Patient Testing – Bronchial Challenge Testing

Audience All personnel in the Pulmonary Function Clinics.

Purpose To describe the procedure for performing a Bronchial Challenge (Methacholine Challenge). In Bronchoprovocation testing, Methacholine is used to diagnose airway hyperreactivity in patients with normal or mildly abnormal spirometry. Inhalation of methacholine by patients with hyperreactive airways results in bronchoconstriction due to the stimulation of cholinergic receptors located in the bronchial smooth muscle.

Indications The following are specified indicators for Bronchial Challenge Testing:

- Patients with chronic recurrent cough and/or recurrent respiratory infections.
- Subjective history of wheezing or shortness of breath not readily apparent on physical exam.
- Symptoms suggestive of an abnormal airway reactivity but not demonstrated by basic pulmonary function testing.

Contraindications

Absolute

- Severe airflow limitation (FEV1<50% or <1.0L
- Heart attack or stroke in last 3 months
- Uncontrolled Hypertension; systolic BP>200 mmHg or diastolic BP >100 mmHg.
- Known aortic aneurysm.

Relative

- Moderate airflow limitation (FEV1<60% predicted or <1.5L)
- Inability to perform acceptable-quality spirometry
- Pregnancy
- Nursing Mothers
- Current use of cholinesterase inhibitor (for myasthenia gravis)
- History of Cardiovascular problems, see ATS guidelines.

If the patient has had an upper respiratory infection within the last 3-6 weeks prior to the study, testing may be rescheduled depending on symptoms.

Precautions Inform Pulmonary Fellow when testing is scheduled and prior to procedure.

Prepare a nebulizer with a beta-agonist agent in order to reverse bronchoconstriction at the completion of the study and/or should complications arise due to severe bronchoconstriction.

Check for any anti-arrhythmic medication the patient may be taking as these medications may produce a false negative test result.

The therapist will ask the patient to close their eyes to avoid conjunctival exposure. Patients may choose to not close their eyes; however, this is at their own risk.

Patient education is extremely important in Bronchoprovocation studies, not only to reduce patient anxiety, but also to ensure reliability of the results. It is important that the patient give a consistent effort on the first forced vital capacity maneuver following each level of methacholine exposure. The reason for this is that a deep breath to total lung capacity during spirometry can temporarily dilate someone who has reacted to methacholine.

Scheduling and Withholding Medications

Patient will be contacted for scheduling and should give a list of medications, including over-the-counter. The list of the patient's current medications will be sent to the fellow on PFT rotation to determine which of their meds needs to be withheld and length of time to hold. Once list is received from fellow, patient will be contacted with instructions, and can be mailed a letter for instructions (or Unit if TDC patient). The appointment may need to be adjusted at that time. The following items should be withheld for the designated time specified:

B-Adrenergic agents (oral or inhaled)	12 hours
Anticholinergic aerosols	24 hours
Tiotropim	48 hours
Long acting beta agonists (Salmeterol)	48 hours
Sustained-action theophylline Preparations	48 hours
Cromolyn sodium and related Preparations	48 hours
Antihistamines	72-96 hours
H_1-receptor antagonists	72-96 hours
Caffeine containing drinks (cola, coffee)	24 hours
B-Blocking agents	May increase response
Corticosteroids, inhaled or oral	Subjects should be challenged while taking a stable (not tapered) dose.

Background Bronchial Challenge testing is used to identify and characterize airway hyper reactivity. Challenge tests are performed in subjects with symptoms of bronchospasm who have normal pulmonary function studies or uncertain results of bronchodilator studies. Bronchial challenge can also be used to assess changes in hyper reactivity of the airways or to quantify its severity. Bronchial challenge tests are sometimes used to screen individuals who may be at risk from environmental or occupational exposure to toxins.

Several commonly used provocative agents can be used to assess airway hyper reactivity. These include the following:

- Methacholine challenge
- Histamine challenge
- Eucapnic hyperventilation (using either cold or room temperature gas)
- Exercise

Each of these agents may trigger bronchospasm, but in slightly different ways. In the Pulmonary Function Clinic, methacholine is used. Methacholine is a chemical stimulus that increases parasympathetic tone in bronchial smooth muscle. Pulmonary function variables are assessed before and after exposure to the challenge. FEV1 is the variable most commonly used.

Preparation of Methacholine

The preparation procedure for single patient testing is as follows:
Supplies needed:

- One vial of Provocholine (100mg) unconstituted.
- Two 10ml vials 0.9% sodium chloride solution containing 0.4% phenol (pH 7.0).
- Six 10cc syringes with needles.
- 1- filtered nebulizer kit
- 1 nebulizer kit
- PPE, Gown, gloves, goggles, head cover, and N-95 mask (for staff to wear during testing to minimize exposure)

Dilution sequence:

Vial/Neb	Add	Concentration
A	4ml of 0.9% NaCl solution (Described above) to vial of Provocholine	25mg/ml
B	1ml from vial A + 1.5ml NaCl Solution	10mg/ml
C	1ml from vial A + 4ml NaCl Solution	5mg/ml
D	1ml from vial C + 1ml NaCl Solution	2.5mg/ml

Procedure The following is a summary involved in performing a Bronchial Challenge test on a patient in the Pulmonary Function Clinic. While this procedure is accurate in

content, the therapist must understand Breeze (testing software) staging protocol for testing, so results are entered and reported accurately.

Note: Ideally, only one FVC maneuver should be performed per trial of Bronchoprovocation; however, should the first FVC maneuver not meet ATS criteria a maximum of 2 additional FVC's may be performed.

On the computer:

- After entering in the patient information, click on the Protocol Log tab at the bottom of the screen.
- In the Protocol dialog box, click on the drop down menu and select the protocol you wish to use – Methacholine Challenge.
- Click on the tab of the first test you wish to perform. For the Pulmonary Function Clinic, FVC needs to be selected.
- Perform all of the testing for each stage before proceeding to the next stage. After testing is complete in one stage, click on the Protocol Stage drop down menu and select the next stage.
- Stages can be skipped if on a particular patient you do not wish to test in that stage.
- After all the testing is complete, verify that each stage has at least one effort selected (red checkmark in the Select column).
- Also, verify that there is a Pre/Baseline, Challenge and Post marker in the Test Mode column of the FVC and Pleth screens if both tests were performed.
- The Dose Units (NaCl, 2.5mg/ml, 5.0 mg/ml, 10.0 mg/ml, and 25.0 mg/ml), Cumulative Doses and PC20 are automatically calculated.
- Click on Reports in the Menu bar and go to the Report Switchboard. Print the appropriate Bronchial Provocation (BRP) report in case Breeze loses the data, or the fellow needs a copy if they can't see the results.

For the patient:

- Ensure that the patient's medical record has been reviewed by the Medical Director of the Pulmonary Function Clinic or a Pulmonary Fellow.
- Inform Pulmonary Fellow when testing is scheduled and prior to procedure.
- Explain the test to the patient. Tell them they may experience some minor symptoms, such as cough or chest tightness, but usually none. Make sure that your explanation is understood. This helps ease any anxieties that the patient may have and ensures reliable test results.
- Review contraindication list, and make sure patient is comfortable including emptying bladder before testing begins.
- Do Pre-Rx spirometry and if applicable, and arterial blood gas.

- If the FEV1 is less than 60% of the predicted or the PaO2 is less than 60mmHg, DO NOT PROCEED WITH THE TEST. Notify the ordering physician, that testing does not meet criteria and will not proceed due to further compromising patient breathing. If the ordering physician wishes to proceed with testing, and notify the Medical Director or rotating Pulmonary Fellow for advisement. This pulmonary laboratory will use spirometry unless otherwise ordered.
- Using a small volume filtered nebulizer loaded with 1cc of the above-described NaCl solution, have the patient inhale slowly from FRC to near TLC five times. This is done to assess whether the patient reacts to the diluent used in the methacholine solution.
- At exactly 5 minutes after inhaling the NaCl solution, have the patient perform a FVC maneuver.
- If the FEV1 is less than 80% of the Pre-Rx FEV1, discontinue the test. If the FEV1 is greater than or equal to 80% of the Pre-Rx FEV1, then this value will be the baseline for the remainder of the test. Empty remining contents of neb into regular trash can or specimen cup.
- Have the patient inhale slowly from FRC to near TLC one breath of a 2.5 mg/ml methacholine solution (empty out prior solution in nebulizer before adding new solution). At exactly 5 minutes after inhalation, have the patient perform the FVC maneuver.
- If the FEV1 is greater than 80% of the baseline, empty contents of neb, and proceed to the next step. If the FEV1 is less than or equal to 80% of the baseline FEV1, stop the test and proceed with the instructions for Discontinuation of Bronchoprovocation Testing, as this is a positive response.
- Have the patient inhale 4 breaths of the 2.5 mg/ml solution. At 5 minutes after inhalation, have the patient perform a FVC maneuver.
- If the FEV1 is greater than 80% of the baseline, empty contents of neb, and proceed to the next step. If the FEV1 is less than or equal to 80% of the baseline FEV1, stop the test and proceed with the instructions for Discontinuation of Bronchoprovocation Testing, as this is a positive response.
- Have the patient inhale 5 breaths of the 5.0 mg/ml solution. At 5 minutes after inhalation, have the patient perform a FVC maneuver.
- If the FEV1 is greater than 80% of the baseline, empty contents of neb, and proceed to the next step. If the FEV1 is less than or equal to 80% of the baseline FEV1, stop the test and proceed with the instructions for Discontinuation of Bronchoprovocation Testing, as this is a positive response.
- Have the patient inhale 5 breaths of the 10 mg/ml solution. At 5 minutes after inhalation, have the patient perform a FVC maneuver.
- If the FEV1 is greater than 80% of the baseline, empty contents of neb, and proceed to the next step. If the FEV1 is less than or equal to 80% of the baseline FEV1, stop the test and proceed with the instructions for

Discontinuation of Bronchoprovocation Testing, as this is a positive response.

- Have the patient inhale 5 breaths of the 25.0 mg/ml solution. At 5 minutes after inhalation, have the patient perform a FVC maneuver.
- If the FEV1 is greater than 80% of the baseline, proceed to the next step. If the FEV1 is less than or equal to 80% of the baseline FEV1, stop the test and proceed with the instructions for Discontinuation of Bronchoprovocation Testing, as this is a positive response.
- If the FEV1 has not decreased by this time, discontinue the test. This is a negative response to Bronchoprovocation.
- With a new nebulizer, give the patient a beta-agonist agent (this lab will use 2.5mg Albuterol nebulize), even though they had a negative response.

Discontinuing Test

If at any time during the test the patient's FEV1 has been documented as being decreased to 80% or less of their baseline value, the therapist discontinues the test and administers a beta-agonist via small volume nebulizer. After allowing sufficient time for the agent to take effect, perform Post-Rx FVC maneuvers. The FEV1 should return to within 10% of the Pre-Rx value (before NaCl). If it does not, notify the Medical Director or Pulmonary Fellow.

Acceptability Criteria

The acceptability criteria for Challenge Testing are the following:

- The patient should follow pretesting instructions including withholding all bronchodilators before the test, be free of upper or lower respiratory infections, and not of ingested any caffeinated beverages before the test. Any criteria not followed will result in postponing the test. Therapist can contact fellow or Medical Director for advice.
- Spirometric and/or plethysmographic efforts must meet standard criteria for acceptability and reproducibility. For adults, two FEV1 measurements should be within 150 ml or 5% (depending on the criteria used by the laboratory) at each challenge level. For methacholine challenges, a nebulizer that produces aerosol particles in the 2 to 5 um range should be used. Nebulizer output, inspiratory flow, lung volume, and breath-hold time should be consistent for all levels (doses) of challenge.
- For all challenge protocols, clinical signs and symptoms (e.g., presence or absence of coughing, wheezing, should be documented).

Report

The FVC, FEV1, FEF 25-75 and PEF results for Pre and Post-Rx, along with the baseline of each level of Bronchoprovocation will be reported. Therapist will comment on the maximum dosage received during the test.
The trend and flow-volume graphics will be included in the final report.

The report will be submitted for interpretation by faculty and/or fellow.

This form documents the approval and history of the policies and procedures for the Pulmonary Function Laboratory. The Medical Director signs all policies verifying initial approval. Annually thereafter, the Director and/or designee may approve reviews and revisions.

Date	Approved by:	Signature
11/07	**V. Cardenas, MD** **Medical Director Pulmonary Laboratory**	
6/09	**V. Cardenas, MD** **No changes to the policy**	
7/10	**V. Cardenas, MD** **No changes to the policy**	
2/12	**A. Duarte, MD** **Medical Director Pulmonary Laboratory**	
5/14	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
8/16	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
8/17	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
11/17	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
8/19	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
9/21	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **Changes made to policy**	
8/23	**A. Duarte, MD** **Medical Director Pulmonary Laboratory** **No changes made to policy**	