Clinical skills

Spirometry: key to the diagnosis of respiratory disorders

Spirometry remains the cornerstone of respiratory function testing and is the key to diagnosing and monitoring the most common respiratory disorders. Spirometry measures how quickly the air can empty from the lungs (flow) and how much air can be moved during a maximal expiration (volume). It is a valuable clinical tool to detect diseases that impair respiratory function, help exclude respiratory disease as a cause of current symptoms, assess the severity of any impairment in function, and monitor the effects of any therapeutic intervention or of disease progression.

Quality of testing

The validity of results depends on the quality of each expiratory effort, and a suboptimal quality test has the potential to negatively influence the interpretation of the result. Interpretation should begin by establishing whether the testing meets spirometry standards:[1-3]

- at least three efforts must meet acceptability criteria (maximal inspiration prior, fast expiration without delay, continuous expiration for $\geq$ 6 s with a plateau in flow despite continued effort, no observed leaks or artefact in trace);[1-3]
- the two best acceptable efforts must be repeatable (ie, the two largest forced expiratory volume in 1 s [FEV_1] values are within 150 mL of each other and the two largest forced vital capacity [FVC] values are within 150 mL of each other); and
- the largest FEV_1 and FVC from the two best repeatable, acceptable trials must be reported for interpretation.

Key parameters

The key parameters used for interpretation are the FEV_1/FVC ratio, FEV_1 and FVC.

Visual representation of the expiratory flow–volume curve provides useful information regarding the type of ventilatory defect (Box 1), while the inspiratory flow–volume curve is useful in identifying upper airways obstruction.

Peak expiratory flow and forced expiratory flow at 25–75% of FVC are not sensitive or specific, and are not recommended for use in interpretation.[1-4]

Normal predicted values

In order to interpret spirometry, predicted normal values (reference equations) are derived from healthy populations to provide an indication of what is expected based on the height, age, sex and ethnicity of the patient. The Thoracic Society of Australia and New Zealand recommends using the reference ranges of the Global Lung Function Initiative.[5] Most respiratory diseases result in abnormally low results for the spirometry parameters used in interpretation. Values below the lower limits of normal (LLN) are regarded as abnormally reduced.[3-5] The LLN is set at the 5th percentile for both FEV_1 and FVC (ie, 5% of the population lie below the normal range).

Interpretive strategy

First, review the FEV_1/FVC ratio to identify any airway obstruction. Next, use the FEV_1 as a percentage of the predicted normal value for your patient (percentage predicted) to classify the severity of any obstruction. Finally, calculate the FVC as a percentage of the predicted value to determine if there is any suggestion of lung restriction (Box 2 provides a diagnostic algorithm for interpreting spirometry results).

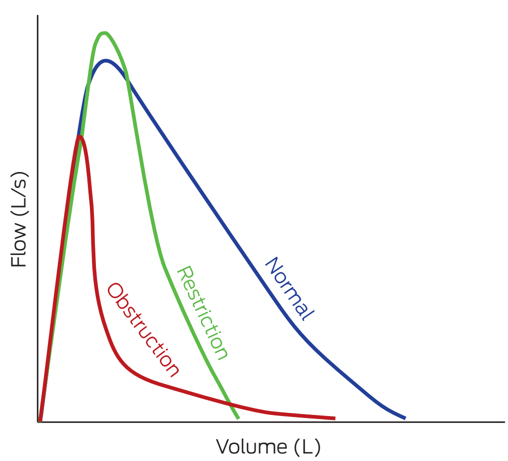
Typical patterns of abnormality

Obstructive ventilatory defect

In patients with an obstructive ventilatory defect, the FEV_1/FVC ratio is below the LLN, with a distinct concave appearance of the flow–volume curve (Box 1).[3,4] Severity of an abnormal test can be graded clinically (Box 3).[3,4]

Possible pathologies include asthma, chronic obstructive pulmonary disease, emphysema, chronic bronchitis, bronchiectasis, cystic fibrosis, bronchiolitis, foreign bodies and tumours.

1 Visual representation of flow–volume curves in a healthy normal person and in patients with obstructive and restrictive ventilatory defects



John R Wheatley

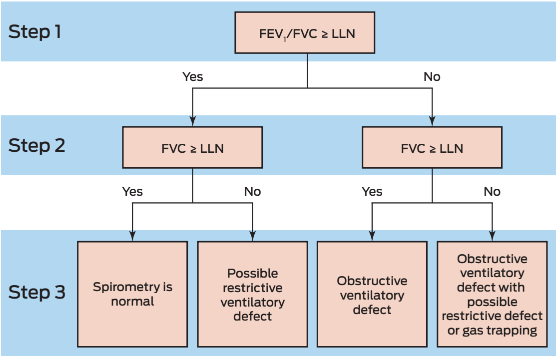
Westmead Hospital and University of Sydney, Sydney, NSW.

john.wheatley@sydney.edu.au

doi: 10.5694/mja17.00684

Series editors
Balakrishnan (Kichu) Nair
Simon O'Connor

2 Interpretation algorithm for spirometry results[3,4]



FEV_1 = forced expiratory volume in 1 s. FVC = forced vital capacity. LLN = lower limits of normal. ◆

Restrictive ventilatory defect

In patients with a restrictive ventilatory defect, the FEV_1/FVC ratio is normal or high, and the FVC percentage predicted is below the LLN.[3,4] A restrictive ventilatory defect requires confirmation by lung volume measurement (total lung capacity) in a specialist respiratory laboratory. Severity of an abnormal test can be graded clinically (Box 3).[3,4]

3 Clinical severity scale for an obstructive ventilatory defect[3,4,*]

Clinical severity	FEV_1 percentage predicted
Mild	≥ 70%
Moderate	60–69%
Moderately severe	50–59%
Severe	35–49%
Very severe	< 35%

FEV_1 = forced expiratory volume in 1 s. * The severity scale for a restrictive ventilatory defect is similar to that for an obstructive ventilatory defect, substituting forced vital capacity percentage predicted for FEV_1 percentage predicted. ◆

Possible pathologies include interstitial lung diseases, congestive cardiac failure, chest wall disorders (eg, kyphoscoliosis), neuromuscular diseases affecting respiratory muscles, lobectomy or pneumonectomy, pleural disease and morbid obesity (body mass index > 40 kg/m^2).

Mixed ventilatory defect

In mixed ventilatory defects, both the FEV_1/FVC ratio and the FVC percentage predicted are below the LLN, and the FEV_1 percentage predicted is also reduced.[3,4] The finding of a mixed ventilatory defect requires confirmation and interpretation by a specialist respiratory laboratory.

Possible pathologies can be a combination of any of those listed above for obstructive and restrictive ventilatory defects.

Reversibility testing and longitudinal monitoring

Responsiveness to bronchodilators is a way of testing the reversibility of an obstructive ventilatory defect. Reversibility is seen most commonly in asthma, but also occurs (to a lesser extent) in chronic obstructive pulmonary disease and cystic fibrosis. A ≥ 12% and ≥ 200 mL increase in FEV_1 or FVC from baseline is considered to be significant reversibility.[3,4]

Longitudinal monitoring of an individual's lung function is very relevant for any patient with chronic respiratory disease. A change of ≥ 12% and ≥ 200 mL in either direction in FEV_1 or FVC may represent a real change over time.[3,4]

Conclusion

The correct interpretation of spirometry testing, in conjunction with clinical assessment, is essential for the diagnosis and monitoring of a wide range of common respiratory disorders. Poor quality spirometry or incorrect interpretation will compromise correct clinical diagnosis and management.

Competing interests: No relevant disclosures.

Provenance: Commissioned; externally peer reviewed. ■

References are available online at www.mja.com.au.

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