How to Perform Spirometry

Purpose

This guideline provides recommendations regarding best practice to support high quality spirometry practice for KINNECT Pre-Employment Medicals.

Scope

This guideline provides information for all health practitioners who perform adult spirometry as part of their clinical duties.

This guideline provides the minimum requirements for obtaining acceptable and repeatable pre- and post-bronchodilator (reversibility) spirometric data.

Why perform spirometry in the occupational setting?

Spirometry, the most frequently performed pulmonary function test (PFT), is the cornerstone of occupational respiratory evaluation programs. In the occupational health setting, spirometry plays a critical role in the primary, secondary and tertiary prevention of workplace related lung disease. Used for both screening and clinical evaluations, spirometry test are performed in a variety of venues.

Spirometry differs from many other medical measurements, since it depends on multiple factors for its results to be valid (subject effort is flawed, equipment is not accurate or technicians fail to elicit maximal cooperation and effort), results can be falsely elevated or reduced.

KINNECT aims to provide the best possible results for interpretation

Guideline for performing adult spirometry

Emergency Protocol

Follow your company Emergency protocols in the event of an emergency.

Infection Control Procedures

Adhere to relevant infection control protocols or procedures at all times and in all facets of spirometry testing.

Gaining Consent

Gain consent at all times.
Identifying Indications and Contraindications for performing spirometry

Indications for performing spirometry:

- assisting with diagnostic evaluations
- monitoring of pulmonary function
- evaluating disability or impairment
- providing public health information.

Contraindications for performing spirometry:

Some conditions may pose a relative danger to a patient or affect the validity of spirometry performance and results. These include, but are not limited to the following:

- unstable cardiovascular status, unstable angina, recent myocardial infarction (within one month), or pulmonary embolism
- haemoptysis of unknown origin
- recent pneumothorax
- thoracic, abdominal, or cerebral aneurysms
- recent thoracic, abdominal or eye surgery
- acute disorders such as nausea or vomiting
- severe respiratory distress
- physical limitations
- cognitive impairment, dementia.

Facilities and Equipment

Ensure clearly defined rooms are available.

Spirometer is in good working order.

Assemble the following supplies:

- disposable/reusable supplies: mouthpieces and nose clips.
- infection control supplies: disposable gloves, gowns, masks, protective eyewear.
- stadiometer for measuring height and scales for weight.
- computer/recorder supplies.
- validated 3L-volume calibration syringe
- for reversibility test: metered dose inhaler (MDI) and spacer.
**Key measures and terminology**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term</th>
<th>Definition/Explanation/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC</td>
<td>Vital capacity, litres (L)</td>
<td>The volume change between the position of full inspiration and complete expiration 7</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced vital capacity, litres (L)</td>
<td>The maximal volume of air exhaled with maximally forced effort from a position of maximal inspiration 1</td>
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<tr>
<td>FEV1</td>
<td>Forced expiratory volume in one second, litres (L)</td>
<td>The maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration 2</td>
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<tr>
<td>PEF</td>
<td>Peak expiratory flow litres per second (L.s-1) or litres per minute (L.min-1)</td>
<td>The maximum expiratory flow achieved from a maximum forced expiration, starting without hesitation from a point of maximal lung inflation 2</td>
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<tr>
<td>BPTS</td>
<td>Body pressure and temperature (saturated)</td>
<td>Body temperature (i.e.37°C), ambient pressure, saturated with water vapour 1</td>
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**Preparing equipment and ensuring quality control**

Quality control must be conducted to ensure the precision and accuracy of the test equipment, test procedure and the results collected. It includes the regular maintenance and calibration of equipment and the regular testing of biological controls to validate testing equipment and test procedures. All results of quality control testing should be recorded and analysed so that any problems can be identified and rectified as soon as they arise. Quality control processes that conform to a “best practice model” are outlined below.

**Preparing a spirometer:**

- Assemble the components according to the manufacturer’s instructions.
- Put in place a new disposable mouthpiece for each patient.
- Turn on the system to ensure adequate warm up. Allow time for equilibration to room temperature for portable systems.
- Perform a validation check
- Only perform spirometry at temperatures recommended by the equipment manufacturers.

Validating the calibration of the spirometer

- A validation is the procedure used to check that the device is within calibration limits (e.g. ±3% of true).
- Conduct daily validation checks according to manufacturer’s instructions.

Preparing the patient

Carry out infection control measures prior to testing, particularly hand washing for both patient and personnel performing spirometry.

Document if the patient has withheld bronchodilator medications prior to testing.

Confirm that the patient has:

- ceased smoking at least 1 hr before testing
- ceased alcohol consumption at least 4 hrs before testing
- refrained from performing vigorous exercise within 30 min of testing
- refrained from eating a large meal within 2 hrs of testing.

Ensure the patient is wearing clothing that enables full chest and abdominal expansion (if possible loosen clothing).

Assess patient for physical and developmental status to determine their ability to perform the test and/or if special arrangements are required.

Engage an interpreter if required.

Record relevant medical history that may assist in the interpretation/reporting of the spirometry. This may include the following.

- Breathlessness
- Cough
- Sputum
- Wheeze
- Symptoms of asthma
- Smoking history (years, packs/day, current status)
- Known lung disease/cHEST injuries/operations
- Work history
- Occupational exposure to dust and respiratory irritants

Record the type, dosage and time taken of any inhaled or oral medication that may alter lung function.

Measure and record the patient’s height (barefoot) in centimetres (cm) to the nearest cm, with feet together, heels against the wall, standing as tall and straight as possible and with the head in the
Frankfort horizontal plane 9 (eyes level and looking ahead). Measure the patient's height using an accurate measuring device, such as a stadiometer.

Patients with spinal deformities and for those who cannot stand, the measurement of arm span can be used as it closely approximates standing height. Have the patient stretch their arms in opposite directions to attain the maximal distance between the tips of the middle fingers. Use the relevant formula below to estimate height.

— For caucasian men: Height = arm span ÷ 1.03
— For caucasian women: Height = arm span ÷ 1.01

Measure and record the patient’s weight in kilograms (kg) to the nearest 0.5kg with indoor clothing and without shoes. The weight is not required for most reference values but may be useful for interpretative reasons.

Verify the patient’s identity (full name and date of birth) and the procedure to be performed.

Document the patient’s ethnic origin, gender and date of birth.

Leave the patient’s dentures in place unless they interfere with the testing procedure or the patient’s ability to perform the procedure as required.

For safety reasons perform the test with the patient sitting comfortably in a chair with arms and without wheels. Ensure the patient is sitting in an upright position, legs uncrossed and both feet on the floor.

Clearly instruct the patient in the procedure prior to the commencement of each test and ensure that the patient understands all requirements of the test. Allow ample opportunity for the patient to ask questions or receive clarification on the test and its requirements.

**Performing test procedure**

*There are two methods for testing spirometry: Open-circuit and Closed-circuit.*

*In the open-circuit method the patient approaches the mouth piece after a complete inhalation to total lung capacity (TLC). This method is described below.*

1. Perform validation of the machine.
2. Introduce yourself to the patient, including your name and position title and establish rapport.
3. Verify the following information:
   — check for completed paperwork.
   — identify patient by name and date of birth
   — check for any contraindications to spirometry testing
   — record current medication that may alter lung function and a brief history
   — record height (cm) and weight (kg) measurements
   — record gender and ethnic origin
   — record testing position if not sitting and justification why test is performed in a non-sitting position.

*Performing the FVC and FEV1 manoeuvre*

4. Explain and demonstrate the test manoeuvre to the patient, including:
Correct use of the mouthpiece and nose clip
Correct posture with head slightly elevated
Position of the mouthpiece, including tight mouth seal over the mouthpiece.
Complete inhalation prior to FVC and FEV1
Rapid and complete exhalation with maximal force for FVC and FEV1.

5. Have the patient assume the correct sitting position i.e. upright posture, legs uncrossed and both feet flat on the floor.

6. Activate the spirometer.
   - Attach the nose clip and instruct patient to inhale completely and rapidly until their lungs are full, place mouthpiece in mouth and close lips tightly around the mouthpiece while holding their lungs full.
   - Instruct patient to exhale forcefully until no more air can be expelled.

7. Encourage the patient to maintain an upright posture (i.e. no bending forwards) during the manoeuvre.

8. Observe the patient at all times during the manoeuvre in case they become unsteady due to light-headedness or experience other adverse reactions, such as chest pain.

9. Terminate the manoeuvre once the end of test criteria has been met.

10. Repeat the instructions and manoeuvres for a minimum of three manoeuvres, more if necessary, coaching vigorously until end of test criteria are met; no more than eight manoeuvres are usually required.

12. Terminate the test once the acceptability and repeatability criteria have been met.

Determining acceptability and repeatability of FEV1, FVC and VC measurements

Clinically useful spirograms must be acceptable (i.e meet the criteria that comprises a good quality manoeuvre) and repeatable (i.e the two highest FEV1, FVC and VC from three acceptable manoeuvres are in close agreement).

A spirogram is “acceptable” if the following are met:

**Start of Test Criteria**

- begins from full inspiration
- has a rapid start of test, that is, the back extrapolated volume (BEV) is <5% of FVC or 0.15L, whichever is greater. If the manoeuvre has an obviously hesitant start then the trial should be terminated early to avoid unnecessary prolonged effort.

**Middle of Test Criteria**

No obstruction, hesitation or artefact impeding the blow including:
- Cough during the first second of exhalation
- Glottic closure that influences the measurement
- Early termination or cut-off
- Effort that is not maximal throughout
- Air leaks at mouth
- Obstructed mouthpiece (due to tongue or teeth in front of the mouthpiece, or mouthpiece deformation due to biting).
End of Test Criteria

- Continuous maximal expiratory blow for ≥6 sec in duration
- A plateau in the volume-time curve (i.e. no change in volume (<0.025L) for a 1 second period)
- The patient cannot or should not continue to exhale.

How to ensure repeatability between individual spiograms

After three acceptable spirometers have been obtained, the following checks are used to assess for repeatability:

- The two largest values of FVC or VC must be within 0.150L of each other
- The two largest values of FEV1 must be within 0.150L of each other
- For patients with an FVC or VC of ≤1.0L the two largest FVC or VC and FEV1 values must be within 0.100L of each other
- A minimum of three acceptable manoeuvres should be saved and utilised for analysis/interpretation.