

# SPIROMETRY IN PRACTICE

*A PRACTICAL GUIDE TO USING SPIROMETRY IN PRIMARY CARE*

Second Edition



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Original quotations reflect the personal experiences of four practitioners (Sue Hill, Kay Holt, Jacqui Jennings, Liz Wiltshire).

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# SPIROMETRY IN PRACTICE

## A PRACTICAL GUIDE TO USING SPIROMETRY IN PRIMARY CARE

Spirometry is fundamental to making a confident diagnosis of COPD,<sup>1</sup> yet research has shown that it has been under-utilised.<sup>2</sup>

Many doctors and nurses have been apprehensive about using spirometry in their day-to-day practice. They regarded it as time-consuming, and they lacked confidence about the interpretation of the results. The first edition of this booklet was produced by the British Thoracic Society (BTS) COPD Consortium to encourage use of spirometry by:

- providing information on how to perform spirometry
- explaining the interpretation of spirometry results
- giving practical examples and case studies
- explaining the importance of spirometry in the management of COPD
- using quotes from nurses which reveal their personal experiences of spirometry.

This second edition has been revised to incorporate recommendations on the use of spirometry in the NICE guideline on COPD.<sup>1</sup>

Keep this booklet handy so that you can refer to it at any time when you are considering spirometry and normal lung function. It is meant to be a working reference. As you get more confident, you may wish to learn more about spirometry, and information is provided about training courses and qualifications.

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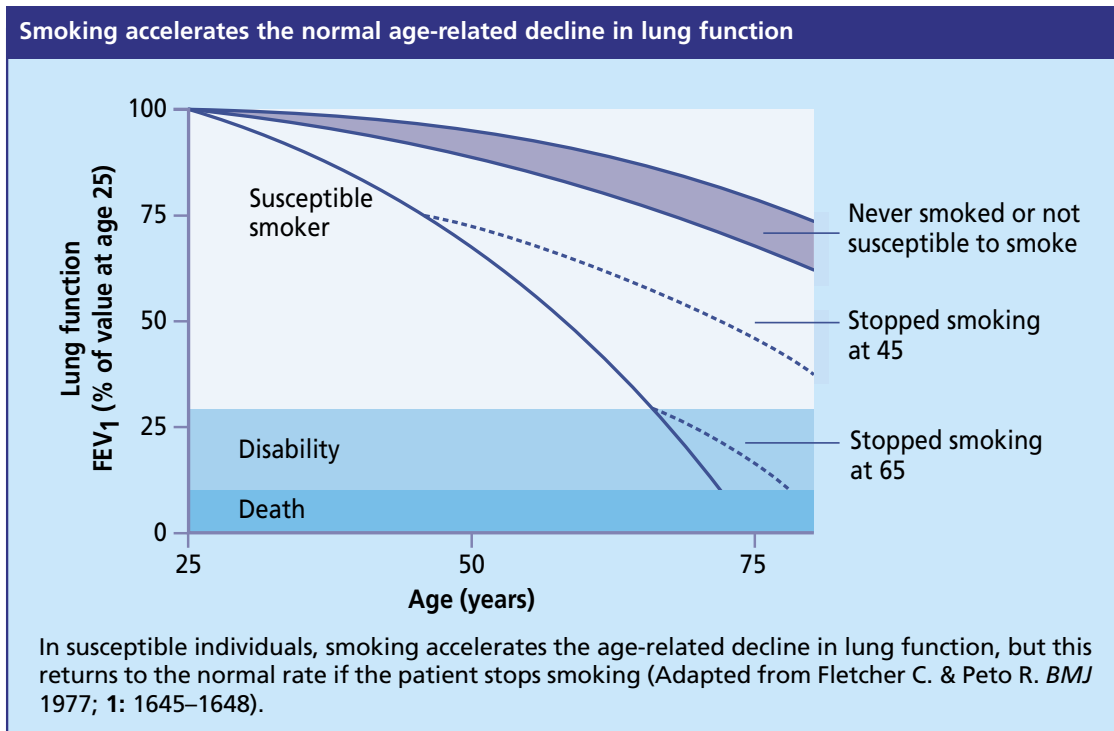
## INTRODUCTION TO SPIROMETRY

### CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

The guidelines from the National Institute for Clinical Excellence (NICE) 2004 define COPD as characterised by airflow obstruction.<sup>1</sup> The airflow obstruction is usually progressive, not fully reversible and does not change markedly over several months. COPD is a spectrum of disorders which include chronic bronchitis and emphysema. Approximately 900,000 people in England and Wales were identified as suffering from COPD in 1999.<sup>3</sup> As many patients go undiagnosed, a more accurate figure would be at least twice this number. COPD is a major cause of mortality. In 1999 there were 30,000 deaths from COPD, almost 20 times the number that died as a result of asthma.<sup>3</sup>

The major cause of COPD is tobacco smoking.<sup>1</sup> In susceptible individuals, smoking accelerates the normal age-related decline in lung function. Although smoking causes irreversible structural changes, cessation allows the rate of decline in lung function to return to that of a non-smoker. Early identification of COPD enables targeting of smoking cessation advice and so may prevent progression of this potentially fatal disease.

How do you make a diagnosis of COPD? You should consider the diagnosis of COPD in patients aged over 35 years who smoke or have smoked, and have appropriate chronic symptoms of breathlessness, cough and sputum. The diagnosis is confirmed by demonstrating airflow obstruction using spirometry. Peak flow meters, whilst excellent for monitoring asthma, are of limited value in COPD diagnosis as the readings may underestimate the extent of lung impairment. NICE and all international guidelines recommend the use of spirometry to confirm the diagnosis and assess the level of severity in COPD.<sup>1,4</sup>



“ *I became aware of the need for a spirometer...  
To be able to identify much earlier those patients  
who may be susceptible, improve smoking cessation  
rates and improve quality of life.* ”



*The major cause of COPD  
is smoking*

## **SPIROMETRY**

Spirometry is a method of assessing lung function by measuring the volume of air that the patient is able to expel from the lungs after a maximal inspiration. It is a reliable method of differentiating between obstructive airways disorders (e.g. COPD, asthma) and restrictive diseases (where the size of the lungs is reduced, e.g. fibrotic lung disease). Spirometry is the most effective way of determining the severity of COPD. However, other measures such as the MRC dyspnoea scale<sup>1</sup> and quality of life assessment forms a more complete picture. Severity cannot be predicted from clinical signs and symptoms alone.

There are spirometers in about 70–80% of practices in the UK and their use is increasing, particularly since changes to the GMS primary care contract introduced in April 2004. Practice nurses predominantly perform the tests but many lack confidence in carrying out the procedure or in the interpretation of the results.<sup>2</sup> Accurate spirometry can only be performed with appropriate training. Most nurses and GPs request more help in carrying out and interpreting spirometry.<sup>2</sup> The purpose of this booklet is to meet that need.

## GETTING STARTED

“ Aiming for small improvements in patient care, initially, is realistic and it is something to build on. ”

The onset of COPD is slow and insidious, and significant airflow obstruction may be present before the individual is aware of it. When symptoms do appear, patients frequently accept them as a consequence of smoking, and do not seek help from a doctor. A major advantage of spirometry is that it enables you to detect COPD before symptoms become apparent. Early identification and persuading patients to stop smoking may mean minimal disease progression and a long-term improvement in quality of life.

### IDENTIFYING PATIENTS FOR SPIROMETRY

While guidelines recommend that primary care practitioners should strive to identify patients with early disease, including all current and ex-smokers who are over 35 years of age, this may not be practicable if you are just starting or expanding the service in your practice.

Many practices will want to start with an opportunistic approach. This means identifying individual patients who may have early disease and, in doing so, you will build up your proficiency and confidence in the use of spirometry. You may notice patients in the asthma clinic with symptoms suggestive of COPD (e.g. recurrent chest infections, productive cough, increasing breathlessness). Lifelong, heavy smokers who are over the age of 35 years and patients whose occupations may expose them to respiratory irritants, such as fumes and dusts, carry a considerable risk of developing COPD. All of these patient types are suitable candidates for you to consider for early assessment of lung function with the use of spirometry.

### TRAINING

Training is an important issue for every healthcare professional. The help and advice of experienced colleagues can be extremely helpful in getting started with spirometry. It is also widely accepted that healthcare professionals will benefit from attending a recognised course that includes professional tuition on the practical application of spirometry and the correct interpretation of the results.

The NICE guideline recommends that all healthcare professionals managing patients with COPD should be competent in the interpretation of the results of spirometry and all healthcare professionals performing spirometry should have undergone appropriate training and should keep their skills up to date.<sup>1</sup>

“ The training gave me the knowledge and motivation to try to improve the health and quality of life for these patients, and it taught me there was actually a lot we could do for them. ”

### ARTP/BTS certificate in spirometry

The Association for Respiratory Technology and Physiology (ARTP), in conjunction with the BTS, assesses the competence of practitioners to perform spirometry. To receive the qualification (a Certificate of Competence), candidates are required to achieve a satisfactory standard in a practical examination, an oral examination and an assignment. The Certificate of Competence is valid for 2 years. Registration for assessment currently costs £100 (or £130 with handbook) and re-issue of the certificate after 2 years (subject to continued portfolio assessment) is £15.

Further details and a list of approved training centres are available from:

Jackie Hutchinson, ARTP Administrator, c/o The Association for Respiratory Technology and Physiology, Suite 4, Sovereign House, 22 Gate Lane, Boldmere, Birmingham, B73 5TT  
Tel: 0121 354 8200 Fax: 0121 355 2420 email: admin@ARTP.org.uk www.artp.org.uk

### COPD training courses which include spirometry

#### **National Respiratory Training Centre**

The Athenaeum, 10 Church Street, Warwick CV34 4AB  
Tel: 01926 493313 Fax: 01926 493224 email: enquiries@nrtc.org.uk www.nrtc.org.uk

#### **Respiratory Education and Training Centre (RETC)**

Unit 48, Ninth Avenue, Lower Lane, Liverpool L9 7AL  
Tel: 0151 529 2598 Fax: 0151 529 3943

#### **Primary Focus – Practical Training for Primary Care**

Brackenrigg, Rannoch Road, Crowborough, East Sussex TN6 1RA  
Tel: 01892 661339 Fax: 01892 610368

### Spirometer manufacturers

Instruction and advice on correct use of a spirometer, and sometimes training courses, are often available as a service from the manufacturers themselves. If you are buying a new spirometer, check to see if this service is available: it may even be free-of-charge.

Two of the major manufacturers in the UK are:

#### **Micro Medical Ltd**

PO Box 6, Rochester, Kent ME1 2AZ  
Tel: 01634 893500 Fax: 01634 893600  
www.micromedical.co.uk

#### **Vitalograph Ltd**

Maids Moreton, Buckinghamshire MK18 1SW  
Tel: 01280 827110 Fax: 01280 823302  
www.vitalograph.co.uk

## RECOGNISING COPD

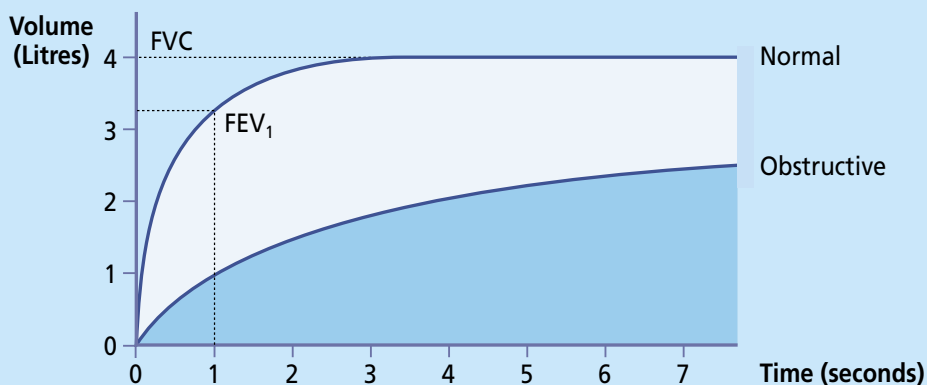
COPD causes significantly more adult mortality and morbidity than asthma.<sup>1</sup> As a progressive disease, COPD passes through mild and moderate phases before becoming severe. A patient who first presents with severe COPD is one who has not been identified at an earlier stage of the disease. Most patients do not present clinically until they have moderate or severe levels of disease. Identifying COPD as early as possible and stopping patients from smoking could, therefore, make a substantial difference to the disease burden. Some indicators, which will suggest further investigation is warranted, include:

- a history of chronic, progressive symptoms of cough, wheeze and breathlessness
- a history of smoking in patients over 35 years of age
- frequent exacerbations of bronchitis.

Spirometry can confirm the presence of COPD, even in mild or moderate stages. COPD is characterised by airflow obstruction which does not change markedly over several months. The impairment of lung function is not fully reversed by bronchodilator or other therapy.

The NICE guideline recommends that spirometry should be performed at the time of diagnosis.

### Forced Expiratory Volume in 1 second (FEV<sub>1</sub>) and Forced Vital Capacity (FVC)



- **Spirometry gives three important measures:**
    - FEV<sub>1</sub>: the volume of air that the patient is able to exhale in the first second of forced expiration
    - FVC: the total volume of air that the patient can forcibly exhale in one breath
    - FEV<sub>1</sub>/FVC: the ratio of FEV<sub>1</sub> to FVC expressed as a percentage
  - **Spirometry can also be used to measure:**
    - VC: slow vital capacity
    - FEV<sub>1</sub>/VC: the ratio of FEV<sub>1</sub> to the slow vital capacity
  - Values of FEV<sub>1</sub> and FVC are expressed as a percentage of the predicted normal for a person of the same sex, age and height
  - **COPD can be diagnosed only if FEV<sub>1</sub> <80% predicted and FEV<sub>1</sub>/FVC <0.7 (70%)**  
The severity of the airflow obstruction in COPD is indicated by the extent of FEV<sub>1</sub> reduction
  - Asthma may show the same abnormalities on spirometry as COPD – if there is diagnostic doubt spirometry following reversibility testing may be used to identify asthma
- N.B. Predicted values may be lower in non-caucasians.



### Signs and symptoms of COPD

Spirometry is a poor predictor of durability and quality of life in COPD, but as well as confirming diagnosis spirometry can be used as part of the assessment of severity. Many treatment decisions are influenced by the severity of airflow obstruction. The NICE COPD guideline definitions are as follows:

- **mild airflow** obstruction as FEV<sub>1</sub> between 50–80%
- **moderate airflow** obstruction as FEV<sub>1</sub> between 30–49%
- **severe airflow** obstruction as FEV<sub>1</sub> <30% predicted

These values have changed from the previous BTS COPD guideline values.

### COPD OR ASTHMA?

Slowly progressive respiratory symptoms in a middle-aged or elderly smoker are likely to indicate COPD. However, such patients may also have asthma. Patients whose symptoms started before the age of 35 years are more likely to be asthmatic, particularly if they are non-smokers with symptoms that vary in severity. Serial peak flow monitoring, looking for diurnal variation of greater than 20%, may help to differentiate these conditions. The NICE guidelines suggest that bronchodilator reversibility testing is not routinely used where the clinical features and spirometry strongly indicate COPD. If there is any doubt, reversibility testing can be performed at a clinic visit (>400mL response to bronchodilator) or after a 2 week trial of prednisolone 30mg daily. Alternatively, spirometric and clinical response to a month's trial of bronchodilator therapy can be assessed. Reversibility testing is not a 'gold standard' and the results must be interpreted alongside the clinical history.

#### Clinical features differentiating COPD and asthma

	COPD	Asthma
Smoker or ex-smoker	Nearly all	Possibly
Symptoms under age 35 years	Rare	Often
Chronic productive cough	Common	Uncommon
Breathlessness	Persistent and progressive	Variable
Night time waking with breathlessness and/or wheeze	Uncommon	Common
Significant diurnal or day to day variability of symptoms	Uncommon	Common

#### Reversibility testing

Bronchodilator	Asthma	FEV <sub>1</sub> before and after
salbutamol	2.5–5mg (nebuliser) 200–400mcg (large volume spacer)	20 minutes
terbutaline	5–10mg (nebuliser) 500mcg (large volume spacer)	20 minutes
ipratropium bromide	500mcg (nebuliser) 160mcg (large volume spacer)	45 minutes

## USING A SPIROMETER

### TYPES OF SPIROMETER

There are many different types of spirometer with costs varying from £300 to over £3000.

- The simplest hand-held spirometers produce FEV<sub>1</sub> and FVC readings, which you then need to compare with predicted normal values (see tables, pages 22–23).
- More advanced spirometers produce traces (i.e. visual display or print-out) of the volume of air exhaled over time, the volume-time curve, so you can see how well the patient has carried out the manoeuvre (see page 11). If your spirometer has a memory facility, you may also be able to store the trace.
- Many electronic spirometers also display a flow-volume curve (see page 14). You do not need this information to calculate FEV<sub>1</sub> and FVC values for your patient, so it is not necessary to use this facility when you are new to spirometry.
- Most spirometers calculate the percentage of the predicted normal values because they have reference data already programmed into them. You have to enter details of the patient's sex, race, age and height.
- Spirometers are designed for use in all types of lung disease and not just COPD. Some spirometers will provide a report on lung function results including comments such as normal, obstructive and restrictive defects. They may also comment on severity of disease, though not necessarily corresponding to the NICE COPD classifications (i.e. actual FEV<sub>1</sub>% predicted values need to be studied to provide the correct severity levels).



## PREPARING THE PATIENT

Ensure that the patient is comfortable, in particular that they are seated (in case they experience any faintness or syncope during the procedure). Begin by explaining the purpose of the test. Many healthcare professionals find it useful to demonstrate the correct technique before inviting the patient to use a spirometer for the first time. It helps if the patient has some practice attempts before the readings are taken. Encourage the patient to keep blowing out so that maximal exhalation can be achieved. Limit the total number of attempts (practice and for recording) to eight or less at each session.

## WHAT INFORMATION IS NEEDED?

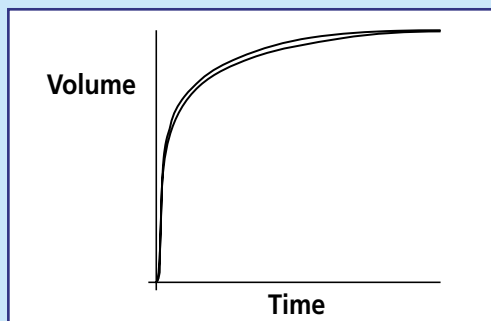
Make a record of the patient's sex, age and height. This is needed so the FEV<sub>1</sub> and FVC can be compared with predicted normal values. Your spirometer may perform the calculations, or you may need to do these yourself, using the tables at the end of this booklet. You will need to adjust the normal values if your patient is of Asian or Afro-Caribbean origin (see pages 22–23). You should make a note of any information that may aid interpretation of the results (e.g. if the patient is suffering an exacerbation or has recently taken a bronchodilator).

## MEASURING FEV<sub>1</sub> AND FVC

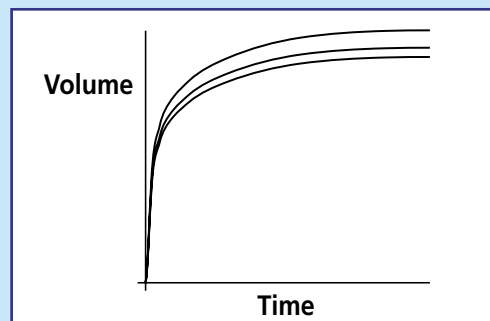
- Attach a clean, disposable, one-way mouthpiece to the spirometer (a fresh one for each patient).
- Ask the patient to breathe in as deeply as possible (full inspiration).
- The patient should hold their breath just long enough to seal their lips. The patient should NOT purse their lips as if blowing a trumpet, and ideally should pinch their nose or wear a nose clip.
- The patient should now blow the breath out, forcibly, as hard and as fast as possible, until there is nothing left to expel:
  - for patients with severe COPD this can take up to 15 seconds
  - encourage the patient to keep blowing out
  - some spirometers give a bleep to confirm the manoeuvre is complete.
- Now repeat the procedure, and then repeat it again.
- You should have three readings of which the best two are within 100ml, or 5%, of each other.
- Depending on your model of spirometer the results may appear on a display (which you may be able to store against the date and time) or may be printed.

### Inconsistent and consistent volume-time curves

Three consistent volume-time curves are required of which the best two curves are within 100ml or 5% of each other.



**Consistent:** Three acceptable and consistent traces.



**Inconsistent:** Although each trace is technically acceptable, they are inconsistent.

## INTERPRETING THE RESULTS OF SPIROMETRY

Take the best of the three consistent readings of FEV<sub>1</sub> and FVC. Find the predicted normal values for FEV<sub>1</sub> and FVC for your patient. Some machines may calculate this for you once you have entered the patient's sex, age and height. Alternatively you can calculate the percentage of the predicted normal values for your patient, by referring to the tables at the end of the booklet. The example below shows you this calculation.

If the results obtained are borderline normal, accept that there may be a level of uncertainty about the diagnosis and repeat the tests again in a few months. This is particularly true in older patients over 75 years where tables of predicted values are less accurate.

Calculating percentage of predicted values			
<b>Patient: 45 year old woman, height 5'3"</b>			
FEV <sub>1</sub>	Reading	$\frac{1.43}{2.60}$	x 100% = 55% of predicted normal
	Predicted value	2.60	
FVC	Reading	$\frac{2.5}{3.03}$	x 100% = 82.5% of predicted normal
	Predicted value	3.03	
$\frac{FEV_1}{FVC}$	Reading	$\frac{1.43}{2.5}$	= 0.57
	Reading	2.5	
Interpretation: patient has mild airflow obstruction as FEV <sub>1</sub> is between 50% and 80% of predicted normal and FEV <sub>1</sub> /FVC is <0.7.			

Identifying abnormalities	
<p><b>Spirometry indicates the presence of an abnormality if any of the following are recorded:</b></p> <ul style="list-style-type: none"> <li>• FEV<sub>1</sub> &lt;80% predicted normal</li> <li>• FVC &lt;80% predicted normal</li> <li>• FEV<sub>1</sub>/FVC ratio &lt;0.7</li> </ul> <p><b>Obstructive disorder:</b></p> <ul style="list-style-type: none"> <li>• FEV<sub>1</sub> reduced (&lt;80% predicted normal)</li> <li>• FVC is usually reduced but to a lesser extent than FEV<sub>1</sub></li> <li>• FEV<sub>1</sub>/FVC ratio reduced (&lt;0.7)</li> </ul> <p><b>Restrictive disorder:</b></p> <ul style="list-style-type: none"> <li>• FEV<sub>1</sub> reduced (&lt;80% predicted normal)</li> <li>• FVC reduced (&lt;80% predicted normal)</li> <li>• FEV<sub>1</sub>/FVC ratio normal (&gt;0.7)</li> </ul>	

## MEASURING VITAL CAPACITY (VC)

The VC is a non-forced measurement and is often greater than the FVC in COPD. It gives a more accurate measure of lung volume when airways are floppy, as in emphysema. It is often measured at the start of the session to familiarise the patient with the equipment.

- Attach a clean, disposable, one-way mouthpiece to the spirometer (a fresh one for each patient).
- Ask the patient to breathe in as deeply as possible (full inspiration).
- The patient should hold their breath just long enough to seal their lips. The patient should NOT purse their lips as if blowing a trumpet, and ideally should pinch their nose or wear a nose clip.
- Breathe out steadily at a comfortable pace.
- Continue until expiration is complete.
- Repeat.
- The NICE guideline states that the measurement of slow VC may allow the assessment of airflow obstruction in patients who are unable to perform a forced measurement to full exhalation.

“ Often it is a matter of helping people to understand their condition, and showing them that it is possible to do things to help themselves and to regain some quality of life. ”

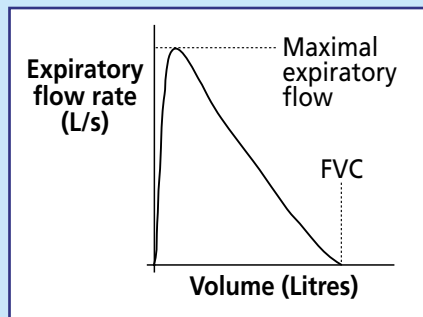
## FLOW-VOLUME MEASUREMENT

Basic spirometry measures the volume of air forcibly exhaled over a time period, allowing calculation of % predicted FEV<sub>1</sub> and FVC from the resulting volume-time curve produced. Obtaining and interpreting volume-time curves was covered on pages 8–11. As you become more experienced with spirometry, you may want to use other features of your spirometer.

Many electronic spirometers can measure expiratory flow plotted against the volume of air exhaled. The trace produced is called a flow-volume curve. The overall shape of the flow-volume curve is helpful for detecting airflow obstruction at an early stage, and yields additional information to the volume-time curve. However, interpretation of the flow-volume curve must take into account the values of FEV<sub>1</sub> and FVC (as a % of predicted normal).

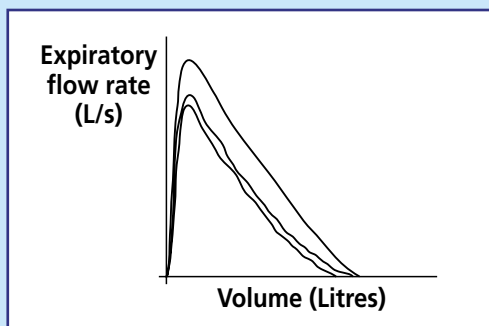
### Normal flow-volume curves

On exhalation, there is a rapid rise to the maximal expiratory flow followed by a steady, uniform decline until all the air is exhaled.

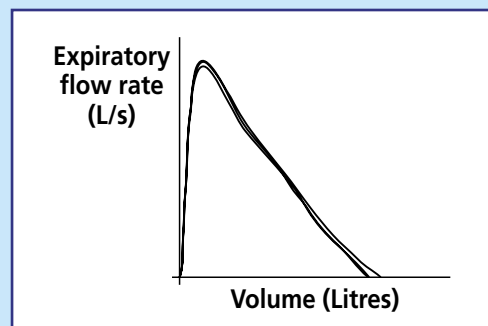


### Inconsistent and consistent flow-volume curves

As with volume-time curves, three consistent flow-volume curves are required.



**Inconsistent:** Although each trace is technically acceptable, they are inconsistent.



**Consistent:** Three acceptable and consistent traces.

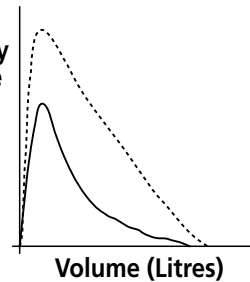
“ I have been pleasantly surprised at how many patients who have been heavy smokers for many years, and whose spirometry is not good, have stopped smoking completely within a few weeks of seeing me. Many of them comment that no one before has taken the time to explain in detail the physiology of emphysema and the effect it has on their respiratory function. ”

## Identifying abnormalities with flow-volume curves

### Obstructive disorder:

In this example of a patient with obstructive airways disease, the peak expiratory flow (PEF) is reduced and the decline in airflow to complete exhalation follows a distinctive dipping (or concave) curve.

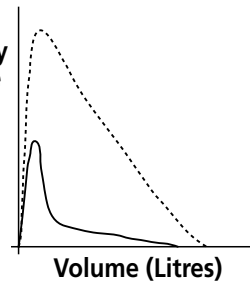
Expiratory  
flow rate  
(L/s)



### Severe obstructive disorder:

In a severe airflow obstruction, particularly with emphysema, the characteristic 'steep pattern' is seen in the expiratory flow trace.

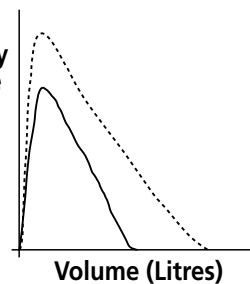
Expiratory  
flow rate  
(L/s)



### Restrictive disorder:

The pattern observed in the expiratory trace of a patient with restrictive defect is normal in shape but there is an absolute reduction in volume.

Expiratory  
flow rate  
(L/s)



## MAINTAINING ACCURACY

The most common reason for inconsistent readings is patient technique. Errors may be detected by observing the patient throughout the manoeuvre and by examining the resultant trace. Common problems include:

- inadequate or incomplete inhalation
- lack of blast effort during exhalation
- additional breath taken during manoeuvre
- lips not tight around the mouthpiece
- a slow start to the forced exhalation
- exhalation stops before complete expiration
- some exhalation through the nose
- coughing.

Good care and maintenance of your spirometer will help to provide accurate and reproducible results. Spirometers should be kept clean, and accuracy checked regularly in accordance with the manufacturers recommendations. Some spirometers can be calibrated with a large volume syringe while in others accuracy can be checked in this way but recalibration would need to be adjusted by the manufacturer.

The NICE guideline emphasises the importance of maintaining accuracy and recommends that spirometry services should be supported by quality control processes.



*The most common reason for inconsistent readings is patient technique*





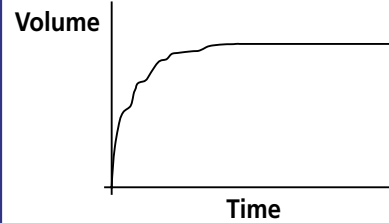
*Spirometry is needed to identify mild disease as peak flow meters only show the flow rate from larger airways, whereas COPD is damage in the smaller airways.*



### Identifying abnormalities

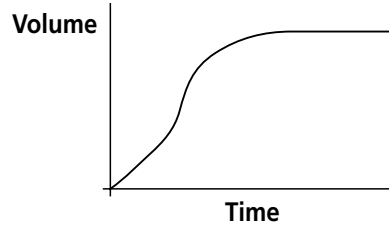
#### Coughing during exhalation

The trace reveals an abrupt cessation of exhalation (shown by a small drop in flow) and a short intake of air associated with the start of the cough. This is followed by an irregular pattern to the exhalation.



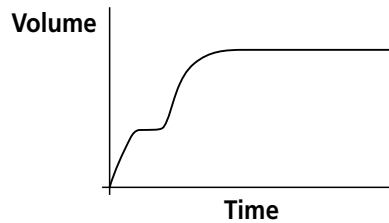
#### Slow start to forced exhalation

There is a marked increase in the force of exhalation a short time after the start of the manoeuvre, shown by the steep change in gradient on the trace.



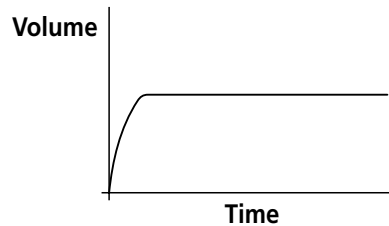
#### Extra breath taken during the manoeuvre

The extra breath is revealed by the abrupt, short plateau which can be seen on the trace shortly before the total expiratory volume is reached; following the extra breath, the total volume of air expelled is clearly seen to be greater than it would have been with only the original exhalation.



#### Early stoppage of the manoeuvre

Following a normal, uniform start to the manoeuvre, the trace reaches a plateau abruptly.



## SPIROMETRY IN PRACTICE

To demonstrate how the results of spirometry can be interpreted to identify accurately the respiratory condition concerned and the most appropriate course of action, here are four illustrative case histories.

### 1. MARION, COOK, AGED 55 YEARS



Marion started smoking in her mid-20s and has since smoked 30 cigarettes a day. Marion is aware that she is not as fit as she used to be. She cheerfully jokes about “old age creeping on” and uses that excuse to avoid anything too strenuous. Marion copes at work by pacing herself carefully and delegating the heavier jobs to a younger colleague. She became aware of increasing dyspnoea when her daughter and grandchildren came to visit. Breathlessness prevented Marion from keeping up during a walk with the family, and her daughter insisted that she see her doctor. Marion has no evidence of heart disease and no other symptoms apart from a “smoker’s cough”.

On the basis of the history a provisional clinical diagnosis of COPD was made. Marion’s examination included spirometry measurements. These showed a reduced FEV<sub>1</sub> and FVC with a ratio of 0.55 confirming the presence of airflow obstruction.

Spirometry	Interpretation
FEV <sub>1</sub> = 1.39 (56% predicted)	Reduced
FVC = 2.53 (86% predicted)	Normal
FEV <sub>1</sub> /FVC ratio = 0.55	Reduced

### CONCLUSION

Spirometry showed mild obstruction, and a firm diagnosis of COPD was made. Marion was surprised to discover that smoking was the cause of her symptoms and, with support from the nurse, set a date for giving up. Her doctor suggested that a bronchodilator inhaler ( $\beta$ 2-agonist or anticholinergic) might help to improve exercise tolerance. Bronchodilators work by reducing air trapping and the work of breathing.

“ It was really gratifying when a lady of 50 years ...  
felt able to go on holiday for the first time in 5 years. ”

## 2. RONALD, A RETIRED BRICKLAYER, AGED 69 YEARS



Ronald has had a bad chest for years. Like most of his friends, Ronald started smoking when he was in the army. Cigarettes were cheap, socially acceptable and it was even considered they may be "good for you". For many years after leaving the army, Ronald smoked up to 40 cigarettes a day. Since retiring from work 15 years ago on health grounds (he had been getting too breathless for the demands of bricklaying) he had enjoyed working in his garden and helping the family with DIY projects.

Ronald has had, for some time, a productive cough and for some years has needed courses of antibiotics for winter chest infections. Recently, however, even light jobs have been proving too demanding. He has started to spend less and less time in the garden and in his workshop, and his wife now complains that he is always "under her feet".

At a visit to the surgery, Ronald was observed to be cyanosed and his lung function was assessed by spirometry.

Spirometry	Interpretation
FEV <sub>1</sub> = 0.89 (28% predicted)	Reduced
FVC = 2.74 (67% predicted)	Reduced
FEV <sub>1</sub> /FVC ratio = 0.32	Severe obstruction

### CONCLUSION

Ronald has severe COPD (his FEV<sub>1</sub> is less than 30%). Bronchodilator therapy was stepped-up and Ronald showed symptomatic benefit from a combination of beta-agonists and anticholinergics. Pulse oximetry showed arterial saturation of 89%. Measurement of blood gases confirmed that he was chronically hypoxic and long-term oxygen therapy was instigated. In line with the NICE guideline he should be started on a long acting bronchodilator (beta agonist or anticholinergic) and as he has an FEV<sub>1</sub> less than 50% predicted and has had frequent exacerbations he should also be started on an inhaled steroid.

### 3. JOHN, AN AREA SALES MANAGER, AGED 42 YEARS

John has always been “chesty”. Even as a child he was considered “wheezy” and he avoided physical education lessons at school. He began smoking in his early twenties and has smoked about 10 cigarettes a day ever since. Apart from bouts of coughing and wheezing following chest infections (upper respiratory tract infections – URTI), John has enjoyed good health over the years. In the past John has been prescribed antibiotics to treat URTI, which he had often referred to as “bronchitis” and from which he typically made a slow recovery. John blamed smoking for slowing his recovery. He recently consulted his GP because yet another cold had “gone to his chest”, and his sleep was being disturbed by cough and wheeze.

John’s lung function was examined with the use of spirometry. Because it was unclear on the basis of the history whether he had asthma or COPD or both, his response to bronchodilators was also tested. He was given salbutamol through a large volume spacer. He was required to take four puffs and his FEV<sub>1</sub> was measured again after 30 minutes.



Spirometry		Interpretation
Baseline	FEV <sub>1</sub> = 3.24 (76% predicted)	Slightly reduced
	FVC = 4.82 (91% predicted)	Normal
	FEV <sub>1</sub> /FVC ratio = 0.67	Slightly reduced
Post-bronchodilator	FEV <sub>1</sub> = 4.17 (+ 930 ml and 29%)	Significant reversibility

### CONCLUSION

John’s spirometry reveals a mild degree of obstruction which was highly responsive (significant reversibility) to the bronchodilator. This reversibility and John’s clinical history are highly indicative of asthma, which spirometry confirms. John was given advice on the long term impact of smoking and the risk of developing COPD. With this encouragement, John stopped smoking.

“ Practice nurses are in a key position to influence the management of these [obstructive airways disease] patients. We all acknowledge how effective and successful the care of asthmatics has been and similar success can be achieved with COPD patients. ”

#### 4. EDDIE, A RETIRED PAINTER AND DECORATOR, AGED 65 YEARS

Eddie has only recently begun to complain of cough and breathlessness. He started smoking as a young man. Eddie made an appointment to see his doctor because he thinks he may have developed asthma. Two reasons lead him to believe this may be the case. Firstly, he lives close to a main road and, through information he has gleaned from television, radio and the newspapers, he is concerned about the effects of pollution on his health. Secondly, he has two nephews who have recently been diagnosed with asthma. He is otherwise fit and well, and takes no medication. On examination he has a few fine crackles. Although asthma was suspected, his peak flow chart is steady at 350 L/minute and he has been referred for spirometry.

Spirometry	Interpretation
FEV <sub>1</sub> = 1.67 (57% predicted)	Reduced
FVC = 2.07 (55% predicted)	Reduced
FEV <sub>1</sub> /FVC ratio = 0.81	Normal

#### CONCLUSION

Eddie has abnormal FEV<sub>1</sub> and FVC readings (both well below 80% of the “predicted normal” values). However the FEV<sub>1</sub>/FVC ratio is above 70% which suggests the presence of a restrictive, rather than an obstructive, airways condition. He was referred to a chest clinic where fibrosing alveolitis was diagnosed. Eddie’s condition is unrelated to environmental air pollution.

*Eddie thought he had asthma, but spirometry showed he had a restrictive lung condition*



## PREDICTED NORMAL VALUES

These values apply to Caucasians.

Reduce values by 7% for Asians and by 13% for Afro-Caribbeans.

Male			Height						
			5'3" 160cm	5'5" 165cm	5'7" 170cm	5'9" 175cm	5'11" 180cm	6'1" 185cm	6'3" 190cm
Age	38-41 years	FVC	3.81	4.10	4.39	4.67	4.96	5.25	5.54
		FEV <sub>1</sub>	3.20	3.42	3.63	3.85	4.06	4.28	4.49
	42-45 years	FVC	3.71	3.99	4.28	4.57	4.86	5.15	5.43
		FEV <sub>1</sub>	3.09	3.30	3.52	3.73	3.95	4.16	4.38
	46-49 years	FVC	3.60	3.89	4.18	4.47	4.75	5.04	5.33
		FEV <sub>1</sub>	2.97	3.18	3.40	3.61	3.83	4.04	4.26
	50-53 years	FVC	3.50	3.79	4.07	4.36	4.65	4.94	5.23
		FEV <sub>1</sub>	2.85	3.07	3.28	3.50	3.71	3.93	4.14
	54-57 years	FVC	3.39	3.68	3.97	4.26	4.55	4.83	5.12
		FEV <sub>1</sub>	2.74	2.95	3.17	3.38	3.60	3.81	4.03
	58-61 years	FVC	3.29	3.58	3.87	4.15	4.44	4.73	5.02
		FEV <sub>1</sub>	2.62	2.84	3.05	3.27	3.48	3.70	3.91
	62-65 years	FVC	3.19	3.47	3.76	4.05	4.34	4.63	4.91
		FEV <sub>1</sub>	2.51	2.72	2.94	3.15	3.37	3.58	3.80
66-69 years	FVC	3.08	3.37	3.66	3.95	4.23	4.52	4.81	
	FEV <sub>1</sub>	2.39	2.60	2.82	3.03	3.25	3.46	3.68	

For men over 70 years predicted values are less well established but can be calculated from the equations below (height in cms; age in years):

$$\text{FVC} = (0.0576 \times \text{height}) - (0.026 \times \text{age}) - 4.34 \text{ (SD: } \pm 0.61 \text{ litres)}$$

$$\text{FEV}_1 = (0.043 \times \text{height}) - (0.029 \times \text{age}) - 2.49 \text{ (SD: } \pm 0.51 \text{ litres)}$$

“ Since I have been doing more COPD work, I have found it to be so much more satisfying than I had expected, it is good to know that you can make some difference to the quality of life for these people. ”



Female			Height						
			4'11" 150cm	5'1" 155cm	5'3" 160cm	5'5" 165cm	5'7" 170cm	5'9" 175cm	5'11" 180cm
Age	38-41 years	FVC	2.69	2.91	3.13	3.35	3.58	3.80	4.02
		FEV <sub>1</sub>	2.30	2.50	2.70	2.89	3.09	3.29	3.49
	42-45 years	FVC	2.59	2.81	3.03	3.25	3.47	3.69	3.91
		FEV <sub>1</sub>	2.20	2.40	2.60	2.79	2.99	3.19	3.39
	46-49 years	FVC	2.48	2.70	2.92	3.15	3.37	3.59	3.81
		FEV <sub>1</sub>	2.10	2.30	2.50	2.69	2.89	3.09	3.29
	50-53 years	FVC	2.38	2.60	2.82	3.04	3.26	3.48	3.71
		FEV <sub>1</sub>	2.00	2.20	2.40	2.59	2.79	2.99	3.19
	54-57 years	FVC	2.27	2.49	2.72	2.94	3.16	3.38	3.60
		FEV <sub>1</sub>	1.90	2.10	2.30	2.49	2.69	2.89	3.09
	58-61 years	FVC	2.17	2.39	2.61	2.83	3.06	3.28	3.50
		FEV <sub>1</sub>	1.80	2.00	2.20	2.39	2.59	2.79	2.99
	62-65 years	FVC	2.07	2.29	2.51	2.73	2.95	3.17	3.39
		FEV <sub>1</sub>	1.70	1.90	2.10	2.29	2.49	2.69	2.89
	66-69 years	FVC	1.96	2.18	2.40	2.63	2.85	3.07	3.29
		FEV <sub>1</sub>	1.60	1.80	2.00	2.19	2.39	2.59	2.79

For women over 70 years predicted values are less well established but can be calculated from the equations below (height in cms; age in years):

$$\text{FVC} = (0.0443 \times \text{height}) - (0.026 \times \text{age}) - 2.89 \text{ (SD: } \pm 0.43 \text{ litres)}$$

$$\text{FEV}_1 = (0.0395 \times \text{height}) - (0.025 \times \text{age}) - 2.60 \text{ (SD: } \pm 0.38 \text{ litres)}$$

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