National Asthma Council Australia
leading the attack against asthma

Spirometry quick reference guide

A guide to performing high-quality spirometry

Definition

Spirometry is a physiological test of lung function. It is the measurement of how much, and how quickly, air can be exhaled in a single blow from full lungs.

Obtaining reliable results

Correct spirometry technique is crucial to obtaining reliable results for making a diagnosis or monitoring management of respiratory conditions.

The test requires effort by the patient, so there must be cooperation between the operator and the patient, and coaching by the operator.

It is essential to meet acceptability and repeatability criteria.

Abbreviations

FEV_1	forced expiratory volume over 1 second
FVC	forced vital capacity
PEF	peak expiratory flow
LLN	lower limit of normal

Predicted values

Use Global Lung Function Initiative (GLI-2012) reference equations validated in multiple ethnic groups and age groups.

If GLI-2012 not available, use NHANES III values for Caucasian subjects and apply ethnic correction where appropriate.

Preparing the spirometer

Prepare spirometer by following the manufacturer's instructions.

Enter patient information:

- height without shoes
- weight without shoes*
- age
- sex
- ethnicity
- smoking status

**Not essential for predicted values but can be useful for interpretation.*

If the patient has taken an inhaled bronchodilator medicine, record the dose and time last taken.

Withholding bronchodilators

When spirometry is performed as a diagnostic test, inhaled bronchodilators should be withheld before the test. However, advise patients to take their reliever if needed for symptom relief.

Medicine	Withholding time
SABAs *e.g. Asmol, Bricanyl, Ventolin*	**6-8 hours**
LABAs with twice-daily dosing *e.g. Oxis, Serevent, Flutiform, Seretide, Symbicort*	**12 hours**
LABAs with once-daily dosing LAMAs SAMAs *e.g. Breo, Bretaris, Seebri, Spiriva, Onbrez, Anoro, Brimica, Ultibro*	**24 hours**

Note: For combination therapies containing more than one listed medicine, withhold for the longer duration.

SABA: short-acting beta$_2$ agonist;
SAMA: short-acting muscarinic antagonist (short-acting anticholinergic bronchodilator)

LABA: long-acting beta$_2$ agonist
LAMA: long-acting muscarinic antagonist (long-acting anticholinergic bronchodilator)

Preparing the patient

1. Explain to the patient:
   - what the test measures

     The aim of this lung function test is to measure how much air you can blow out with one breath, and also how fast you can blow that air out.

   - what they will need to do

     To do the test properly you will need to have a very big breath in, and then blow out very hard and very fast into the mouthpiece, until your lungs are completely empty or you cannot blow any longer.

   - how many times they will need to do it

     You will need to do the test at least three times (but probably more) to make sure we get reliable results.

2. Demonstrate correct posture and the amount of force needed when exhaling.
3. Give clear, simple instructions.
4. Advise the patient to stop if they become dizzy or light-headed, or if they have any pain.

Note: The use of a nose clip is recommended for forced manoeuvres, but is not essential.

Performing the test

Either method is acceptable.

Open circuit method

- Sit upright with legs uncrossed and feet flat on the floor; do not lean forward
- Breathe in rapidly until lungs feel completely full
- Do not pause for more than 1 second
- Place mouthpiece in mouth and close lips to form a tight seal
- Blast air out as hard and fast as possible and for as long as possible, until your lungs are completely empty or you are unable to blow out any longer
- Breathe in rapidly and completely again
- Remove mouthpiece.

Closed circuit method

- Sit upright with legs uncrossed and feet flat on the floor; do not lean forward
- Place mouthpiece in mouth and close lips to form a tight seal
- Breathe normally for 2–3 breaths
- Breathe in rapidly until lungs feel completely full
- Do not pause for more than 1 second
- Blast air out as hard and fast as possible and for as long as possible, until your lungs are completely empty or you are unable to blow out any longer
- Remove mouthpiece.

Vigorous verbal encouragement and coaching (no need to yell) is essential to achieve the best result and complete exhalation.

> *Keep going, you're doing well, keep going.*

Checking acceptability and repeatability

Obtain at least 3 acceptable blows. Usually no more than 8 blows in total should be attempted. Check repeatability.

Acceptability criteria

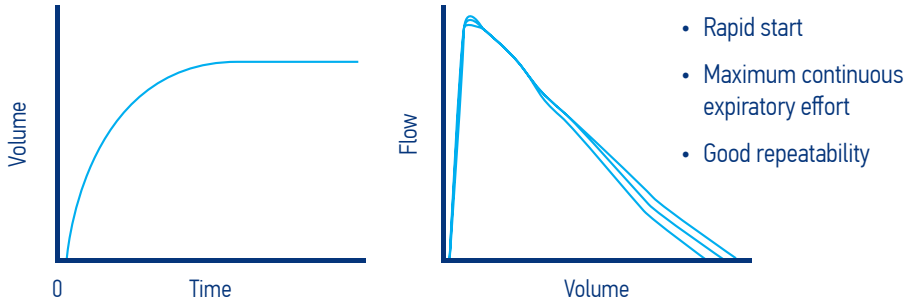
A blow is acceptable if it meets **all** start and end criteria.

Start-of-test criteria:

- Maximal inspiration
- Maximal expiration with a rapid start: PEF achieved with a sharp rise and close to start of expiration

End-of-test criteria:

- Smooth continuous exhalation (no cough)
- Maximal expiration: minimal or no change in volume during the last second and full expiration:
  - → >6 seconds for adults and children 10 years and over
  - → >3 seconds for children under 10 years



Repeatability criteria

FEV_1

The two largest values for FEV_1 from acceptable tests should be within 150 mL of each other.

FVC

The two largest values for FVC from acceptable tests should be within 150 mL of each other.

If FVC is ≤1 L then the two largest values for FVC and FEV_1 from acceptable tests should be within 100 mL of each other

Note: Superimposing curves helps determine repeatability.

Post spirometry check

- ✓ **Are the demographics entered correctly?** ***(e.g. correct height, age, sex and ethnicity)***
- ✓ **Do the tests meet acceptability criteria?**
- ✓ **Have you achieved 3 acceptable blows?**
- ✓ **Do the tests meet repeatability criteria?**

Assessing bronchodilator reversibility

Performing baseline and post-bronchodilator spirometry

1. Perform baseline spirometry.
2. Administer bronchodilator (e.g. 4 separate puffs salbutamol *(Ventolin/Asmol)* via a pressurised metered-dose inhaler and spacer).
3. Wait 10–15 minutes.
4. Repeat spirometry.

Definition of positive bronchodilator response

Adults and adolescents >12 years: an increase in FEV_1 (or FVC) of ≥12% **and** an absolute increase in FEV_1 (or FVC) of ≥200mL

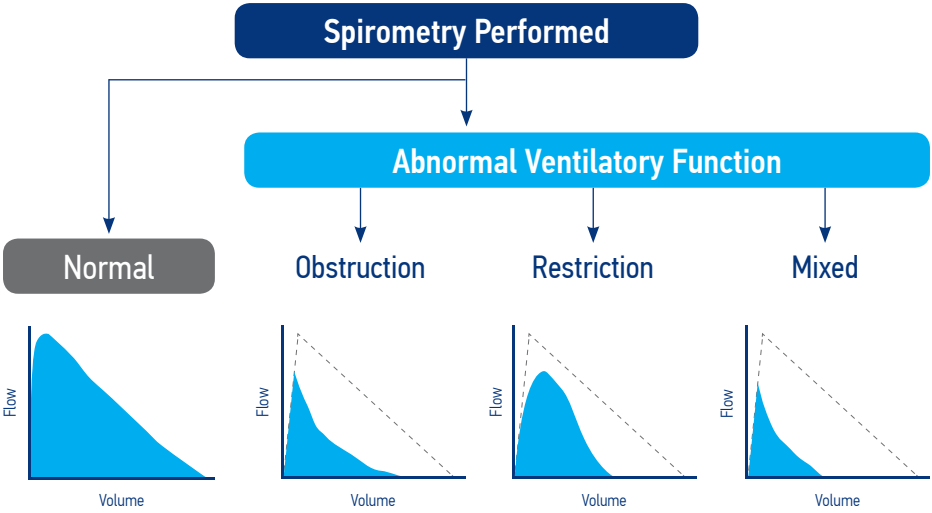
Children: an increase in FEV_1 (or FVC) of ≥12%

Calculations

$$\textit{\% increase in } FEV_1 = 100 \times \frac{FEV_1 \text{ (post bronchodilator)} - FEV_1 \text{ (baseline)}}{FEV_1 \text{ (baseline)}}$$

$$\textit{Absolute increase in } FEV_1 = \text{post-bronchodilator } FEV_1 - \text{baseline } FEV_1$$

Identifying ventilatory defects

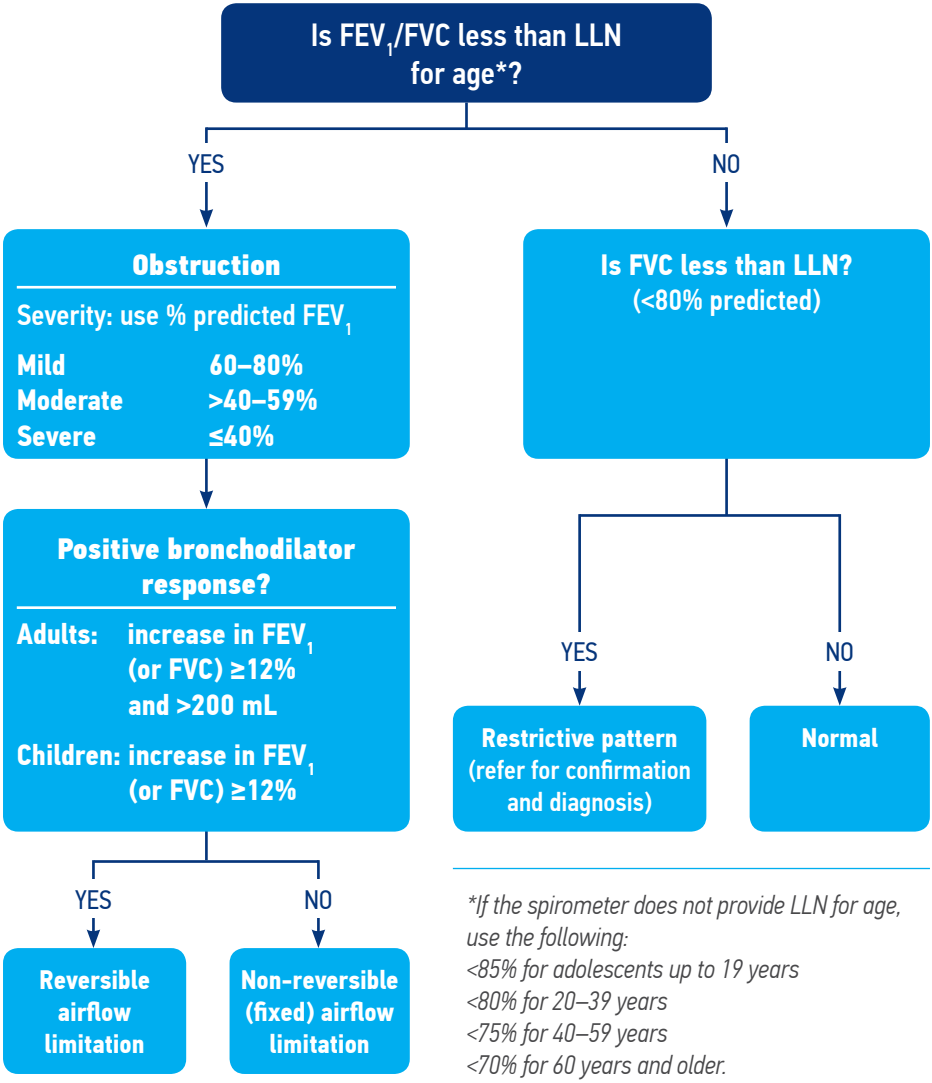


Types of ventilatory defects

	Obstruction	Restriction	Mixed defect
Problem	Expiratory airflow limitation: unable to blow out quickly *e.g. asthma, COPD, overlap of asthma and COPD*	Limitation to inspiration: small lungs *e.g. obesity, pulmonary fibrosis, pleural/chest wall disease, weak inspiratory muscles*	Small lungs and unable to blow out quickly
Spirometry findings	Reduced FEV_1/FVC ratio	Low FVC but normal or high FEV_1/FVC ratio	Reduced FEV_1/FVC ratio plus low FVC

Interpreting results

Simple algorithm for interpreting spirometry



**If the spirometer does not provide LLN for age, use the following:*
<85% for adolescents up to 19 years
<80% for 20–39 years
<75% for 40–59 years
<70% for 60 years and older.

More information

Asthma guidelines, *Australian Asthma Handbook:* asthmahandbook.org.au

COPD guidelines, *The COPD-X Plan:* copdx.org.au

GLI-2012 software: spirxpert.com/gli_validation.html

National Asthma Council Australia has many resources to support spirometry in primary care, including:

- Spirometer Users' and Buyers' Guide
- Spirometry Handbook, an introductory guide
- Performing Spirometry in Primary Care, a how-to video
- Spirometry training courses

For details visit: nationalasthma.org.au

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