Pulmonary Diagnostics: Plethysmographic Lung Volumes (FRCPleth)

Site Applicability

St. Paul's Hospital

Mount Saint Joseph Hospital

Practice Level

Respiratory Therapist

Requirements

The determination of FRC (functional residual capacity) is the key component in the measurement of lung volumes and can be assessed by body plethysmography, gas dilution, or washout methods. At PHC, only body plethysmography is used to measure FRC.

Air casts and personal items such as water bottles and cell phones must be removed prior to the patient entering the body box.

For inpatients requiring continuous IV infusions with pumps or other equipment that will not fit into the body box, testing should be deferred until the infusion can be safely discontinued.

Need to Know

Plethysmographic measurements are based on Boyle's Law, which states that *under isothermal conditions, when a constant mass of gas is compressed or decompressed, the gas volume and pressure at any given moment is constant*. FRCPleth is the second measurement in the complete pulmonary function testing sequence.

Slow vital capacity (SVC) measurements are performed along with Lung Volume (FRCPleth) measurements in a "linked" maneuver. Immediately after the acquisition of the FRC measurement(s), an inspiratory capacity (IC) is performed to measure the total lung capacity (TLC) without the patient coming off the mouthpiece. The IC is then followed by a linked slow expiratory vital capacity (VC) maneuver to residual volume (RV).

Indications

- To determine the presence or absence of lung disease
- To distinguish between restrictive and obstructive lung disease
- To measure the severity of disease
- To measure response to therapeutic intervention

- To assist with preoperative assessments in patients with compromised lung function.
- To evaluate the level of disability or impairment

Contraindications

- Hemoptysis of unknown origin
- Pneumothorax
- Unstable cardiovascular status (recent MI or PE)
- Acute nausea or vomiting
- Severe claustrophobia
- Continuous oxygen therapy that cannot be temporarily discontinued

Cautions

- Patients should be observed for dizziness or signs of syncope and testing stopped accordingly.

Special Considerations

- Some patients may need to take tidal breaths immediately after the determination of FRC. This is acceptable as long as they remain on the mouthpiece.
- Patients who arrive using ambulatory oxygen may require access to hospital wall oxygen in order to conserve their own supply.
- Patients with significant kyphosis, scoliosis, or neck mobility issues may encounter difficulty with the height and angle of the mouthpiece.
- In situations where the ERV is difficult to obtain (i.e. in severe airflow obstruction), during the FRCpleth maneuver, the SVC may be performed independently (“unlinked”) of the FRCpleth in the spirometry program.
- If the patient is severely claustrophobic, has upper body paralysis, or is unable to bend both knees into a sitting position, they may be unable to perform the Lung Volume portion of their pulmonary function test. In these cases, please refer the patient to an alternate site that allows for the measurement of lung volumes without the use of a body plethysmograph, if clinically indicated.

Equipment

- Jaeger MasterScreen Body Plethysmograph with SentrySuite Software
- MicroGard Bacterial/Viral Filter
- Silicone Mouthpiece
- Nose Clip

Patient Preparation

- The patient should refrain from smoking 1 hour prior to testing.
- The patient should not eat a large meal immediately prior to testing.
- If possible, the patient should be tested at the same time of the day as previously tested due to diurnal variation.
- The patient should wear loose, comfortable clothing that does not restrict chest expansion.
- Patients may need to withhold taking certain respiratory medications before testing if possible.
- Patients will have to remove their supplemental oxygen for testing. Patients should be assessed for their ability to tolerate the removal of their supplemental oxygen for the duration of the testing.
- The patient should be seated upright.
- Assess the patient for the physical and mental ability to undergo testing.
- Review the Pre Test Questionnaire with the patient to determine any contraindications to testing.

Procedure

Steps

1. From the SentrySuite desktop, click on “Applications” button. Select “Body Plethysmography” from the pop-up menu.
2. Enter patient demographics:
    - New Patients: Select ‘New’ from the patient information box. Enter patient data on the patient data pop-up screen. Click ‘OK’.
    - Previous Patients: Choose ‘Search’ from the patient information box. Enter PHN, or last name. Click ‘Search’. Choose correct patient from search result list. Click ‘Select’.
3. Ensure the patient is seated comfortably, with both feet flat on the floor. Adjust the mouthpiece to a comfortable height.
4. Explain the procedure to the patient and demonstrate appropriate technique.
5. Close the door to the Body Box and wait one minute or more to allow pressure within the body box to stabilize.
6. Press F1 to start measurement.
7. Confirm that there is no drift in the volume/time graph prior to placing the patient onto the mouthpiece.
8. Ask the patient to place the mouthpiece in their mouth and apply the nose clips to their nose.
9. Instruct the patient to breathe normally, in and out through their mouth.
10. After achieving a stable baseline of tidal breathing, initiate the FRCPleth measurement by pressing F1. This will activate the closing of the shutter for 3 seconds, at the end of expiration.

The patient should breathe against the closed shutter at a rate of 30 to 60 breaths per minute (or approx. one breath per second).

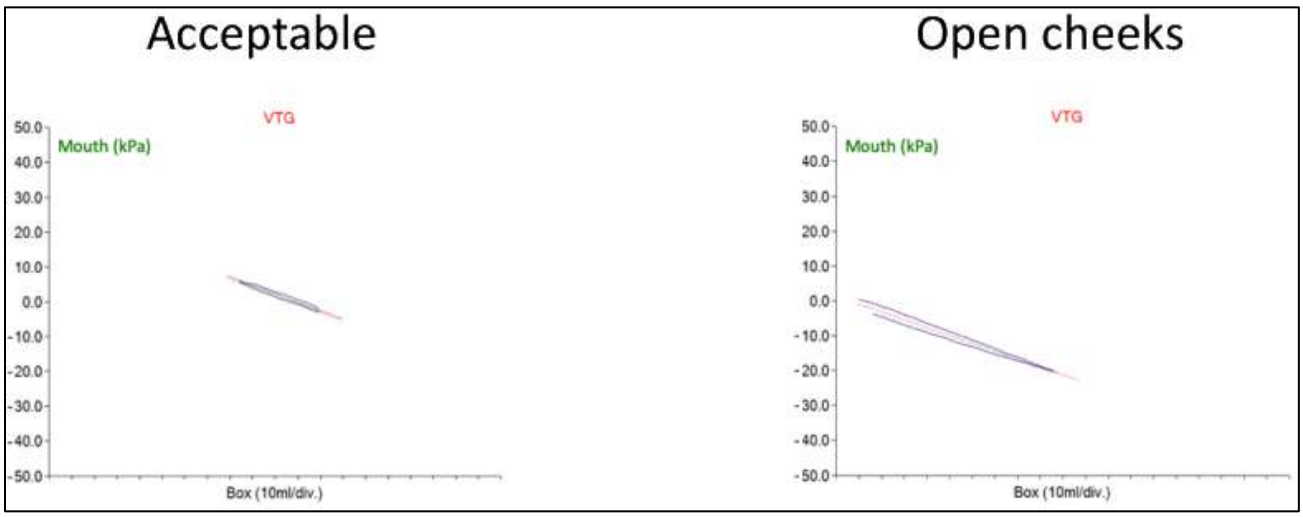
11. As soon as the FRCPleth maneuver is completed and the shutter reopens, instruct the patient to complete an SVC maneuver as per SHOP DST B-00-12-12113. There should be no delay between the reopening of the shutter and inspiratory effort of the SVC maneuver.

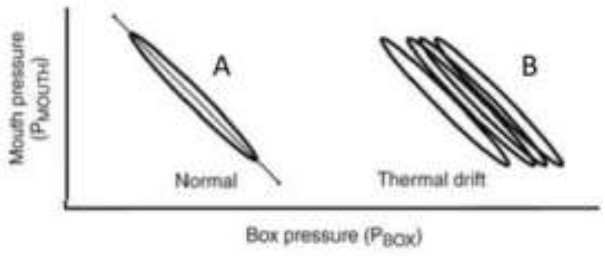
    Note: Patients with severe dyspnea may have difficulty performing linked spirometry immediately after closed shutter panting. To overcome this, instruct the patient to stay on the mouthpiece and take 2 to 3 tidal breaths after the panting maneuver, prior to performing the linked IC and exhaled VC maneuvers.

12. Repeat the testing sequence a minimum of 3 times, allowing the patient to rest in between maneuvers. FRCPleth curves should be tight, nearly identical in slope, and without artifact (refer to abstract for examples of normal and abnormal closed shutter loops). ATS recommends that the values obtained agree within 5%.

13. To continue with pulmonary function testing, choose a different test from the application drop-down menu or, if testing is complete, use the Desktop button to return the screen to the SentrySuite desktop and use the “close patient” button in the patient information box to clear any patient information from the screen.

Abstract





A: Normal closed shutter manoeuvre with the loop nearly closed.
B: Open loops due to thermal drift.

Documentation:

Within the SentrySuite application, generate a report by selecting the appropriate report icon. In the "Therapist Comment" box, use the "PFT" report template to comment on patient effort, ability to meet ATS criteria, and any other relevant information related to testing.

References

1. CareFusion Instructions for Use, MasterScreen Body, Body/Diff, Diff, PFT, IOS Manual for SentrySuite Software 2.19, Version 01.00.
2. Bhakta NR, McGowan A, Ramsey KA, et al. European Respiratory Society/American Thoracic Society Technical Standard on Standardisation of the Measurement of Lung Volumes - 2023 Update. Eur Respir J 2023
3. College of Physicians and Surgeons of British Columbia, Diagnostic Accreditation Program, *Accreditation Standards, Pulmonary Function* (May 3, 2017).

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