SPIROMETRY

Best Techniques for best results

Marijke Currie

Care Medical Ltd

Phone: 0800 333 808

Email: sales@caremed.co.nz

What is spirometry

Spirometry is a physiological test that measures the volume of air an individual can forcefully exhale over time.

An estimation of flow, or the rate that volume is changing over time can also be calculated.

Objectives of spirometry

- Diagnosis
  - Screening for persons at risk of having pulmonary disease.
  - Evaluating symptoms of respiratory impairment
  - Pre-op assessment
  - Pre-employment screening
- Monitoring
  - Occ Health: monitor those exposed to hazardous agents
  - Determine effectiveness of medication
  - Monitor for adverse reactions of other drugs e.g. chemotherapy
  - Follow the course of disease – helps predict mortality and morbidity.
- Disability and Impairment
  - Assessing changes during respiratory rehab
  - Insurance risk
  - Employment/environmental risk
- Research
  - Large population studies - predicted (reference equations),
  - Pharmaceutical trials

Terminology

- **FORCED VITAL CAPACITY (FVC)**
  - Volume of air that can be forcibly expelled from the lungs following a maximal inspiration.
  - Measured in Liters
- **FORCED EXPIRATORY VOLUME IN 1 sec. (FEV_1)**
  - Volume of air blown out in the first one second of an FVC maneuver.
  - Measured in Liters.
- **FEV_1 / FVC Ratio**
  - This if the FEV1 expressed as a percentage of FVC
  - May be reported as FER [Forced Expiratory Ratio]

Terminology

- **PEF or PEFR**
  - Peak Expiratory Flow Rate
  - Recorded as Liters/sec (LPS) or Liters/minute (LPM)
- **FET - Forced expiratory time**.
  - Time taken to complete an FVC maneuver.
- **$FEF_{25-75\%}$**
  - Average expired flow over the middle half of the FVC maneuver. An indication of small airways narrowing

Predicted Values

- These values are derived from statistical analysis of population studies of healthy individuals.
- Predicted equations for Spirometry are based on age, sex, height, and in some cases weight.
- Weight and ethnicity should be noted on any report as they may influence interpretation

Selecting Predicted Values

NHANES III is the preferred reference equation set in NZ

Contraindications to testing

Think about what questions you may need to ask, prior to the test……

- Unstable angina
- Post MI (one week) or stroke
- Recent Pneumothorax or pulmonary embolus
- Lack of coordination
- Mental confusion
- Lack of cooperation
- Recent surgery- eye, abdominal, thoracic

Potential hazards and/or complications

- Pneumothorax
- Syncope, dizziness, light-headedness,
- Chest pain
- Cough
- Bronchospasm

Activities that should be avoided prior to spirometry

- Smoking within 1hour of testing
- Performing vigorous exercise within 30min of testing
- Wearing clothes that substantially restrict full chest and abdominal expansion
- Eating a large meal within 2 hours of testing

Test Procedure

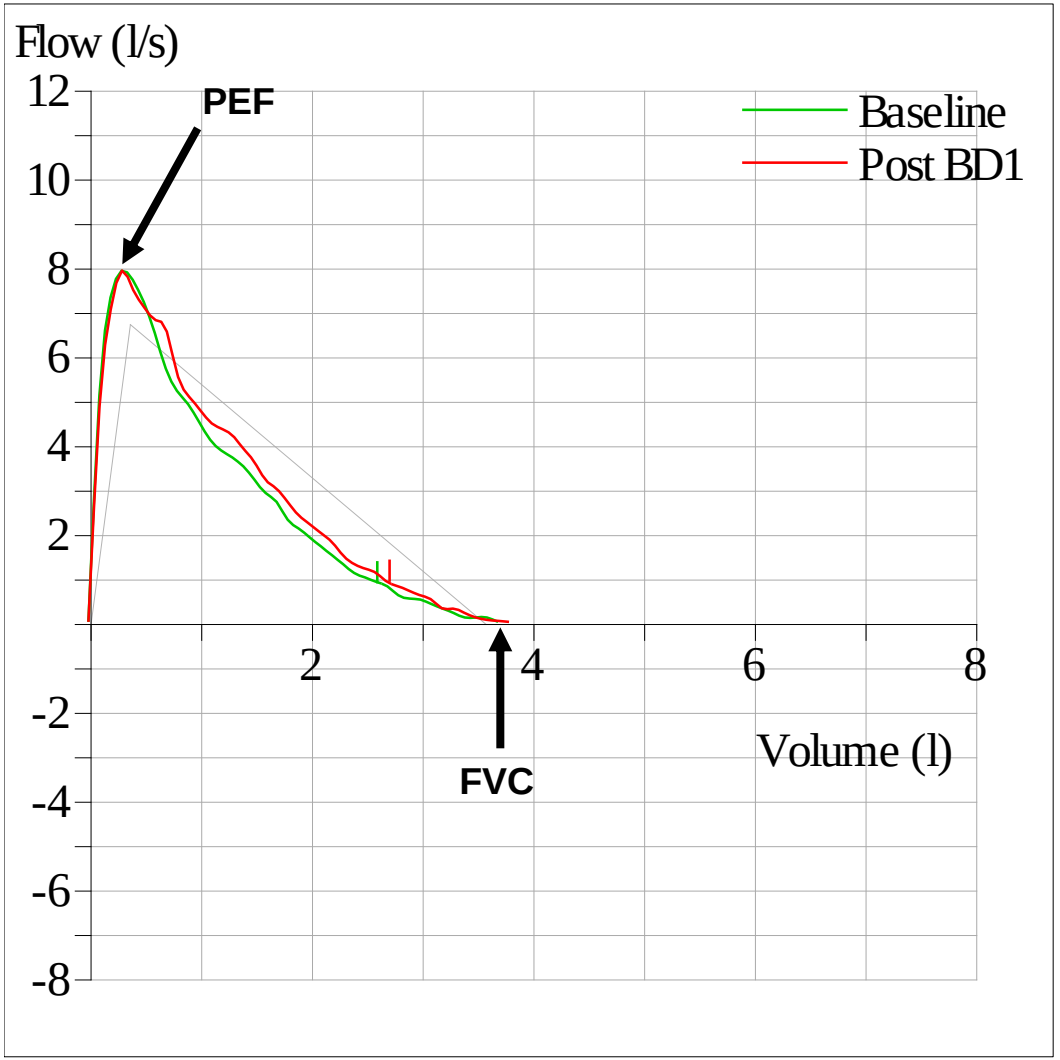
- Enter patient demographics into the spirometer (age, sex, height, weight), and make a note of any details from patient history which could affect the results
- Explain the purpose of the test, and instruct the patient on correct posture, with an emphasis on complete inhalation, and exhalation with maximal force.
- Explain the use of the mouthpiece, ensuring they understand to completely seal their lips around the outside, and to not block the mouthpiece with their tongue.
- Explain the use of the nose clip.
- Explain that the test will be repeated at least 3 times but no more than 8 times, with a break in between each blow to let them get their breath back

Performing the FVC Manoeuvre

1) Take a deep breath as much as you can.
2) Seal your lips around the tube (Using a bacterial filter eliminates this step as the patient can breath in and out on the mouthpiece prior to the forced manoeuvre).
3) Blow out "as hard and fast as long as you can" until no more air can be expelled- do not lean forward!
4) Come of the mouthpiece when finished/ or when I instruct you.

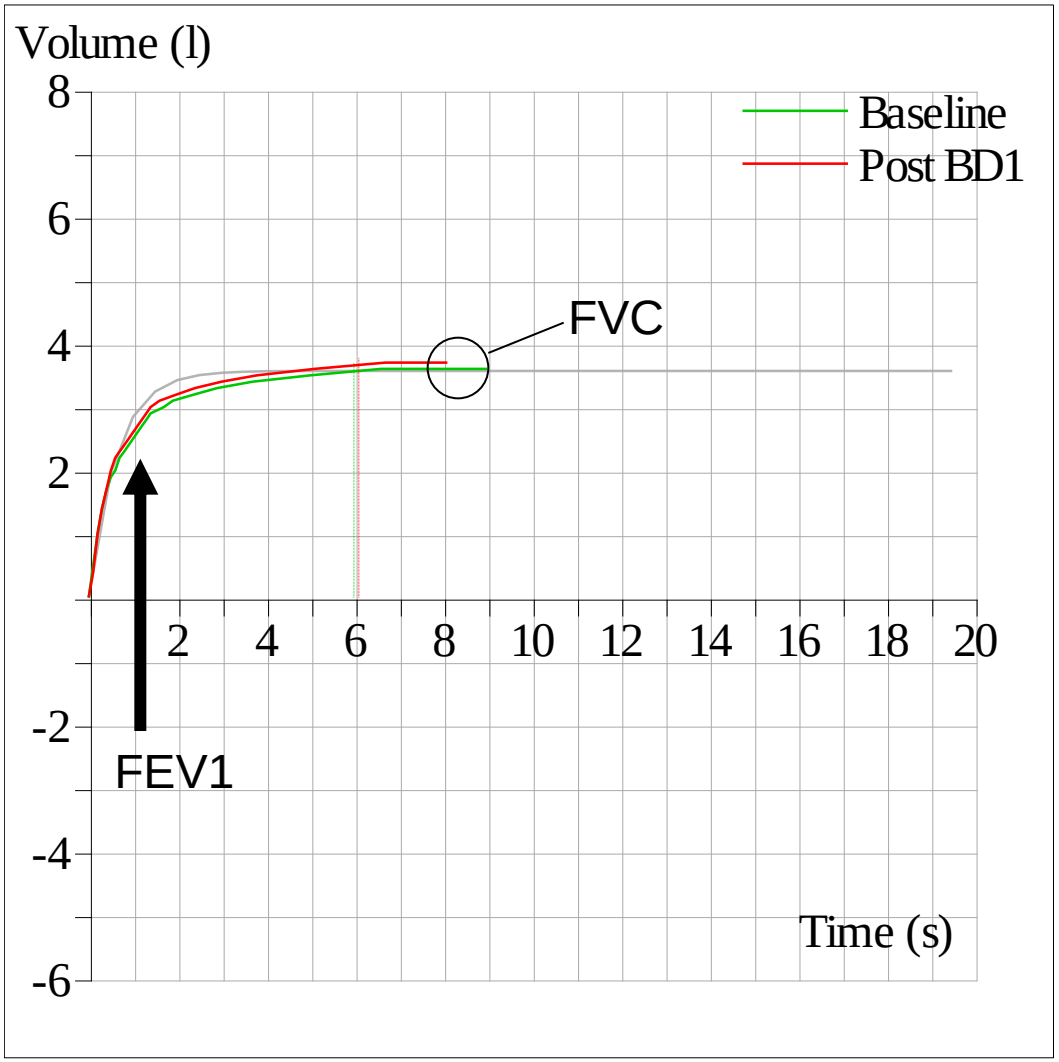
Flow/Volume Curve

Shows PEF and FVC



Volume/Time Curve

Shows FEV1 and FVC

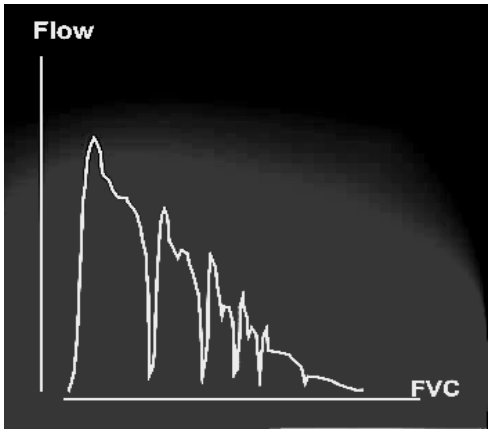


Patient-related errors

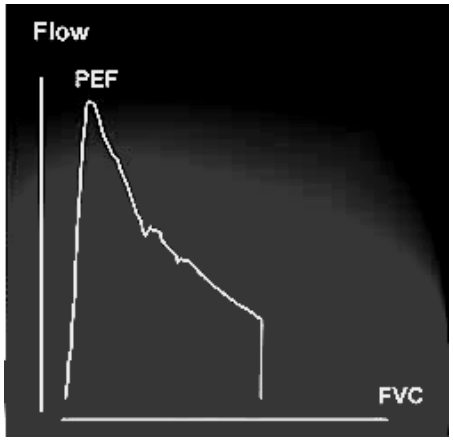
- Inadequate inspiration or expiration
- Poor mouth seal (air leakage)
- Teeth or tongue obstructing mouthpiece
- Slow start to FVC
- Premature termination
- Coughing
- Glottis closure
- Poor posture

Common Problems

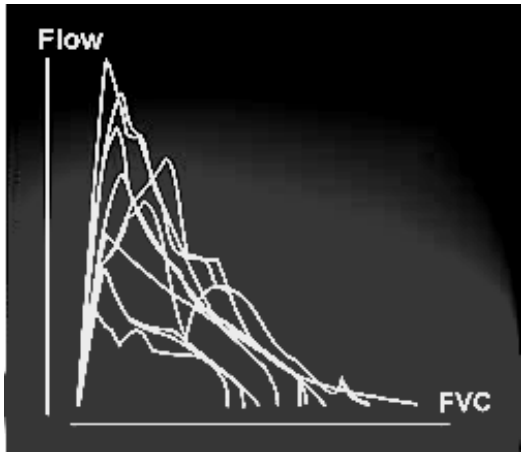
Cough



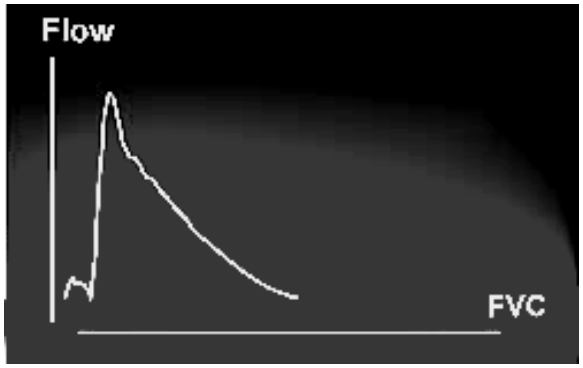
Early termination



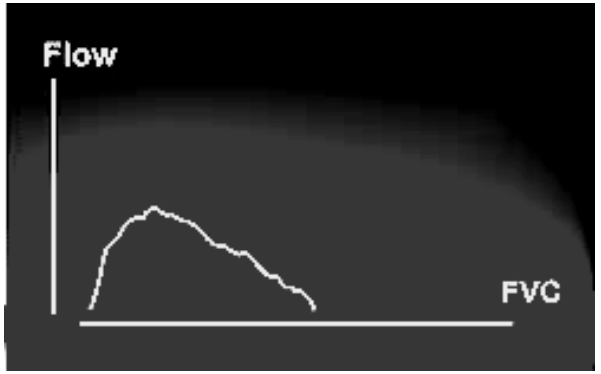
Variable effort



Slow start



Poor effort



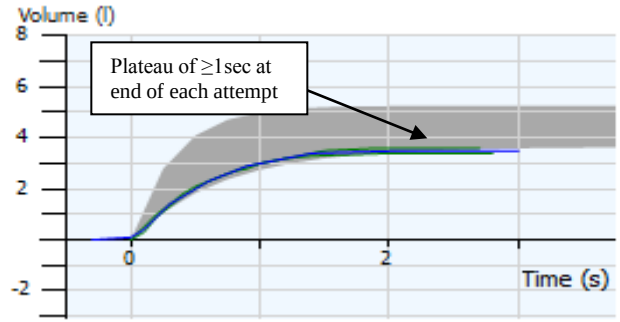
Summary of standards

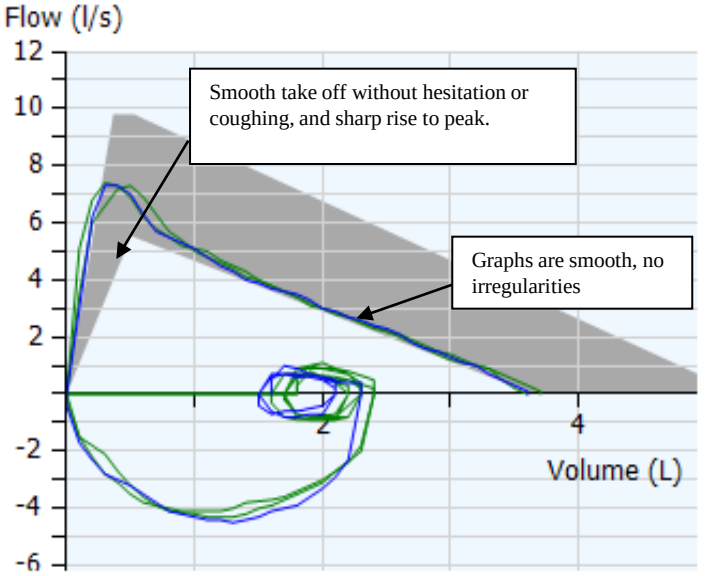
- A minimum of **3** technically satisfactory tests.
- A maximum of **8** attempts.
- The two best FVC and FEV_1's should have a variance of less than **150mls.**
- Exhaled for at least 6 seconds (adults) or reached a plateau on the volume-time graph. (No change of volume for at least one second.)
- Graph traces are smooth and free from irregularity
- Smooth take-off without hesitation

Determining acceptable and repeatable results

1) FVC manoeuvre performed, each attempt is checked after the manoeuvre to check it is acceptable, otherwise attempt rejected

"These manoeuvres are all **acceptable"**





2) Once you have three acceptable manoeuvres check if the results are repeatable.

Test	Stage	FEV1	FVC	PEF	FEV1/FVC	Quality	Variation	Time
1	Base	3.10	3.57	442	87%	Good Blow	-2%	3:57 p...
2	Base	3.03	3.46	435	88%	Good Blow	-5%	3:57 p...
3	Base	3.13	3.71	443	84%	Good Blow	0%	3:58 p...

Two best FEV1's are within 150ml

Two best FVC's are within 150mls of eachother- JUST!

"The two best results from those manoeuvres are **repeatable"**

Selection of best test

- This can programmed on many spirometers and/or Software programs.
- Report the highest FEV1 and FVC from any acceptable manoeuvre.
- The FEV1 and FVC do not have to be from same manoeuvre.
- The “best test” curve has the highest sum of FVC + FEV1
- Flow measurements are taken from this same curve eg PEF.

The FEV1 and FVC will be reported from this test, and it will also be picked for the best test curve

Test	Stage	FEV1	FVC	PEF	FEV1/FVC	Quality	Variation	Time
1	Base	3.10	3.57	442	87%	Good Blow	-2%	3:57 p...
2	Base	3.03	3.46	435	88%	Good Blow	-5%	3:57 p...
3	Base	3.13	3.71	443	84%	Good Blow	0%	3:58 p...

REPORT FORMAT

ID:	care				
Name:	Care				
Age:	26 years 8 months	**DOB:**	19/09/1984	**Exam Date:**	01/06/2011 15:56
Height:	176 cm	**Weight:**	63 kg	**BMI:**	20.3
Gender:	Female	**Ethnic Origin:**	Caucasian	**Factor:**	100
Smoking:	Non Smoker	**Dyspnoea:**	0		

Please Note: Spirometry data and graphs are either best individual values or composite curve

Summary of All forced tests

	FEV1	FVC	PEF	FEV1/FVC	Quality	VAR	Time	Date
Base	3.10	3.57	442	87%	Good Blow	-2%	3:57 p.	01/06/2011
Base	3.03	3.46	435	88%	Good Blow	-5%	3:57 p.	01/06/2011
Base	3.13	3.71	443	84%	Good Blow	0%	3:58 p.	01/06/2011
Base+	**3.13**	**3.71**	**443**	**84%**	-	-		
	ATS/ERS Criteria [2005]: Criteria Met.							
Key: * - Default best, ^ - Manual best, + - Individual best								
Variation is based on FEV1 + FVC.								

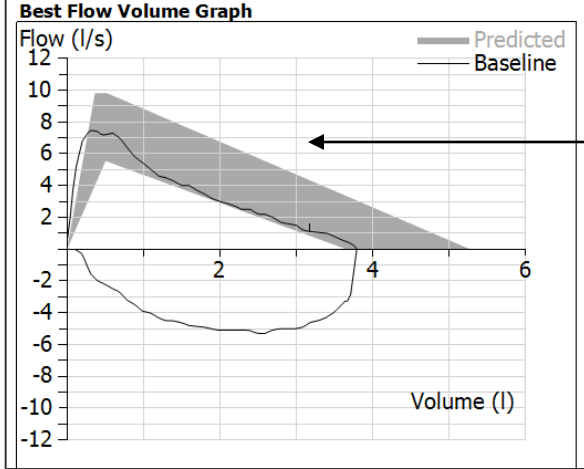
Selected indices of the best blows

Index	Base	%Pred	Zscr	Post1	%Pred	%Chg	Zscr	[Min	Pred	Max]
FEV1	3.13 l	83%	-1.5					3.08 l	3.77 l	4.45 l
FVC	3.71 l	83%	-1.5					3.65 l	4.46 l	5.27 l
PEF	443 l/min	95%	-0.3					348 l/min	468 l/min	588 l/min
FEV1/FVC	84%		-0.2					75%	85%	95%
Lung Age	56 years									

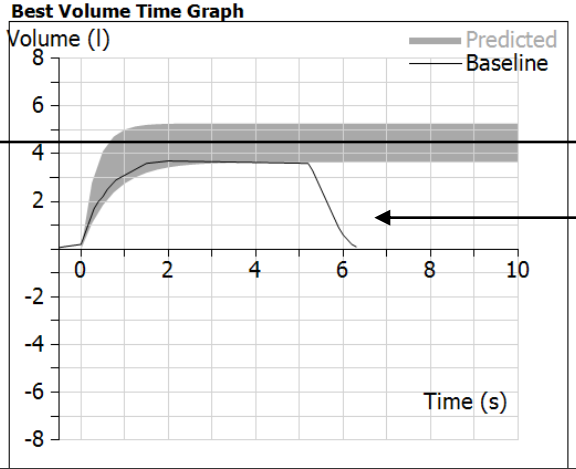
Interpretation: (ATS)
Base: Normal Spirometry

Predicted Source: NHANES III
Results at BTPS.

Best Flow Volume Graph



Best Volume Time Graph



Patient Name

Exam date & Time

Patient details

All test data
Including units

Best result with %predicted displayed

If interpretation reported, source of interpretation

Predicted set used

Best FVL graph displayed

VTG optional but can be useful

Interpreting spirometry results

FVC, FEV_1, and FEV_1 / FVC ratio
form the basis for interpretation.

Obstructive **"**Indicative of airways disease affecting the AIRWAYS".

- FEV1 reduced (<80% predicted normal), FVC is usually reduced but to a lesser extent
- FEV1/FVC < 70% (70% used in COPD)- The lower the ratio, the worse the obstruction

Severity — Eur Respir J 2005; 26: 948–968. Interpretive strategies for lung function tests

Mild <70
Moderate 60–69
Moderately severe 50–59
Severe 35–49
Very severe <35

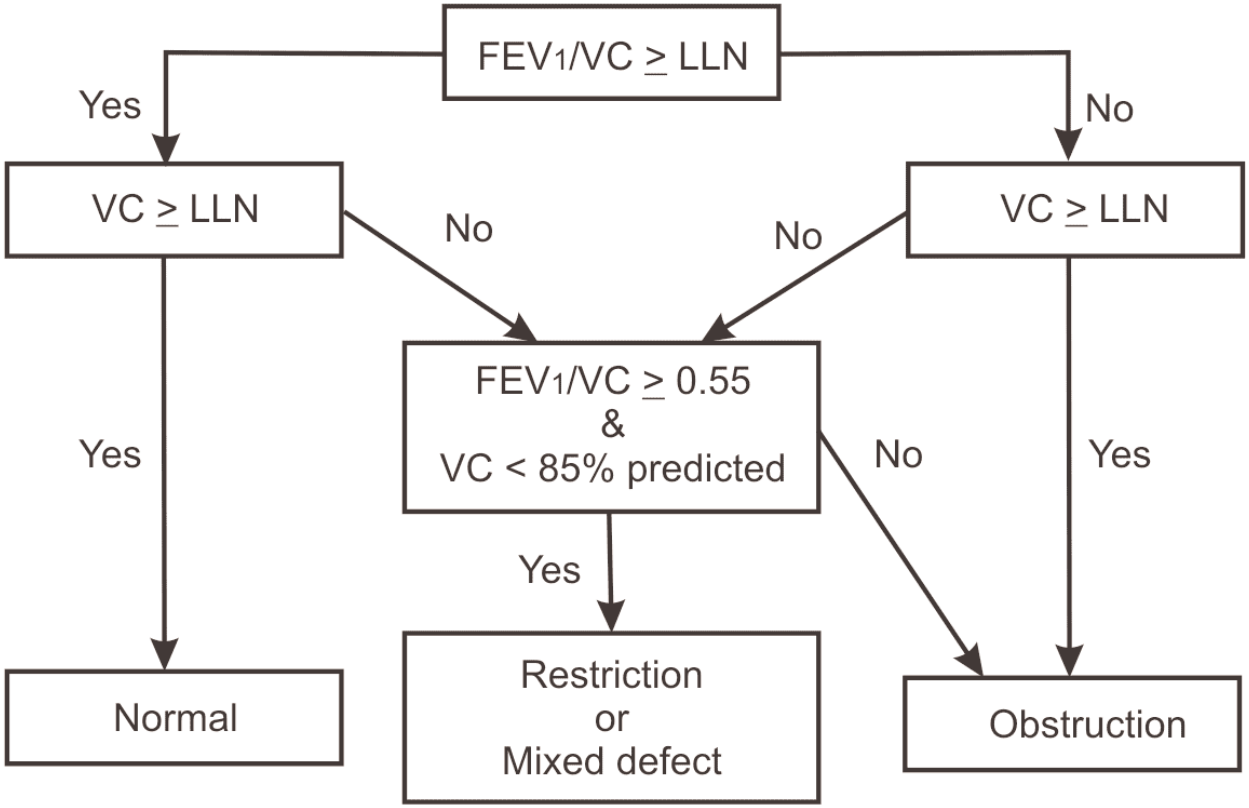
Restrictive **"**Indicative of disease affecting the LUNG TISSUE".

- Reduced FVC (<80%); and normal or elevated (>70%) FEV1/FVC

*For a diagnosis of restrictive lung disease, Lung volumes (TLC) must be measured through a PFT lab using pethysmography, helium dilution or a nitrogen washout method

Mixed obstructive/restrictive
Showing signs of both obstructive and restrictive lung disease.

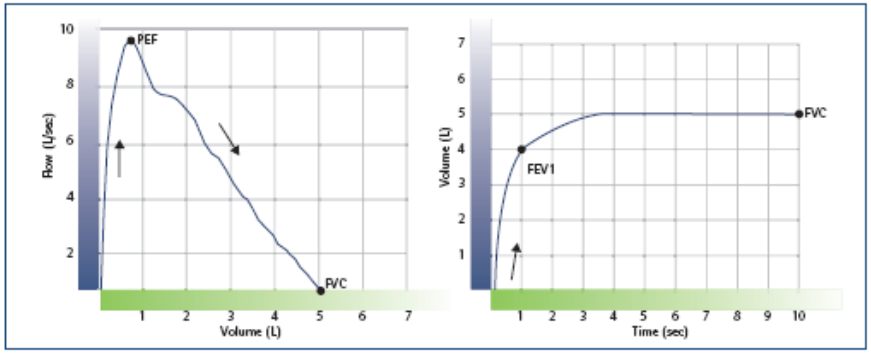
Interpretive Algorithm



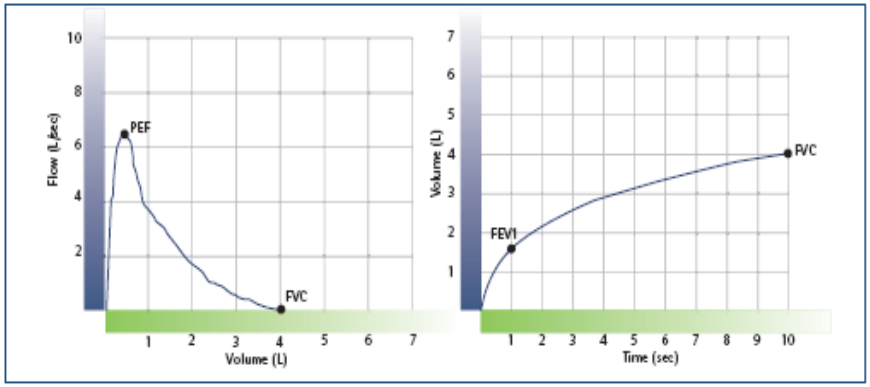
Glady CA, Aaron SD, Lunau M, Clinch J, Dales RE. A spirometry-based algorithm to direct lung function testing in the pulmonary function laboratory. *Chest* 2003;**123**(6):1939-46. http://dx.doi.org/10.1378/chest.123.6.1939

Disease classification

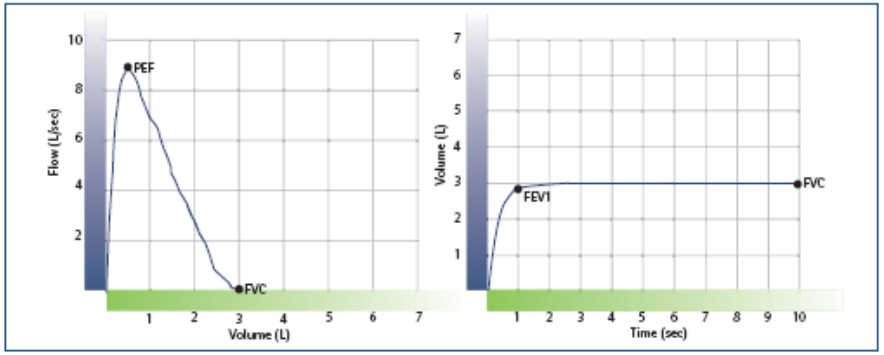
Normal Pattern: N

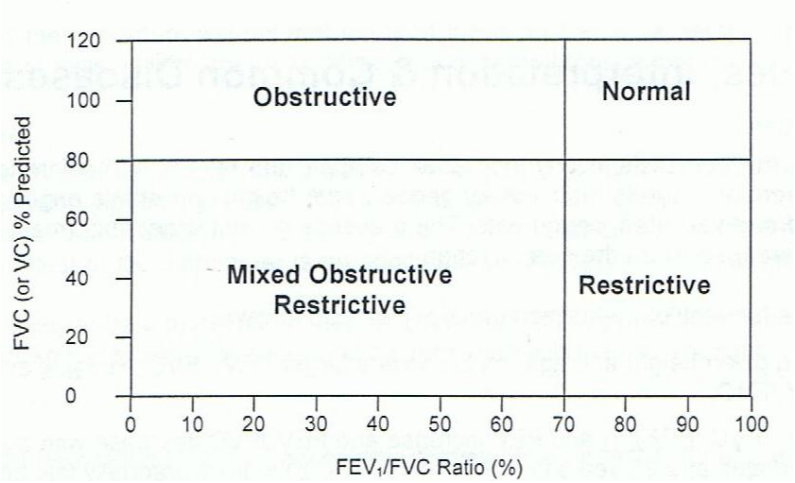


Obstructive Pattern: Obs



Restrictive Pattern (Reduced Inflation, No Obstruction): RINO





Obstructive disease examples

Asthma, Emphysema, chronic bronchitis

Restrictive disease examples

Intrinsic: Pulmonary Fibrosis, Sarcoidosis.
Extrinsic: Neuromuscular disease, Kyphosis

HOUSE KEEPING

Cleaning/Infection control

- Follow manufacturers advice for cleaning of the turbine/transducer/pneumotach.
- BEST PRACTISE is the use of a single-use disposable bacterial/viral filter. This ensures maximum protection to all patients, the technician and to the environment.
- Filters also give protection to sensors/turbines and internal surfaces of the spirometer, reduces damage from corrosive effects of cleaning agents.
- The expected life span of the sensors are increased, reducing running costs.
- An alternative option is to use a disposable mouthpiece with a one-way valve – note that only expiratory testing can be done.
- If no filter is used the turbine should be cleaned and dried thoroughly after each patient.

Spirometer quality control

- To ensure that the spirometer is measuring volume accurately regular verification with a 3L syringe is recommended.

- Verification consists of injecting a known volume of air (usually 3L), and checking that the device is within calibration limits (+/- 3%).

- A biological control is also a good idea to validate the spirometer calibration.

  This is where a staff member with consistent spirometry performs the manoeuvre on the device on a regular basis, and compares the results to their previous recorded results (Values should be within 5%).

Now lets put that into practise!