YOUR ESSENTIAL GUIDE TO SPIROMETRY

What is spirometry?

Spirometry is used to measure lung volumes and air flow. Alongside clinical assessment, it is an essential tool used in the diagnosis, assessment and monitoring of Chronic Obstructive Pulmonary Disease (COPD)[1], may contribute to the diagnosis of asthma and detect restrictive respiratory conditions.[2]

What measurements are undertaken using spirometry?[3]

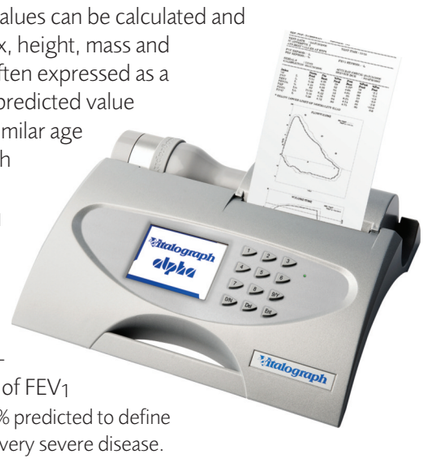
- **Relaxed or slow vital capacity (VC)**
  The volume of air that can be slowly expelled from the lung from maximal inspiration to maximum expiration
- **Forced vital capacity (FVC)**
  The volume of air that can be forcibly expelled from the lung from maximal inspiration to maximum expiration
- **Forced Expiratory Volume in 1 second (FEV_1)**
  The volume of air that can be forcibly expelled from maximum inspiration in the first second
- **FEV_1/FVC ratio**
  The FEV_1/FVC ratio is the FEV_1 expressed as a percentage of the FVC (or VC if that is greater). i.e. the proportion of the vital capacity exhaled in the first second. It distinguishes between a reduced FEV_1 due to restrictive lung volume and that due to obstruction. Obstruction is defined as an FEV_1/FVC ratio less than 70%
- **Forced Expiratory Volume in 6 seconds (FEV_6)**
  The volume of air that can be forcibly expelled from maximum inspiration in six seconds.

This measurement is sometimes used as an alternative for FVC. Similarly FEV_1/FEV_6 is sometimes used instead of FEV_1/FVC.

Abnormal spirometry is divided into restrictive and obstructive ventilatory patterns.

- Restrictive patterns appear in conditions where the lung volume is reduced e.g. interstitial lung diseases, scoliosis. The FVC and FEV_1 are reduced proportionately
- Obstructive patterns appear when the airways are obstructed e.g. due to asthma or COPD. The FEV_1 is reduced more than the FVC

Predicted normal values can be calculated and depend on age, sex, height, mass and ethnicity. FEV_1 is often expressed as a percentage of the predicted value for any person of similar age sex, and height with adjustments for ethnic origin. FEV_1 %predicted is used to classify the severity of COPD. National and international guide-lines use the levels of FEV_1 <80%, <50% or <30% predicted to define moderate, severe or very severe disease.



Who should undertake spirometry?

Poorly performed spirometry is meaningless. Spirometry should only be undertaken by healthcare professionals who are trained and competent (accredited) in performing (and ideally, interpreting) the tests.[3,4,5] Regular updates and quality audits are fundamental to ensuring the quality of spirometry testing.

Accredited training courses include:-

Institution	Course
http://www.artp.org.uk/ Association for Respiratory Technology & Physiology	The ARTP with the British Thoracic Society (BTS) offer a variety of training methods and an accreditation system to ensure acceptable standards of spirometry testing and interpretation.
https://www.educationforhealth.org/ Education for Health	Education for Health have a range of Spirometry courses written by experts, including workshops for those who simply need to feel more confident recording accurate measurements. The spirometry modules are developed with the Association of Respiratory Technology & Physiology (ARTP) and supported by the British Thoracic Society (BTS).

Types of spirometry testing[4]

- **Baseline testing** Used to investigate lung function where diagnosis has not been established.
- **Post-bronchodilator testing**
  - o **Investigative**: To diagnose obstructive conditions where baseline spirometry shows an obstructive pattern
  - o **Monitoring**: To monitor clinical progress in diagnosed asthma and COPD
- **Reversibility testing** May help to differentiate asthma from COPD.

What equipment is required to conduct spirometry?[4,6]

- Spirometer (must meet ISO standard 26783).
  - o 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]
- One-way disposable mouthpieces and nose clips
- Bacterial and viral filters (selected patients with any risk of infection)
- Accurate height measures – calibrated according to manufacturer's instructions
- Short-acting bronchodilators for reversibility testing and suitable means for delivery (volumatic/nebuliser)

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PATIENT PREPARATION[3-6]

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For investigative or reversibility testing patients should be advised to continue taking oral or inhaled corticosteroids but stop taking short-acting bronchodilators (SABA) for 4 hours, long-acting bronchodilators (LABA) for 12 hours and long-acting anticholinergic bronchodilators (LAMA) for 36 hours. For monitoring existing conditions patients should continue to take normal prescribed therapy.

Assess patient for contra-indications – see seperate box

Patients should be asked to avoid:
- Smoking for at least 24 hours before the test
- Eating a large meal before the test
- Vigorous exercise before the test
- Wearing tight clothing

Patients should be asked to bring their inhalers with them to the appointment

Immediately before the test patients should be advised to:-
- Remove loose fitting dentures
- Remove chewing gum
- Ensure bladder is empty

How is spirometry performed?[3-6]

- Ensure that the equipment is ready and in good working order verify according to manufacturer's instructions
- Record age, height and weight
- Record race using ethnic correction factors (see table below)
- Make sure the patient is sitting comfortably ideally in a chair with arms
- Explain the procedure and advise the patient not to obstruct the mouthpiece with the teeth or tongue
- Ensure there is a good seal around the mouthpiece
- Discourage the patient from leaning forward as this may compromise the results
- Nose clips should be used for baseline VC though they are not essential for FVC
- Encourage the patient throughout the procedure and ensure that they exhale fully and that this is demonstrated on the graph
- Carry out VC and FVC ensuring patient has sufficient time to recover between blows
- A minimum of three acceptable blows should be performed for each manoeuvre
- Repeatability criteria are met when there is no more than 100mls ideally (5%) variability between each blow. Some spirometers will inform the user when this has been achieved
- A maximum of 8 attempts is believed to be acceptable in any one session. If the patient is unable to achieve the quality criteria, record why this has not been possible and where appropriate use exemption code in the record. A further appointment may be required or referral for specialist assessment
- Print out the numerical and graphical spirometry results and document the results using the template available in the practice system
- Import (or scan) the spirometry results into the patient's electronic health record
- Inform patient of the results (if you are qualified to interpret the findings) or make an appointment for the patient to discuss the results and future treatment with their GP or an appropriate healthcare professional trained in spirometry interpretation

Calibration, verification and maintenance of spirometry equipment[3-6]

Calibration of spirometry test equipment should be performed using a certificated 3 litre syringe and following the manufacturer's recommended procedures. For a device to be within calibration limits it must read +/- 3% of true.[4] Calibration should be verified prior to each clinic/session or after every 10th patient (whichever comes first). A calibration log should be maintained.

Spirometers should be cleaned and service/ maintenance processes carried out regularly according to the manufacturer's instructions and in line with local and national guidance for infection control and equipment maintenance.

Contraindications to spirometry testing[3-6]

Absolute
- Active infection e.g. AFB positive TB until treated for 2 weeks
- Conditions that may cause serious consequences to health if aggravated by forced expiration e.g. dissecting/unstable aortic aneurysm, pneumothorax, recent surgery (abdominal, thoracic, neurosurgery, eye surgery)

Relative
- Suspected respiratory infection in the last 4-6 weeks requiring antibiotics or steroids
- Undiagnosed chest symptoms e.g. haemoptysis
- Any condition which may be aggravated by forced expiration e.g. prior pneumothorax, history of myocardial infarction, stroke or embolism in the last 3 months, previous thoracic, abdominal or eye surgery
- Perforated ear drum
- Acute disorders such as nausea and vomiting
- Confusion, communication problems

COMMON ERRORS IN SPIROMETRY TESTING[6]

- **Poor seal around mouthpiece**
- **Hesitation or false start**
- **Early termination of exhalation: a 'short blow' which has not achieved the full FVC**
- **Poor intake of breath**
- **Poor forced expiratory effort**
- **Cough during procedure**
- **Incorrect data entered into the spirometer prior to testing**
- **Spirometer not calibrated and verified**

Adjusting Caucasian reference values to other ethnic groups. To apply these, multiply the FEV_1 and FVC by the factors below[6]

Population	FEV_1	FVC
Hong Kong Chinese	1.0	1.0
Japanese American	0.89	-
Polynesian	0.9	0.9
North Indian and Pakistani	0.9	0.9
South Indian, African	0.87	0.87

The guidance provided on this wall chart has been adapted from the following resources and publications:-

1. National Institute for Health and Care Excellence. Management of chronic obstructive pulmonary disease (COPD) in adults in primary and secondary care (partial update) 2010 http://www.nice.org.uk/CG101
2. British Thoracic Society – Scottish Intercollegiate Guideline Network. British Guideline on the Management of Asthma. *Thorax* 2008;**63**(Suppl 4): 1-121 Last Update October 2014. Available from https://www.brit-thoracic.org.uk/guidelines-and-quality-standards/asthma-guideline/
3. Spirometry PCRS-UK opinion Sheet Number 1, version 5. 2012. Available at https://www.pcrs-uk.org/resource/Opinion-sheets/spirometry-opinion-sheet
4. A guide to performing quality assured diagnostic spirometry. 2013 Primary Care Commissioning. Available at http://www.pcc-cic.org.uk/article/guide-quality-assured-diagnostic-spirometry
5. Mark L Levy, Philip H Quanjer, Booker Rachel, Brendan G Cooper, Stephen Holmes & Iain R Small. Diagnostic Spirometry in Primary Care: Proposed standards for general practice compliant with American Thoracic Society and European Respiratory Society recommendations. A Primary Care Respiratory Society UK (PCRS-UK) document, in association with the Association for Respiratory Technology & Physiology (ARTP) and Education for Health. *Prim Care Respir J.*2009;**18**:130–147. http://dx.doi.org/10.4104/pcrj.2009.00054
6. Spirometry in COPD Protocol. Primary Care Respiratory Society UK 2010. Available at https://www.pcrs-uk.org/resource/Nurse-tools/pcrs-uk-protocol-spirometry-copd-pdf

Further Information for Patients
http://patient.info/health/spirometry-leaflet
http://www.artp.org.uk/en/patient/lung-function-tests/pretest-info.cfm

http://www.pcrs-uk.org

Join the PCRS-UK http://www.pcrs-uk.org/join

The cost effective way to ensure you are delivering high value patient centred respiratory care

- Easy access to a wealth of online resources - written by primary care experts for primary care clinicians: saving you time and ideal tools to use with your respiratory team
- Primary Care Respiratory Update, the PCRS-UK members publication bringing you an overview of the latest respiratory research and policy as well as commentary on the latest developments and examples best practice
- Electronic membership mailings and news alerts making it easy to keep up to date
- Support with your own professional development
- Access to a friendly community of like minded peers passionate about respiratory care
- Access to exclusive member-only events
- Annual membership just £59 inclusive of VAT - plus huge savings on registration for our annual national primary care conference

It pays to join if you are a respiratory lead for your practice or a respiratory healthcare professional working in the community!

Contact **info@pcrs-uk** to find out about discounts available to CCGs/ health boards, community teams or other groups wishing to buy 10+ memberships

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See http://www.pcrs-uk.org/sites/pcrs-uk.org/files/files/PI_funding.pdf for PCRS-UK statement on pharmaceutical funding.

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