Spirometric protocol

Spirometry is the most common of the Pulmonary Function Test, that measures lung function, specifically the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. Spirometry is an important tool for the screening of general respiratory health.

The spirometer, in epidemiological study in the schools, should be portable and comply with the recommendations of the American Thoracic Society (ATS) and European Respiratory Society (ERS) on Standardization of Spirometry. It is essential that the variability of the measurements is within appropriate limits to allow accurate measurement of change in lung function.

The principal parameters measured in spirometry are:

- Forced Vital Capacity (FVC), which is the total volume of air expired forcefully and completely after a full inspiration;
- Forced Expiratory Volume in one second (FEV1), which is the volume of air expired in the first second FVC manoeuvre;
- Peak Expiratory Flow (PEF), which is the maximal expiratory flow achieved during the maximally forced expiration;
- Forced Expiratory Flow (FEF), which is the flow of air coming out of the lung during specific intervals of a forced expiration, usually 25-75% of FVC manoeuvre (FEF25-75%);
- Maximal Expiratory Flow (MEF) which is the instantaneous forced expiratory flow when 75% or 50% or 25% of the FVC remains to be expired (MEF75%, MEF50%, MEF25%);
- FEV1/FVC is the ratio of FEV1 to FVC.

The maneuver to measure FVC has three distinct phases: 1) maximal inspiration; 2) a "blast" of exhalation; and 3) continued complete exhalation to the end of test (EOT). The technician should demonstrate the appropriate technique and follow the procedure described in table 1. [1]

<table>
<thead>
<tr>
<th>Check the spirometer calibration according to specific guidelines of the chosen instrument</th>
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<tbody>
<tr>
<td>Explain the test to the subject</td>
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<tr>
<td>Prepare the subject</td>
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<td>Ask about age, race, sex, smoking habits, recent illness, medication use, etc. (Annex 1)</td>
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<td>Measure weight and height without shoes</td>
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<td>If possible ask to loosen tight clothing and to remove braces</td>
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<td>Ask to relax.</td>
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<td>Wash hands</td>
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<tr>
<td>Instruct and demonstrate the test to the subject, to include</td>
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<td>Correct posture: sit up or stand up with head slightly elevated</td>
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</tbody>
</table>
Inhale rapidly and completely
Sealing lips around the mouthpiece so that there are no leaks, taking care not to block its opening with teeth or tongue or bite down excessively
Blasting out as hard and fast as possible with minimal hesitation after the preceding inspiration
Continue blowing out until the lungs are completely empty.

Perform manoeuvre (closed circuit method)
- Have subject assume the correct posture
- Attach nose clip, place mouthpiece in mouth and close lips around the mouthpiece
- Inhale completely and rapidly with a pause of <1 s at total lung capacity (TLC)
- Exhale maximally until no more air can be expelled while maintaining an upright posture
- Repeat instructions as necessary, coaching vigorously
- Repeat for a minimum of three manoeuvres; no more than eight are usually required
- Check test repeatability and perform more manoeuvres as necessary

Perform manoeuvre (open circuit method)
- Have subject assume the correct posture
- Attach nose clip
- Inhale completely and rapidly with a pause of <1 s at TLC
- Place mouthpiece in mouth and close lips around the mouthpiece
- Exhale maximally until no more air can be expelled while maintaining an upright posture
- Repeat instructions as necessary, coaching vigorously
- Repeat for a minimum of three manoeuvres; no more than eight are usually required
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Spirometric manoeuvre assessment (Annex 2)

Table 1. Procedures for recording forced vital capacity [1]

It's important an enthusiastic coaching of the subject using appropriate body language and phrases, such as «blast out» and "keep going". The subject should be encouraged in every step of spirometric maneuver. In the pulmonary function testing of children is important a pleasant atmosphere, encouragement, detailed but simple instructions, lack of intimidation and visual feedback in the teaching

Acceptability criteria

An adequate test requires acceptable and repeatable manoeuvres (within- and between-manoeuvre acceptability criteria) (table 2).
**Within-manoeuvre criteria**

Individual spirograms are "acceptable" if

- They are free from artefacts
  - Cough during the first second of exhalation
  - Glottis closure that influences the measurement
  - Early termination or cut-off
  - Effort that is not maximal throughout
  - Leak
  - Obstructed mouthpiece

- They have good starts
  - Extrapolated volume $\leq 5\%$ of FVC or 0.15 L, whichever is greater

- They show satisfactory exhalation
  - Duration of $\leq 6$ s (3 s for children) or a plateau in the volumetime curve (plateau: flow $< 0.025$ L/sec for at least 1 sec) or if the subject cannot or should not continue to exhale

**Between-manoeuvre criteria**

After three acceptable spirograms have been obtained, apply the following tests

- The two largest values of FVC must be within 0.150 L of each other
- The two largest values of FEV1 must be within 0.150 L of each other

If both of these criteria are met, the test session may be concluded.

If both of these criteria are not met, continue testing until

- Both of the criteria are met with analysis of additional acceptable spirograms
- A total of eight tests have been performed (optional) or
- The patient/subject cannot or should not continue

Save, as a minimum, the three satisfactory manoeuvres

**Table 2. Summary of within- and between-manoeuvre acceptability criteria. [1]**

FVC: forced vital capacity; FEV1: forced expiratory volume in one second.

**Test result selection**

FVC and FEV1 should be measured from a series of at least three forced expiratory curves that have an acceptable start of test and are free from artefact, such as a cough (i.e. "usable curves"). The largest FVC and the largest FEV1 should be recorded after examining the data from all of the usable curves, even if they do not come from the same curve.[1]
Annex 1 [2]

1. date of birth
2. sex
3. race
4. smoking habits
5. symptoms/diagnosis of asthma

Safety questions (if the subjects has one of these items you can't perform the spirometry)

1. surgery on chest or abdomen within the past three months
2. heart attack within the past three months
3. eye surgery within the past three months
4. hospitalization for any other heart problem within the past month
5. other reason to not performing the spirometry maneuver

Respiratory medication use

1. respiratory infection (cold) in the last three weeks
2. any medications for breathing
   a. in the last 6 hours: short-acting B2 agonist, anticholinergic inhaler
   b. in the last 12 hours: oral B2 agonist, long acting B2 agonist
   c. in the last 12-24 hours: oral theophyline
   d. in the last 24 hours: long acting anticholinergic

Annex 2[2]

Spirometric manoeuvre assessment:

1. acceptable
2. non acceptable:
   a. the participant did not understand instructions
   b. the participant was medically excluded
   c. the participant was unable to physically cooperate
   d. the participant refused

References


2. Project IMCA2 (Indicators for Monitoring COPD and Asthma in the EU) funded by EU, DG SANCO (Directorate General for Health and Consumer Affairs).
Nasal lavage

Needed for each subject:

20 ml plastic syringe with nasal olive
5 ml of 0.9% saline, room temperature
Disposable plastic container
10 ml centrifuge tube

Also needed:

Centrifuge
Ice

Lavage of the nasal mucosa is done with a 20-ml plastic syringe attached to a nose olive. The subjects are standing or sitting, with their heads flexed about 30° forward. At room temperature (20-22°C), sterile 0.9% saline solution is introduced into the nasal cavity. Each nostril is lavaged with 5 ml of the solution, which is flushed back and forth five times via the syringe, at intervals of a few seconds. The fluid is transferred into 10-ml polypropylene centrifuge tubes. The samples are kept on ice and within 300 min, the solution is centrifuged at 800 g for 5 min. The supernatant is then recentrifuged at 1400 g for 5 min, and immediately frozen to \(20°C\).

Reference Norback D. Wieslander G. Biomarkers and chemiosensory irritation, Int Arch Occup Environ Health 2002, 75: 298-304
Self-reported Breakup time (BUT)

Needed: sheet of paper, felt pen

Stopclock (present in most mobile phones)

Tear film stability is estimated by a standardized method, self-reported BUT [BUT(s)] measuring the length of time that the subject could keep the eyes open without pain when watching a fixed point on the wall. The method has been used previously and has been shown to correlate well with the fluorescein method for the detection of tear film BUT (Wyon 1992; Wyon and Wyon 1987).


The child is sitting, looking at a fixed point on the wall at about 5 m (usually a flower painted with a felt pen),

The child is instructed to blink at a command, when a stopwatch is started, and to fix the point on the wall until feels the need of blinking again. The time between the blinks is recorded three times.
Measurement Exhaled nitric oxide

Will be performed using a Niox Mino apparatus according to the instruction of the manufacturer