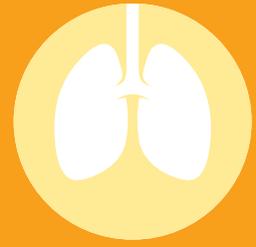


Asthma

& Lung Function Tests



An information paper for health professionals



FOR HEALTH PROFESSIONALS

Spirometry

Spirometry is an objective and reproducible test of lung function. It measures how quickly full lungs can be emptied and the total volume of air expired.

The most important measurements obtained from the spirometry test are FEV₁ (forced expiratory volume in one second) and FVC (forced vital capacity). The FEV₁ is the volume expired in the first second of maximal expiration initiated at full inspiration, and is one measure of airway calibre.¹ FVC is the maximum volume of air that can be expired during the test.

Spirometry is very safe to perform. Most adults and children 7 years of age and over can perform spirometry.² However, the test is physically demanding as it requires maximal patient effort that may cause transient breathlessness, oxygen desaturation, syncope and cough; and in poorly controlled asthma, can induce bronchospasm. As such, some contraindications to spirometry include myocardial infarction, angina, aneurysms, recent eye, thoracic or abdominal surgery, and pulmonary embolism.³⁻⁵

Spirometry is the lung function test of choice for diagnosing asthma and assessing asthma control in response to treatment. In contrast, case-series studies have shown that the measurement of peak expiratory flow (PEF), especially with conventional peak flow meters, has significant limitations.^{2,6,7}

While spirometry's role in diagnosis and assessment is well established,^{2,8} its optimal role in the management of asthma is an area of ongoing investigation and debate. There are few published studies that specifically examine the outcomes of routinely measuring spirometry in patients with asthma.^{9,10}

A randomised controlled trial suggests that the use of spirometry alone is not sufficient to guide management effectively;⁹ symptom patterns and other patient-centred outcomes should also be considered.^{11,12}

For further guidance on the use of spirometry in asthma management, see the latest edition of the Asthma Management Handbook (nationalasthma.org.au).

How do I get the best results?

Trained staff

Staff performing spirometry tests should be properly trained, as untrained (or poorly trained) staff are a major cause of poor-quality spirometry.¹³ For information on training courses, see *Spirometry Resources*.

Correct patient technique (open circuit method)

Correct patient technique and cooperation is essential for accurate results.⁵

1. Explain clearly to patients what the test involves, and demonstrate the correct technique to them
2. Emphasise that the test requires the deepest possible inspiration (to fully inflate the lungs) immediately followed by a maximum forced expiration until no more air can be exhaled
3. The expiration must be rapid and complete with maximal effort maintained throughout
4. Vigorous verbal encouragement and coaching is essential for the patient to continue exhaling until the end of the manoeuvre (e.g. "keep going")
5. It is also important to ensure that a good seal around the mouthpiece is maintained, and that the patient is seated and encouraged to remain upright during the test. The use of a nose clip is recommended.^{1,4,14}

Why do spirometry?

Spirometry is mainly used in medical practice to detect and quantify the degree of airflow obstruction. The diagnosis of asthma is confirmed by demonstrating the presence of variable airflow obstruction. Accurate measurement of lung function is also necessary to assess and manage asthma.

Successive measurements before and after bronchodilator use allow you to:

- diagnose and assess changes in airflow obstruction
- measure the degree of airflow obstruction and its variability
- demonstrate the presence and reversibility of airflow obstruction to the patient
- provide objective feedback to the patient about the presence and severity of asthma
- determine if the patient can perceive or sense a change in airflow obstruction
- monitor the effects of treatment
- accurately back-titrate preventive medication to determine the minimum effective dose.²

Patient instructions (open circuit method⁵):

1. Sit upright in a chair with legs uncrossed and feet flat on the ground
2. Breathe in completely and rapidly
3. Pause for less than 1 second
4. Place spirometry mouthpiece in your mouth and close lips to form a tight seal
5. Breathe out as fast and as hard as possible, until your lungs are completely empty, or until you are unable to blow out any longer
6. Breathe in completely and rapidly again
7. Remove mouthpiece.

Best practice guidelines recommend that all doctors managing asthma should have access to and use a spirometer to assess, diagnose and monitor lung diseases affecting airway function.

Acceptable & repeatable results

At least three acceptable tests should be obtained, ideally with less than 150 ml variability for FEV₁ (and FVC) between the highest and second highest values.¹⁴

Features of an acceptable test include:

- a forced expiration that starts immediately after full inspiration
- a rapid start
- continuous maximal expiratory effort throughout the test (i.e. no stops and starts)
- no cough or premature termination.

The highest FEV₁ and FVC result from the three acceptable tests should be reported even if they come from separate blows. Usually no more than eight test attempts should be undertaken, as more attempts are unlikely to be successful due to patient fatigue.^{1,2,4,14}

Spirometry results should be expressed both as absolute values and as a percentage of predicted values (based on the patient's age, height, gender and ethnic origin).^{1,2,4}

Assessment of bronchodilator reversibility

To assess reversibility of airflow obstruction, repeat spirometry at least 10 minutes after administering a short-acting bronchodilator (e.g. four puffs of salbutamol via a spacer). A significant bronchodilator response is an increase in FEV₁ of at least 200 mL and by at least 12%.^{1,4,15}

The absence of reversible airflow obstruction does not exclude the diagnosis of asthma. Repeated measurements (perhaps combined with home measurement of PEF) and challenge tests are sometimes necessary to confirm the presence of asthma.² Challenge tests (e.g. mannitol, methacholine) may be particularly useful when occupational asthma is suspected or the person has not benefited from asthma treatment.² Challenge tests are best performed in a lung function laboratory.

Quality assurance

Accurate and reliable measurements of spirometry are very important otherwise comparison with reference normal values or previous tests would be meaningless; and there would not be any confidence that a given result, or change over time, is real. Those performing the spirometry tests require ongoing refresher courses to keep the quality at the required standard.

A spirometer maintenance and quality assurance regimen should be documented, including:

- regular cleaning
- calibration checks
- equipment maintenance to ensure that the spirometer is safe and operating correctly
- regular review to ensure ongoing test quality.¹⁴

Practical tips

Medicare billing

MBS item 11506 may be used to claim for a service that includes both the pre- and post-bronchodilator spirometry if you have documented the results in the patient's medical record. A printout of the results should be kept. Additionally, patients who have a chronic medical condition, including asthma, and who would benefit from a structured care approach, may be eligible for a GP Management Plan (MBS item number 721).

How can I do spirometry cost-effectively, and within a normal consultation?

When you become aware that the consultation concerns asthma and requires a spirometry test, the pre-bronchodilator spirometry can be done before finishing the history-taking. Give the bronchodilator, and use this opportunity to check inhaler technique.

Post-bronchodilator spirometry can be done after you have finished taking the history and examining the patient, and have started to outline a management plan – enough time should have elapsed by then. The consultation time would not be overly extended.¹⁶

In a longer consultation, the time between pre- and post-bronchodilator tests can be used to complete the written asthma action plan, or to provide other asthma education. Salbutamol works very quickly and valid results are obtained if the interval is at least 10 minutes.¹⁶

Other Suggestions:

- First, do the pre-bronchodilator spirometry, take the history, examine the patient and administer the bronchodilator. Then send the patient out and get the next patient in. When finished with the second patient, get the first patient back in. Do the post-bronchodilator spirometry and then consider the management plan for the patient
- Ask your spirometry trained practice nurse to do the spirometry, and then do the consultation following this
- Send the patient to your local respiratory laboratory service for testing. A respiratory laboratory will accurately calibrate their equipment each day and interpret the results for you
- Schedule a follow-up appointment specifically for spirometry
- See if the local hospital physiotherapy department or asthma educators are prepared to perform spirometry on request.¹⁶

I'm not confident with interpretation – is there an easy way?

A simple algorithm to help interpret spirometry results is shown in Figure 1.^{1,2,4} The FEV₁/FVC ratio is used to detect airflow obstruction and the FEV₁ is expressed as a percent predicted to grade severity. Additionally, respiratory diseases can alter the shape of the flow-volume curve (see Figure 2), and it is useful to learn how to recognise these.

A respiratory laboratory can also perform the test accurately and interpret the results for you.

Figure 1: A guideline for spirometry interpretation.

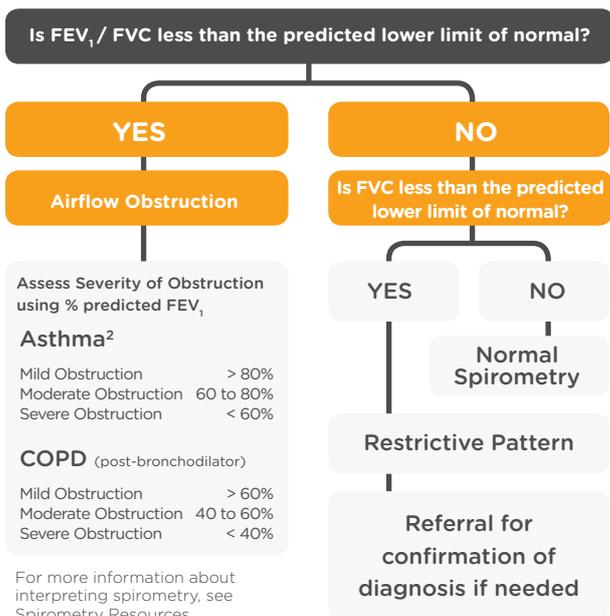
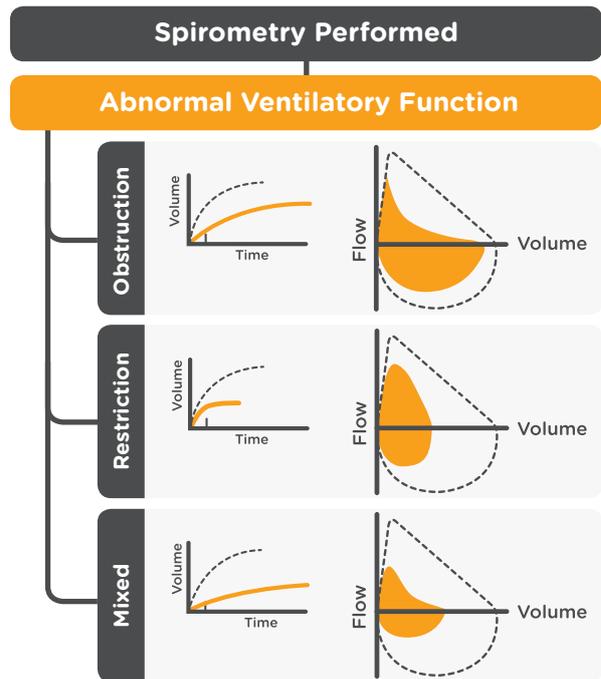


Figure 1: Lower limit of normal: An FVC test result (adjusted for age, gender and height) that is considered lower than what it should be for a person. Most modern spirometers will provide the lower limit of normal values based on the normal reference values.

When selecting a spirometer, consider:⁴

- its ease of use, and whether it comes with easy-to-follow instructions
- its accuracy (can it be calibrated or accuracy validated?)
- whether it meets the ATS/ERS* spirometer performance criteria¹³
- its robustness and reliability, and whether it has low maintenance requirements
- its ability to print out the results
- its ability to provide real-time graphic display of the manoeuvre and print the results
- whether its flow sensor is disposable or can be easily cleaned/disinfected
- whether the supplier can provide technical support and supplies
- its ability to link with clinical software
- its price (including consumables).

* American Thoracic Society/European Respiratory Society



Guidelines for spirometer infection control

Precautions must be taken to minimise any risk of cross-infection via the spirometer. The use of low resistance barrier filters significantly reduces the risk of cross-infection and helps to protect the equipment. These filters are for single patient use, so a *new* filter must be used for each patient.

Some spirometers use a single-patient-use disposable sensor or mouthpiece. Re-useable mouthpieces must be cleaned, disinfected and dried between patients. In the case of disposable mouthpieces, a *new* one must be used for each patient.

Peak Expiratory Flow

Peak expiratory flow (PEF) measures maximum expiratory flow occurring just after the start of a forced expiration from the point of maximum inspiration (total lung capacity).

A peak flow meter is used to detect and measure a person's variation from best PEF in order to assess variability of airflow obstruction.¹⁷

However, PEF measurement has significant limitations because it:

- is effort-dependent
- varies considerably between instruments
- has a wide range of 'normal' values.¹⁸

Therefore, PEF is not a substitute for spirometry when diagnosing asthma. In addition, single PEF measurements are not adequate for routine asthma management by doctors.¹⁹

When is PEF useful?

Despite its limitations, PEF monitoring by patients at home or work is useful when:

- symptoms are intermittent
- the patient finds it difficult to gauge asthma severity based on symptoms
- the diagnosis is uncertain
- monitoring treatment response.²

Short-term PEF monitoring may be useful following a recent diagnosis of asthma, a change in asthma treatment, or discharge from hospital. PEF readings may be recorded for 2–3 weeks. However, patient compliance with continual monitoring is an issue.

PEF can be valuable in patients who are poor perceivers of their asthma symptoms (*see below, under Practical tips*). A randomised controlled study suggests long-term regular PEF monitoring should be considered in persistent poor perceivers.²⁰

Overall, the role of PEF monitoring appears to be most useful in combination with symptom monitoring and regular review.

Are PEF-based asthma action plans useful?

A written asthma action plan for your patients may be symptom-based and/or PEF-based. However, a systematic review found there is clear evidence to support that symptom-based plans are superior to PEF-based ones in children and adolescents.²¹

Peak flow measurements are not reliable for children aged less than 6–7 years; and, during acute attacks, older children may not produce reliable measurements. Therefore, in young people, more attention should be given to asthma symptoms.

In older adults, one systematic review and two randomised controlled trials found no significant differences between symptom- and PEF-based plans.^{22,23,24} However, some older patients may also have difficulty producing reliable measurements, and can deliver very low peak flows.

Practical tips

How often is PEF measurement necessary?

In most situations, a morning PEF measurement before bronchodilator is an adequate test and guide. If using PEF to validate patients' symptoms, or confirm a diagnosis of asthma, more frequent measurements are required.

How can I identify poor perceivers?

Poor perceivers are patients who accept their chronic asthma symptoms as the norm, or do not recognise that they have symptoms. They live with under-treated asthma. This leads to poor quality of life and puts them at risk of severe attacks.

Check whether these patients are aware of symptom improvement when correlated with a bronchodilator response, measured either during formal lung function tests or PEF monitoring. Encourage regular, long-term self-monitoring in patients who fail to recognise symptom improvement with a 15% increase in FEV₁.

How can I encourage PEF measurement in appropriate patients?

Show your patients how to use a peak flow meter and chart their PEF. Be wary of common techniques that may produce falsely high results, such as coughing instead of blowing, and transient obstruction of the mouthpiece at the start of the blow, by the tongue or teeth.

Ask your patients to bring their own PEF meter to each consultation – this will ensure that home tests and tests taken in the clinic can be compared. Check the chart at each visit.

Discuss the benefits of PEF monitoring with your patients. Only ask the patient to continue if there is a benefit – in all but poor perceivers, explain that the monitoring period will be short-term, but can be episodic to provide you with information at reviews.

Other hand-held devices

Small hand-held devices that measure FEV₁ and/or FEV₆ could be useful in primary care in case-finding for COPD.^{2,6,25} and other airway obstruction. In relation to asthma, evidence is limited; further investigation is needed to establish usefulness.

Hand-held devices are also becoming available for home use; however, as these devices are relatively new and continuously evolving their role in asthma self-management needs further investigation.

You would not consider managing hypertension without a sphygmomanometer, or diabetes without a glucometer. Evidence suggests accurate and objective assessment and management of asthma is not possible without a spirometer.^{2,17,26}

Spirometry Resources

A wide range of resources on spirometry are available via the National Asthma Council Australia, including:

- Spirometer Users' and Buyers' Guide – a guide to selecting a spirometer including a summary of the specifications, features and suppliers of the main spirometers on the Australian market, plus general information about the measurement and application of spirometry in the primary care clinical setting
- Spirometry Handbook [Spirometry: The measurement and interpretation of ventilatory function in clinical practice] – an introductory guide for those involved in the performance and interpretation of spirometry in primary care
- Pocket Guide to Spirometry, 3rd edition – detailed guide to spirometry, including what a spirometer is, how to use one, how to interpret test results and the different types of spirometers
- Performing Spirometry in Primary Care – video demonstrating correct technique for performing spirometry on a patient in primary care
- Spirometry Training Course – comprehensive training for GPs and practice nurses in the application, measurement and interpretation of spirometry in general practice

For details, visit: nationalasthma.org.au

Acknowledgements

This information paper was prepared in consultation with the following health professionals:

Professor John Upham, respiratory physician and clinical scientist
Associate Professor Debbie Burton, respiratory scientist
Associate Professor David P. Johns, respiratory scientist
Dr Steven Rudolph, general practitioner
Ms Marg Gordon, asthma educator
Ms Judi Wicking, asthma educator
And with the assistance of Ms Lesh Karan, medical writer.

Supported through funding from the Australian Government Department of Health and Ageing

To access more brochures in this series visit the National Asthma Council Australia: nationalasthma.org.au

Publication Recommended citation:
National Asthma Council Australia. *Asthma and Lung Function Tests*. Melbourne, National Asthma Council Australia, 2012.

Further Information

Visit the National Asthma Council Australia website at: nationalasthma.org.au

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