Patient Testing – Bronchial Challenge Testing

**Audience**
All personnel in the Pulmonary Function Clinic.

**Purpose**
To describe the procedure for performing a Bronchial Challenge. Bronchoprovocation testing using 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**
The following are specified contraindications for Bronchial Challenge Testing:
- Patients with known hypersensitivity to methacholine or other parasympathomimetic agents.
- Patients receiving Beta-adrenergic blocking agents (because they may potentate the effects of the Methacholine).
- Patients with known moderate to severe airway obstruction on baseline pulmonary function studies or reversible airway disease demonstrated by pre and post bronchodilator pulmonary function studies or whose FEV1 is <.70.
- If the patient has had an upper respiratory infection within the last three weeks prior to the study, reschedule the study for a later date.
- Pregnancy
- Uncontrolled Hypertension; systolic BP >190 mmHg or diastolic BP >100 mmHg.

**Precautions**
Notify a Pulmonary Fellow or Faulty when the test is to begin.

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.

Always have the patient close their eyes so as to avoid conjunctival exposure.
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.

### Background

Bronchial Challenge testing is used to identify and characterize airway hyperreactivity. 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 hyperreactivity 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 hyperreactivity. 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.

**Dilution sequence:**

<table>
<thead>
<tr>
<th>Vial/Neb</th>
<th>Add</th>
<th>Concentration</th>
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<tbody>
<tr>
<td>A</td>
<td>4ml of 0.9% NaCl solution (Described above) to vial of Provocholine</td>
<td>25mg/ml</td>
</tr>
<tr>
<td>B</td>
<td>1ml from vial A + 1.5ml NaCl</td>
<td>10mg/ml</td>
</tr>
</tbody>
</table>
Solution

C 1ml from vial A + 4ml NaCl 5mg/ml
Solution

D 1ml from vial C + 1ml NaCl 2.5mg/ml
Solution

**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 Med Graphics protocol for testing.

**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 or Raw 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.

For the patient:
- Insure that the patient’s medical record has been reviewed by the Medical Director of the Pulmonary Function Clinic or a Pulmonary Fellow.
- Instruct the patient on the complete procedure, making sure that your explanation is understood. This helps ease any anxieties that the patient may have and ensures reliable test results.
- Do Pre-Rx spirometry and if applicable, an arterial blood gas.
• If the FEV1 is less than 70% of the predicted or the PaO2 is less than 60mmHg, DO NOT PROCEED WITH THE TEST. Notify the ordering physician. If the ordering physician wishes to proceed with testing, notify the Medical Director regarding results.

• Using a small volume 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 and notify the Medical Director due to this being a positive response to Bronchoprovocation. 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.

• 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, 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, 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, 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, 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.
- Give the patient a beta-agonist agent, even though they had a negative response.

**Discontinuing Test**

If at anytime during the test the patient’s FEV1 has been documented as being decreased to 80% or less of their baseline value, discontinues the test and administer 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. If it does not, notify the Medical Director or Pulmonary Fellow.

**Withholding Select Items**

The following items should be withheld for the designated time specified:

- B-Adrenergic agents (oral or inhaled) 12 hours
- Anticholinergic aerosols 12 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
- H1-receptor antagonists 48 hours
- Caffeine containing drinks (cola, coffee) 6 hours
- B-Blocking agents May increase response
- Corticosteroids, inhaled or oral Subjects should be challenged while taking a stable dose.

**Acceptability Criteria**

The acceptability criteria for Challenge Testing are the following:

- The patient should withhold all bronchodilators before the test. The patient should also be free of upper or lower respiratory infections and not of ingested any caffeinated beverages before the test.
- 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.

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.

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<thead>
<tr>
<th>Date</th>
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<th>Signature</th>
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| 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 | |