse reactions to drugs with known pulmonary toxicity
- Disability/impairment evaluations
- To assess patients as part of a rehabilitation programme
- To assess risks as part of an insurance evaluation
- To assess individuals for legal reasons
- Public health
- Epidemiological surveys
- Derivation of reference equations
- Clinical research

Who should have Spirometry?

- Smokers
- COPD
- Asthma
- Chest tightness
- Unexplained chronic cough
- Neuromuscular disease
- Exertional dispneoa
- Systemic diseases

Relative contraindications to Spirometry

- Known or suspected respiratory infection
- Haemoptysis of unknown origin
- Pneumothorax
- Unstable cardiovascular status: recent (within 1
- month) myocardial infarction, uncontrolled
- hypertension or pulmonary embolism
- Uncontrolled hypertension or history of haemorrhagic cerebrovascular event
- Recent thoracic, abdominal or eye surgery
- Nausea/vomiting/Pain
- Confusion/dementia

Performing the test

- The patient should be sitting comfortably with both feet on the ground, and tight clothing loosened
- The patient begins by tidal breathing with their lips and teeth around the mouthpiece for at least three breaths*
- The patient should inspire maximally and rapidly and immediately blow out as hard and as fast as possible
- After a full and complete expiration the patient should inhale maximally again in a relaxed mannor

*for a closed circuit system, a bacterial filter should always be used

- http://www.youtube.com/watch?v=lWHx31BquBA

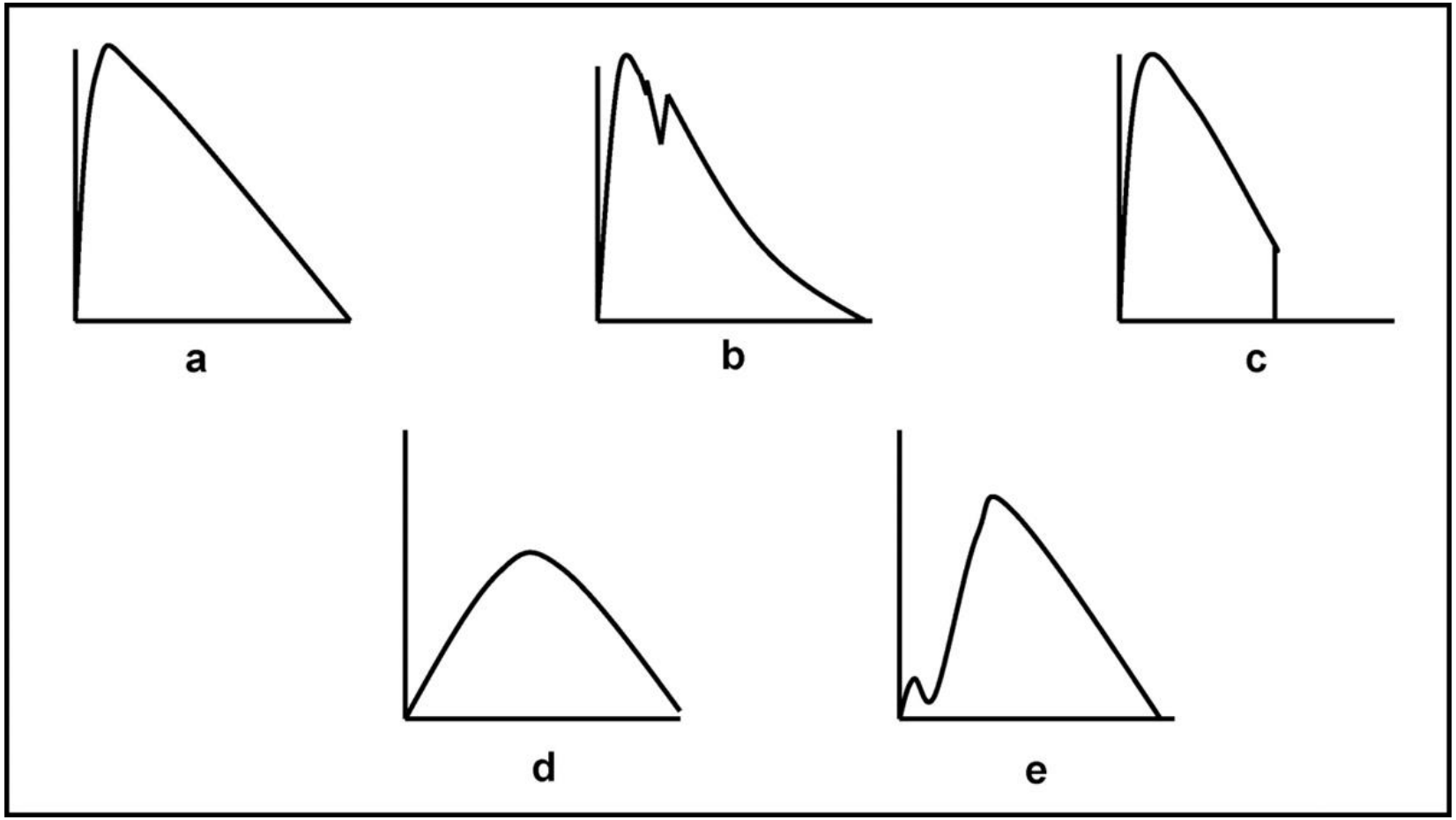
What are the most important measurements?

- FVC: Forced Vital Capacity is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration (expressed in litres)
- FEV1:FEV1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration (expressed in litres)
- FEV1/FVC ratio
- PEF: Peak expiratory flow is the measurement of fastest flow

Spirometry: the Good

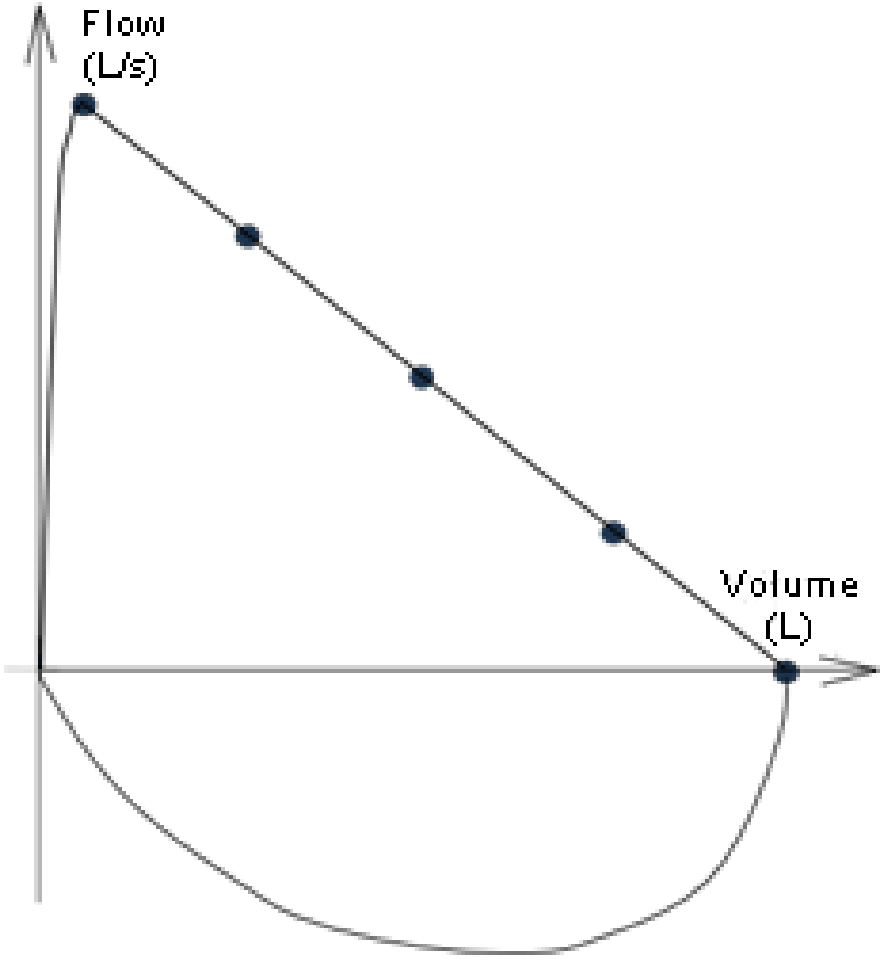
- Satisfactory peak flow must be achieved
- Exhalation should be for at least 6 seconds (3 for a child)
- A minimum of three trials must be performed (two of which are reproducible within 5%
- When expiring the patient must do so without hesitation
- A nose clip should be worn
- Test should be performed with an open glottis and without a cough
- The patient should have their mouth and teeth around the mouthpiece with their lips tight
- The results must be reproducible

Examples: unsatisfactory spirometry



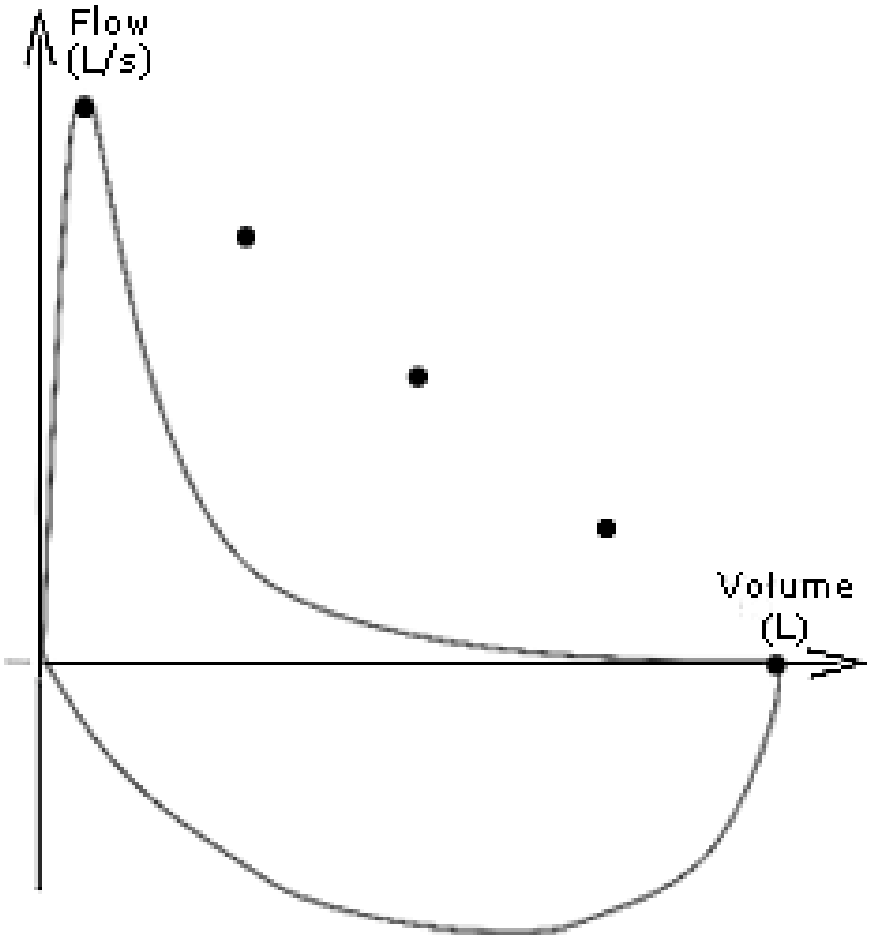
Normal Spirometry

- Satisfactory performance of test
- Full inspiration followed by complete forceful expiration
- Reproducible



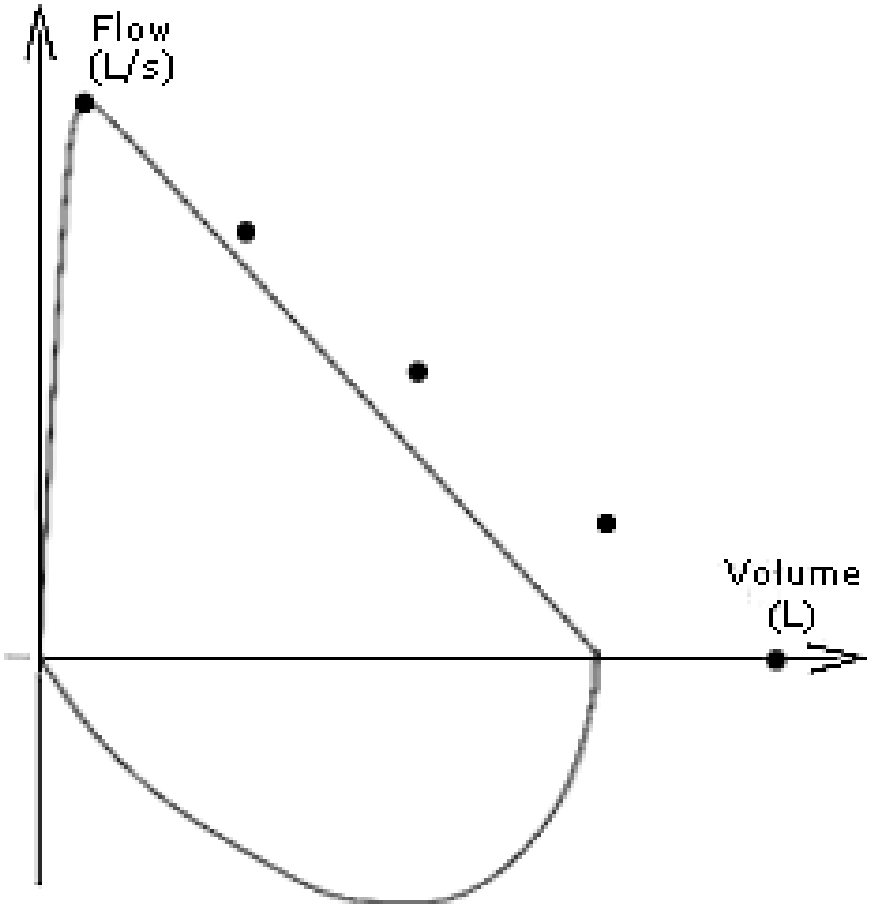
Obstructive Spirometry

- Seen in:
- COPD
- Uncontrolled asthma
- Emphysema



Restricitve Spirometry

- Seen in
- Neuromuscular disease
- Kyphoscholiosis
- Fibrosis of the Lung
- Diaphragm paralysis
- Obesity



Patterns of Spirometric Curves

There are 3 basic patterns to recognise:

Normal

- FEV1 and FVC above 80% predicted
- FEV1/FVC >0.7

Restrictive

- FEV1 below 80% predicted
- FVC below 80% predicted
- FEV1/FVC ratio normal (>0.7)

Obstructive

- FEV1 below 80% predicted
- FVC can be normal or reduced
- FEV1/FVC ratio <0.7

How to differenciate between Obstrctive and Restrictive

	FEV_1 / FVC ratio	FEV_1	FVC (threshold 80 %)
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

A Guide to interpretation

1. Begin with FEV1/FVC ratio
   - 70% + Normal or restriction
   - Look at FEV1 to decide
   - <70% Obstruction

2. Characterize degree of airflow obstruction

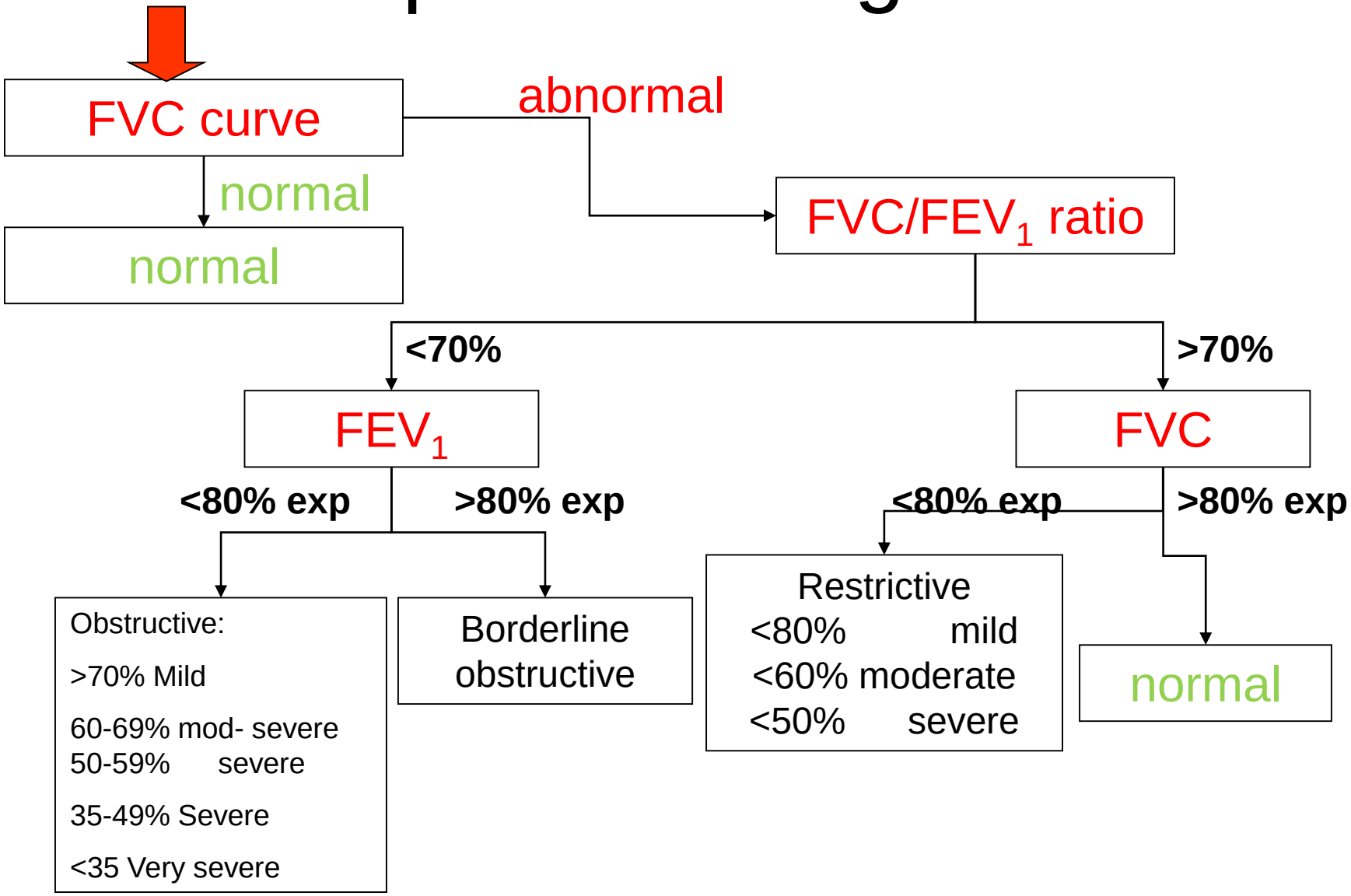
   FEV1 – 70-80% predicted - Mild airflow obstruction
   FEV1 – 60-69% predicted - Moderate airflow obstruction
   FEV1 – 50-59% predicted – Moderate Severe airflow obstruction
   FEV1 -- 35-49% predicted – Severe airflow obstruction
   FEV1 – <35% predicted –Very Severe airflow obstruction

3. Assess reversibility

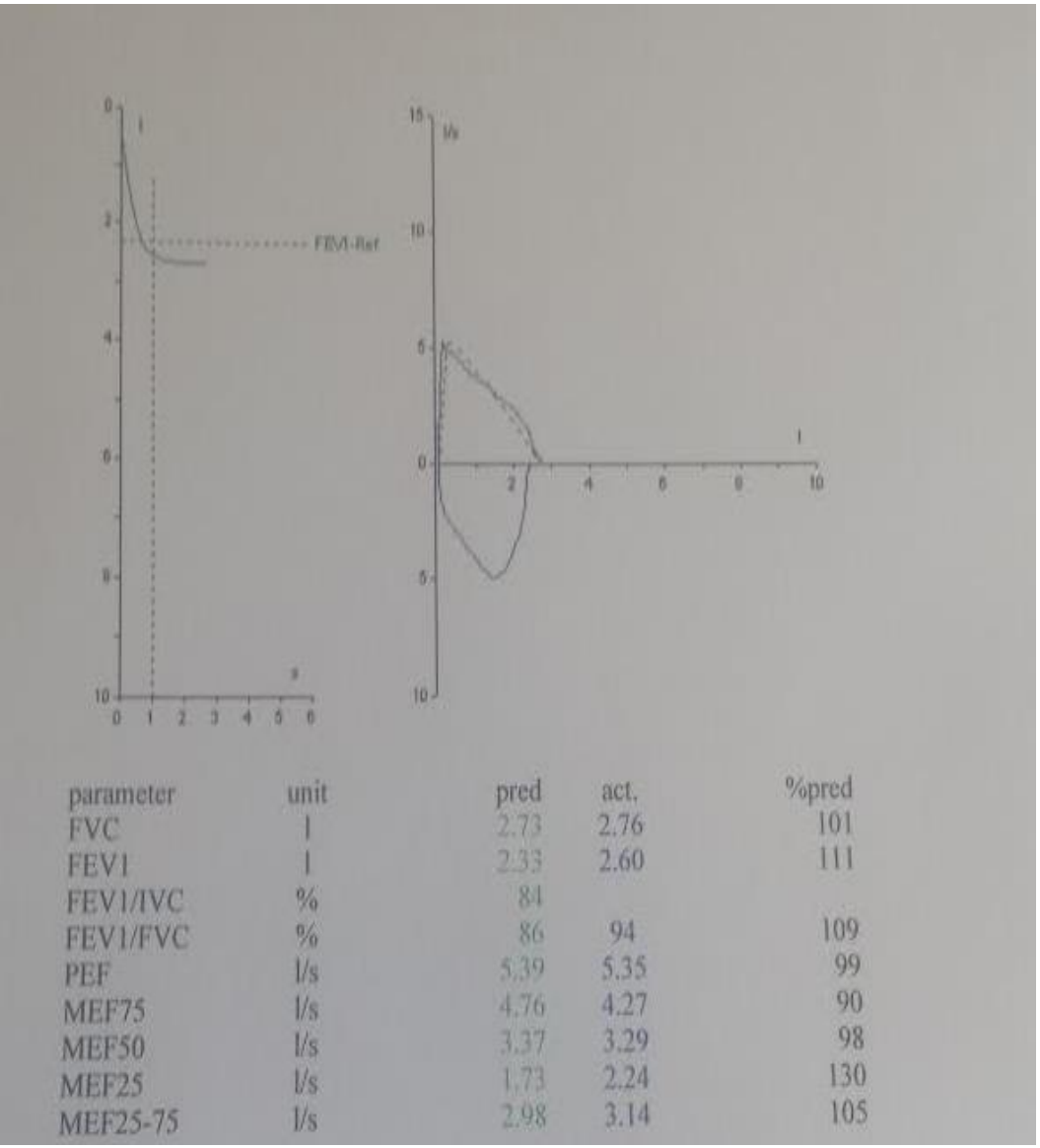
   Give Salbutamol through volumatic spacer
   Reversibility > 12% and 200 mls

4. Assess flow volume curve

Interpretation algorithm



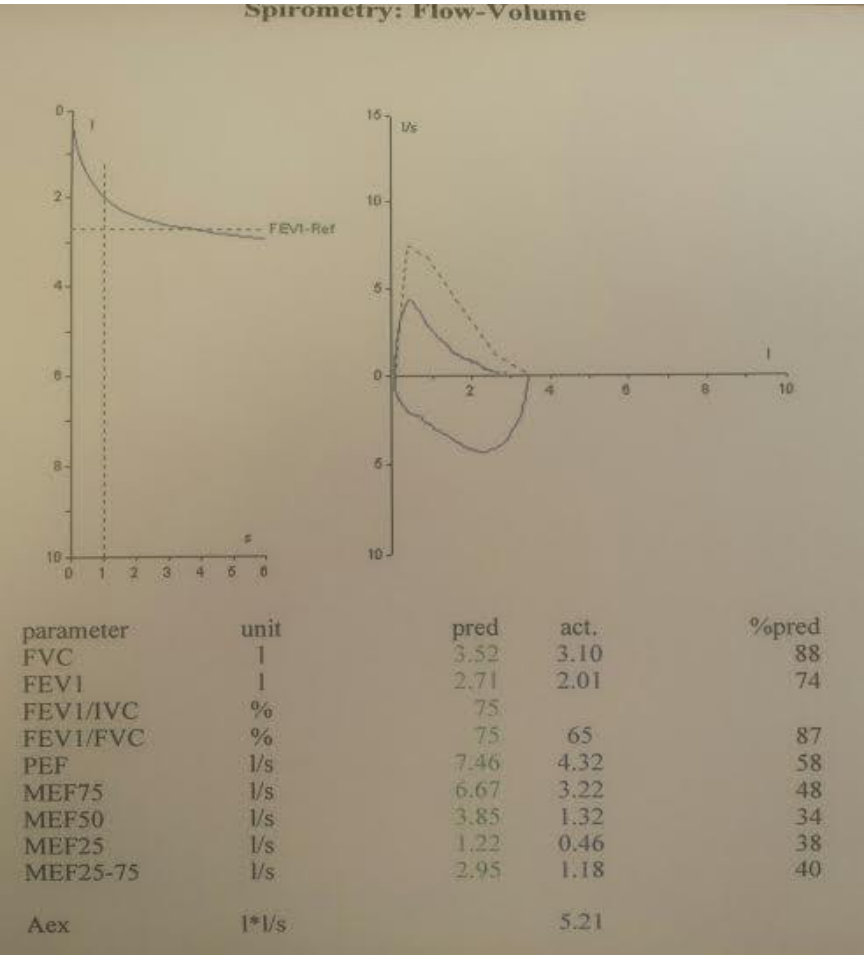
Examples of Spirometry



parameter	unit	pred	act.	%pred
FVC	l	2.73	2.76	101
FEV1	l	2.33	2.60	111
FEV1/IVC	%	84		
FEV1/FVC	%	86	94	109
PEF	l/s	5.39	5.35	99
MEF75	l/s	4.76	4.27	90
MEF50	l/s	3.37	3.29	98
MEF25	l/s	1.73	2.24	130
MEF25-75	l/s	2.98	3.14	105

	FEV_1 / FVC ratio	FEV_1	FVC
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

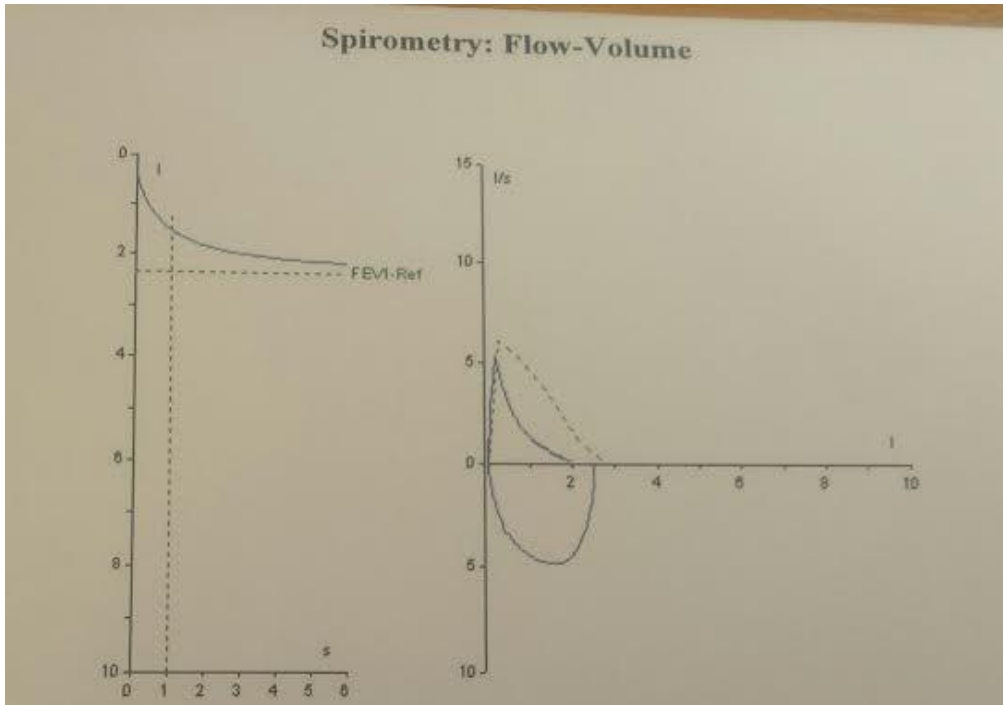
Mild Obstruction



parameter	unit	pred	act.	%pred
FVC	l	3.52	3.10	88
FEV1	l	2.71	2.01	74
FEV1/IVC	%	75		
FEV1/FVC	%	75	65	87
PEF	l/s	7.46	4.32	58
MEF75	l/s	6.67	3.22	48
MEF50	l/s	3.85	1.32	34
MEF25	l/s	1.22	0.46	38
MEF25-75	l/s	2.95	1.18	40
Aex	l*l/s		5.21	

	FEV_1 / FVC ratio	FEV_1	FVC (threshold 80 %)
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

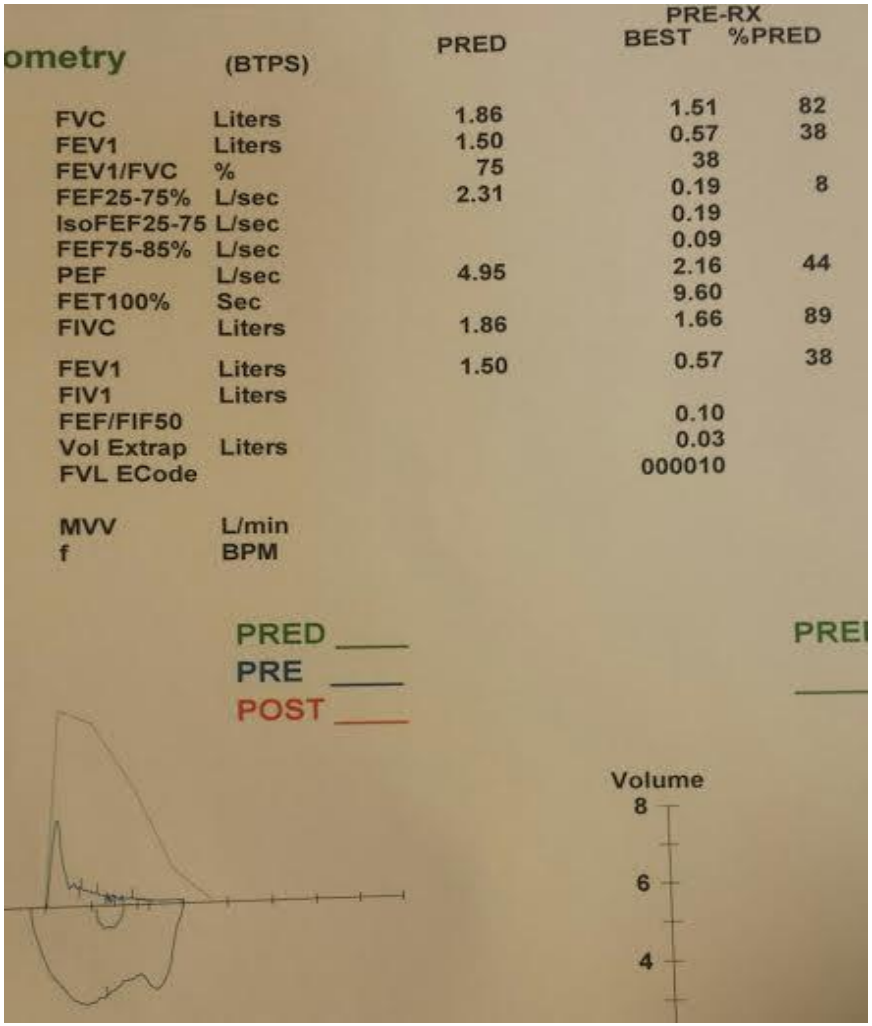
Moderate obstruction



parameter	unit	pred	act.	%pred
FVC	l	2.80	2.23	80
FEV1	l	2.36	1.55	65
FEV1/IVC	%	78	70	90
FEV1/FVC	%	78	69	89
PEF	l/s	6.09	5.29	87
MEF75	l/s	5.37	2.67	50
MEF50	l/s	3.68	1.12	31
MEF25	l/s	1.35	0.41	30
MEF25-75	l/s	2.95	0.97	33

	FEV_1 / FVC ratio	FEV_1	FVC (threshold 80 %)
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

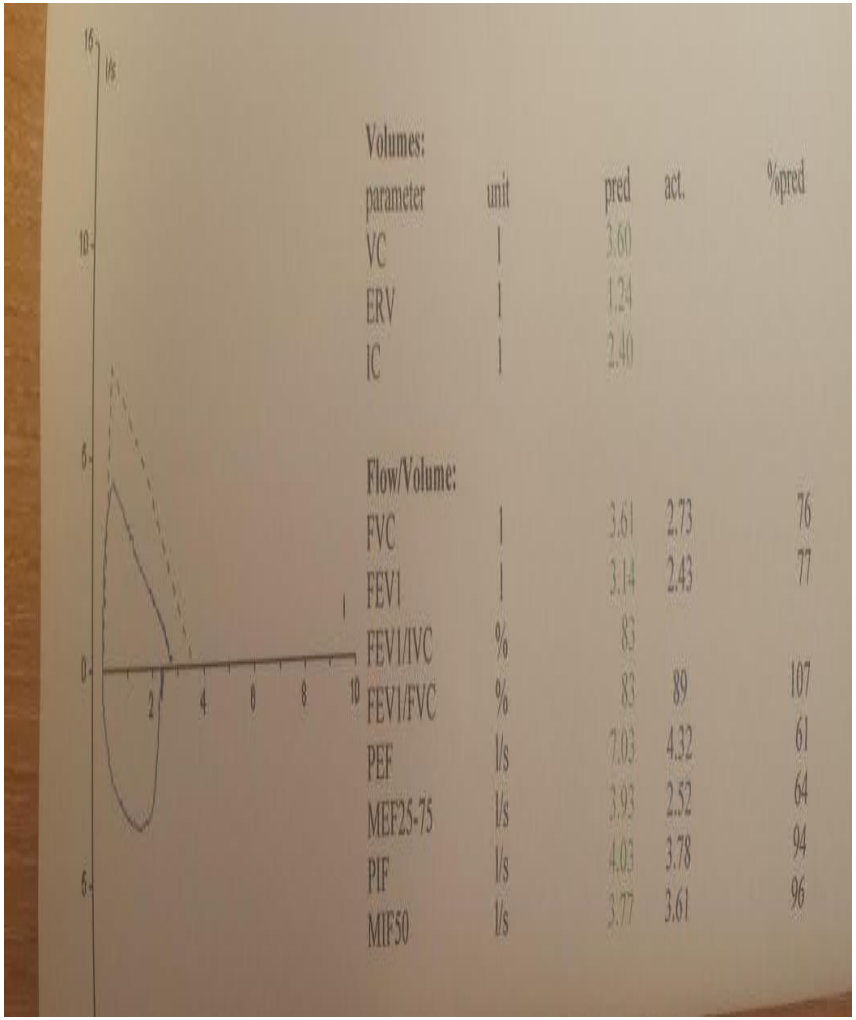
Severe obstruction



ometry	(BTPS)	PRED	PRE-RX BEST	%PRED
FVC	Liters	1.86	1.51	82
FEV1	Liters	1.50	0.57	38
FEV1/FVC	%	75	38	
FEF25-75%	L/sec	2.31	0.19	8
IsoFEF25-75	L/sec		0.19	
FEF75-85%	L/sec		0.09	
PEF	L/sec	4.95	2.16	44
FET100%	Sec		9.60	
FIVC	Liters	1.86	1.66	89
FEV1	Liters	1.50	0.57	38
FIV1	Liters			
FEF/FIF50			0.10	
Vol Extrap	Liters		0.03	
FVL ECode			000010	
MVV	L/min			
f	BPM			

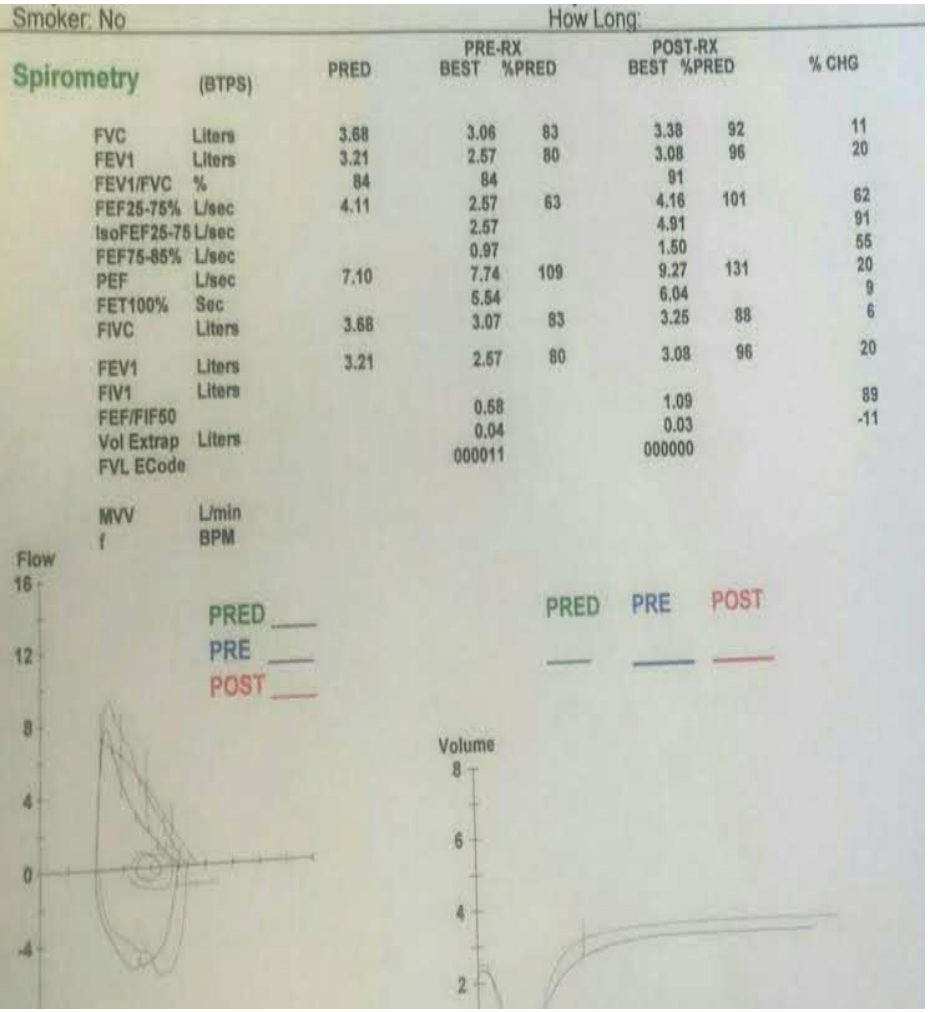
	FEV_1 / FVC ratio	FEV_1	FVC (threshold 80 %)
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

Restriction



	FEV_1 / FVC ratio	FEV_1	FVC
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

Bronchodilator Response



Smoker: No How Long:

Spirometry	(BTPS)	PRED	PRE-RX BEST	PRE-RX %PRED	POST-RX BEST	POST-RX %PRED	% CHG
FVC	Liters	3.68	3.06	83	3.38	92	11
FEV1	Liters	3.21	2.57	80	3.08	96	20
FEV1/FVC	%	84	84		91		
FEF25-75%	L/sec	4.11	2.57	63	4.16	101	62
IsoFEF25-75	L/sec		2.57		4.91		91
FEF75-85%	L/sec		0.97		1.50		55
PEF	L/sec	7.10	7.74	109	9.27	131	20
FET100%	Sec		5.54		6.04		9
FIVC	Liters	3.68	3.07	83	3.25	88	6
FEV1	Liters	3.21	2.57	80	3.08	96	20
FIV1	Liters						
FEF/FIF50			0.58		1.09		89
Vol Extrap	Liters		0.04		0.03		-11
FVL ECode			000011		000000		
MVV	L/min						
f	BPM						

	FEV_1 / FVC ratio	FEV_1	FVC (threshold 80 %)
Obstructive disease	↓	↓	N
Restrictive disease	Normal	↓	↓

conclusion

- Peak flow is a cheap and useful tool in practice
- In both spirometry and peak flow technique is vital
- Correctly performed tests can give vital information in primary care
- Any Questions?