IPCRG - Opinion No.1
PCRS-UK - Opinion No.1 (v5)

Opinion

Spirometry

Spirometry is essential for the diagnosis, assessment and monitoring of COPD,[1,2] may support the diagnosis of asthma,[3,4] and contribute to the diagnosis of other causes of dyspnoea.

What equipment?

The guide to performing quality assured spirometry document (DH 2012) sets equipment requirements and standards:[5]

- A spirometer which meets the ISO standard 26782[6]
- One way mouthpieces and nose clips
- Bacterial filters (if indicated on selected patients)
- Accurate height and weight measuring tools – calibrated according to manufacturers instructions
- Short-acting bronchodilators for reversibility testing and suitable means for delivery (nebuliser, volumatic)

A spirometer should have a graphical display to allow technical errors to be detected. It should be able to produce a hard copy. Annual electrical calibration is essential. All spirometers should be verified before each session using a 3 litre calibration syringe, and regular performance of a physiological control is a further means of quality assurance.

There are two types of spirometer commonly used in primary care:

- Portable meters with integral printers will undertake all the calculations, including reversibility, as well as showing predicted ranges. Small displays of the volume time graph help monitor the blow and the printout includes flow volume and volume time graphs.
- Systems designed to work with the practice computer which will display a graph, calculate predicted and reversibility and provide a print-out. Some systems can transfer the spirometry readings directly into the electronic health record.

Small, hand held meters which provide digital readings (but no visual display) are a cheap option which may be useful as a screening tool to identify people with abnormal readings who should be assessed by full diagnostic spirometry.[5]

How is spirometry performed?

Sit or stand? Sitting is recommended in a chair with arms. Three satisfactory blows should be performed.

Two types of blow are performed. Firstly the 'relaxed' vital capacity (VC) and then the forced vital capacity (FVC). A significant difference between the VC and FVC indicates air trapping: use the larger figure to calculate the ratio (see page 2)

- **VC**: Starting with full inspiration, the patient blows out in a relaxed way, similar to a heavy sigh until the lungs are empty. A nose clip should be worn for this procedure. Three blows shows be performed of which the best two should be within 5% or 100mls (or 150mls) of each other.
- **FVC**: Starting with full inspiration the patient blows out as hard and fast as possible until the lungs are 'empty'. Three blows should be performed, of which the best two should be within 5% or 100mls (or 150mls) of each other. When looking at the volume time graph the blow should continue until a volume plateau is reached and maintained for at least 2 seconds. This may take more than 12 seconds in people with severe COPD.
- The expiratory volume-time graph should be smooth and free from irregularities. The flow volume graph should rise to a peak and merge with the horizontal axis when FVC has been reached.

Reversibility tests

Reversibility tests involve measuring spirometry before and after treatment and can help distinguish between COPD and asthma (but note that spirometry may be normal in stable asthma).

Preparation of the patient:

The patient's condition should be stable (ie at least 4-6 weeks post-exacerbation). If spirometry is to be performed for diagnostic purposes the patient should stop their short-acting β_2-agonist for 6 hours, long acting bronchodilator for 12 or 24 hours (depending on duration of action of the drug) and theophyllines for 24 to 36 hours.

Procedure

- Perform baseline spirometry
- *Bronchodilator reversibility*: Administer bronchodilator (at least 400mcg salbutamol via a large volume spacer). Perform post bronchodilator spirometry after 15 minutes.
- *Steroid reversibility*: A steroid trial (30–40mg daily for 2 weeks or 1,000ug of inhaled steroids for three months) may be appropriate if the clinical history is suggestive of an asthma diagnosis.

People with COPD may have a small but significant increase in FEV_1. Substantial reversibility, defined as an increase in FEV_1 of >400mls, suggests a diagnosis of asthma.[3,4]

Training

Poorly performed spirometry is meaningless. Diagnostic spirometry should only be undertaken by health care professionals or operators with accredited training.[6] Regular updates and quality audits are fundamental.[5]

Training courses

- Spirometry manufacturers can provide training in the use of their equipment.
- Accredited training is defined as 'Association for Respiratory Technology & Physiology (ARTP) equivalent' and competence is measured and recorded on the ARTP register as 'full certification' for those who can perform and interpret and foundation level for those who only perform the manouevre.

References

1. Global Initiative for Obstructive Lung Disease. *Global Strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease: 2011.* Available from http://www.goldcopd.com
2. National Institute for Health and Clinical Excellence. Management of chronic obstructive pulmonary disease in adults in primary and secondary care (partial update 2011). London: National Institute for Health and Clinical Excellence (NICE); 2010. Available from: www.nice.org.uk
3. Global Initiative for Asthma. *Global Strategy for Asthma Management and Prevention GINA Workshop Report: 2011.* Available from http://ginasthma.com
4. British Thoracic Society-Scottish Intercollegiate Guideline Network. British Guideline on the Management of Asthma. *Thorax* 2008;**63**(Suppl 4):1-121. Last updated 2011. Available from http://www.brit-thoracic.org.uk and http://www.sign.ac.uk
5. Mark L Levy, Philip H Quanjer, Rachel Booker, Brendan G Cooper, Steve Holmes, Iain Small. Diagnostic Spirometry in Primary Care: Proposed standards for general practice compliant with American Thoracic Society and European Respiratory Society recommendations. *Prim Care Respir J* 2009;**18**:130-147 DOI: http://dx.doi.org/10.4104/pcrj.2009.00054
6. Department of Health, August 2012.

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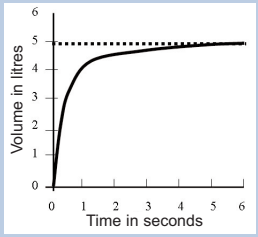
A guide to interpreting spirometry

i) Normal spirometry

The Forced Vital Capacity (FVC) of the lung is the volume of air that can be forcibly expelled from the lung from maximum inspiration to maximum expiration.

Normal

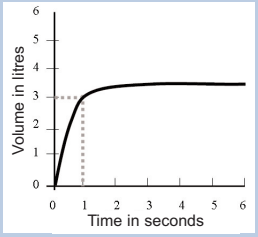


Male, 49yrs, 180cm
FVC = 4.90 litres

Predicted FVC = 4.95litres
%predicted = 99%

Forced Expiratory Volume in 1 second = FEV_1. The FEV_1 is the volume of air that can be forcibly expelled from maximum inspiration in the first second.

Normal

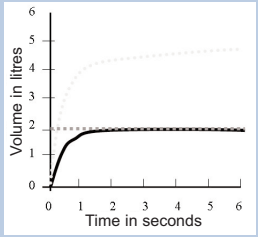


Female, 33yrs, 165cm
FEV_1 = 3.20 litres

Predicted FEV_1 = 3.03litres
%predicted = 105%

ii) Abnormal spirometry is divided into restrictive and obstructive ventilatory patterns

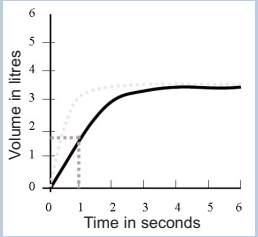
Restrictive: due to conditions in which the lung volume is reduced, eg fibrosing alveolitis, scoliosis. The FVC and FEV_1 are reduced proportionately.



Male, 49yrs, 180cm
FVC = 2.00 litres
(40% predicted)

FEV_1 = 1.80 litres
(45% predicted)

Obstructive: due to conditions in which the airways are obstructed eg asthma or COPD. The FVC and FEV_1 are reduced disproportionately.



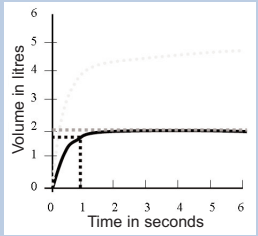
Female, 33yrs, 165cm
FVC = 3.50 litres
(98% predicted)

FEV_1 = 1.8litres
(58% predicted)

Severity of COPD: FEV_1 as a %predicted may be used to classify the severity of COPD. National guidelines vary, but many use the levels of FEV_1 <80%, <50%, or <30% predicted to arbitrarily define mild, moderate or severe disease.

iii) Forced expiratory ratio (FEV_1/FVC ratio, or FEV_1%)

The FEV_1/FVC ratio is the FEV_1 expressed as a percentage of the FVC (or VC if that is greater): ie the proportion of the vital capacity exhaled in the first second. It distinguishes between a reduced FEV_1 due to restricted lung volume and that due to obstruction. Obstruction is defined as an FEV_1/FVC ratio less than 70%.



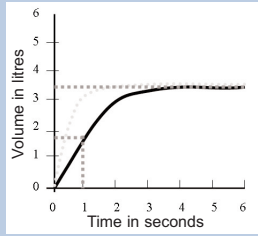
FVC = 2.00 litres (40% predicted)

FEV_1 = 1.80 litres
(45% predicted)

FEV_1/FVC ratio = 90%

Restrictive ventilatory pattern

FVC reduced <80%
FEV_1 reduced
FEV_1/FVC ratio normal



FVC = 3.50 litres (98% predicted)

FEV_1 = 1.80 litres (58% predicted)

FEV_1/FVC ratio = 51%

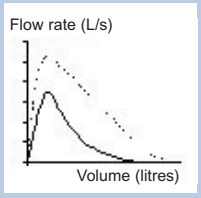
Obstructive ventilatory pattern

FVC normal or reduced
FEV_1 reduced <80%
FEV_1/FVC ratio reduced <70%

iv) Flow volume loops

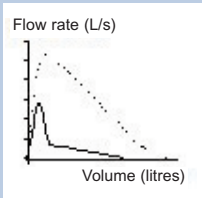
This is the same forced expiration converted electronically to illustrate the flow rate as the lung empties. The x axis represents volume - from full inspiration to full expiration: The y axis represents the flow rate. The shape of the flow volume loop depends on the mechanical properties of the lung and the shape can give important clues about the diagnosis. The dotted line is a normal curve.

Asthma



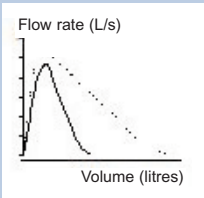
Typically the curve is a comparatively smooth concave shape as the airway obstruction is relatively stable throughout expiration

COPD



Typically the curve is angled as the damaged lungs in COPD collapse with forced expiration

Restrictive



Typically the curve is a normal height, but very steep as the lung volume is decreased

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