Objectives

• To understand the uses and importance of spirometry testing
• To perform spirometry testing including reversibility testing
• To identify normal and abnormal patterns and classify asthma severity
• To review the definitions of lung volumes and capacities

Objectives

• To understand the value of spirometry for asthma diagnosis and management in the primary care setting
• To feel comfortable in the interpretation of PFTs and be able to use them as an aid in the diagnosis of obstructive and restrictive pulmonary disease
• To have a basic understanding of how to properly administer a PFT
Myths

• Spirometry is a poor test of little benefit
• Equipment is expensive, works poorly
• Spirometry is hard to do right
• Numbers are difficult to interpret

Objective Testing

• Spirometry is a powerful diagnostic and assessment tool
• Provides clear, objective documentation of lung function
• Reliable tool to obtain pulmonology vital signs
  - easy to use and accurate
  - carried out in primary care setting

Spirometry in primary care...

• Improves clinical outcomes through better diagnosis and staging
• Supports motivation and lifestyle
• Promotes more appropriate referrals to specialists
• Generates revenue
Spirometry in the Management of Asthma and COPD

• Spirometry permits an objective measurement of the degree of airway obstruction (impairment and risk)
  – Patients' perceptions of obstruction are notoriously inaccurate
  – Significant obstruction can be present even when the chest is clear on physical examination
  – Clinical symptoms alone will underestimate severity up to 30% of the time in primary care
  – PEF (peak expiratory flow) testing alone is highly variable, is not a very sensitive measure of obstruction, and is no longer recommended for diagnosis

Barriers to Performing Spirometry in Primary Care

– Lack of training for support staff and providers
– Lack of a spirometer (or its use)
– Lack of time (problems with work flow and lack of planned visits)
– Lack of interest or enthusiasm in incorporating a new device and procedure
– Lack of incentives

Desktop Electronic Spirometers

• Portable
• Easy to calibrate
• Immediate feedback
• Billable
When to Utilize Spirometry

- Symptoms:
  - chronic cough
  - frequent colds
  - dyspnea
  - wheezing
  - orthopnea
  - chest pain

- Signs:
  - hyperinflation
  - expiratory slowing
  - cyanosis
  - chest deformity

Indications for Spirometry

- Used to determine:
  - Presence and severity of disease
  - Response to treatment
  - Etiology of disease
  - Reversibility
  - Surgery risk evaluation
  - Disability
  - Progression and variability of disease

When should spirometry be performed and how often?

- 1-6 month intervals:
  - At time of initial assessment
  - After treatment is initiated and symptoms and PEF have stabilized
  - During periods of progressive decline or extended loss of asthma control

At least every 1-2 years
What is Spirometry?

- Spirometry is a method of assessing lung function by measuring the volume of air the patient can expel from the lungs after a maximal inspiration.

Benefits of Spirometry

- Spirometry results can help confirm a diagnosis of asthma
- Spirometry shows severity of airways obstruction
  - peak flow shows only a moment in time
  - spirometry looks at the breathing process over time
- Spirometry and the bronchodilator test
  - allows patient to see benefit of medication
  - allows physician to better assess patient response to medication and adjust treatment regimen as appropriate

Spirometry

- Quantifies patients ability to exhale
- Measures basic lung function – spirometry values
  - Total exhaled volume: forced vital capacity (FVC)
  - Forced expiratory volume exhaled in first second (FEV1)
  - Ratio of volume exhaled in first second to total (FEV1/FVC)
Interpreting Results

• Spirometry allows comparison of patient’s lung function to reference values
• Helps to define disease class: obstructive, restrictive or mixed type

Inter-individual variability

• Age
• Sex
• Race
  – Race correction factor
  • NHANES for those 8 and older
  • Wang et al for children < 8 years old
• Height (measure with shoes off)
• Room temperature

Predicted normal lung values

• Based on large population surveys
• Predicted values are the mean values obtained from the survey
• No surveys have been done in elderly populations
Lung Volume Terminology

- Total lung capacity
- Inspiratory reserve volume
- Tidal volume
- Expiratory reserve volume
- Vital capacity
- Residual volume

Normal Trace Showing FEV₁ and FVC

- FEV₁ = 4L
- FVC = 5L
- FEV₁/FVC = 0.8

Spirogram Patterns

- Normal
- Obstructive
- Restrictive
- Mixed Obstructive and Restrictive
Spirometry:
Obstructive Disease

FEV1 = 1.8L
FVC = 3.2L
FEV1/FVC = 0.56

Diseases Associated w/ Airflow Obstruction

• Obstruction: Characterized by a limitation of expiratory airflow so that airways cannot empty as rapidly compared to normal (such as through narrowed airways from bronchospasm, inflammation, etc.)
  • COPD
  • Asthma
  • Bronchiectasis
  • Cystic fibrosis
  • Post-tuberculosis
  • Lung cancer (greater risk in COPD)
  • Obliterative bronchiolitis

Diseases Associated w/ Airflow Restriction

• Restriction: Characterized by reduced lung volumes/decreased lung compliance
  • Interstitial fibrosis
  • Scoliosis
  • Obesity
  • Lung resection
  • Neuromuscular diseases
  • Cystic fibrosis
CRJ1  Sue i have inserted a bracket and shifted the obstructive label. The FVC in this slide is about 3.4 by eyeball - should be moved down to 3.2 or the numbers should be changed

Christine Jenkins, 4/14/2008
Results

• An increase in FEV₁ that is both greater than 200 ml and 12% above the pre-bronchodilator FEV₁ (baseline value) is considered significant

• It is usually helpful to report the absolute change (in ml) as well as the % change from baseline to set the improvement in a clinical context

Flow Volume Loop

• Standard on most desk-top spirometers
• Adds more information than volume time curve
• Less understood but not too difficult to interpret
• Better at demonstrating mild airflow obstruction

Flow Volume Loop
Expiration is the area above the "waterline" Indicates lung disease
need to delete Figure reference.
Christine Jenkins, 4/14/2008
Flow Volume Loop: Inspiration is the area below the “waterline” indicates extrathoracic area.

- **Expiratory flow rate (L/sec)**
- **Volume (L)**
  - **FVC**
  - **Maximum expiratory flow (PEF)**

**Flow Volume Curve Patterns**

- **Obstructive**: Severe obstructive
  - Reduced peak flow, steeple pattern, scooped out mid-curve

- **Restrictive**: Normal shape, normal peak flow, reduced volume

**Spirometry: Volume Time Curve**

- FEV₁ = 1.8L
- FVC = 3.2L
- FEV₁/FVC = 0.56

- **Normal**

**Volume, liters  Time, seconds**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow Volume Loop</th>
<th>Inspiration is the area below the “waterline” Indicates extrathoracic area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expiratory flow rate L/sec</td>
<td>Volume (L)</td>
</tr>
<tr>
<td>Maximum expiratory flow (PEF)</td>
<td>FVC</td>
</tr>
</tbody>
</table>

**Flow Volume Curve Patterns**

- **Obstructive**: Severe obstructive
  - Reduced peak flow, steeple pattern, scooped out mid-curve

- **Restrictive**: Normal shape, normal peak flow, reduced volume

**Spirometry: Volume Time Curve**

- FEV₁ = 1.8L
- FVC = 3.2L
- FEV₁/FVC = 0.56

<table>
<thead>
<tr>
<th>Volume, liters</th>
<th>Time, seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
Sue I have inserted a bracket and shifted the obstructive label. The FVC in this slide is about 3.4 by eyeball - should be moved down to 3.2 or the numbers should be changed.

Christine Jenkins, 4/14/2008
Spirometry: Abnormal Patterns

- **Obstructive**
  - Slow rise, reduced volume expired; prolonged time to full expiration

- **Restrictive**
  - Fast rise to plateau at reduced maximum volume

- **Mixed**
  - Slow rise to reduced maximum volume; measure static lung volumes and full PFTs to confirm

Ensuring Accuracy: Best Effort

- **Best effort**
  - Inhale as deeply as possible
  - Exhale as fast and as long as possible
  - Exhale for at least six seconds

- **Reproducibility**
  - Two "best efforts" out of a minimum of three exhalations, no more than 6-8 attempts
  - Largest and second largest FVC and FEV1 within 0.15 L of each other

No spirometry effort should be rejected due to poor reproducibility; just document

Unacceptable Efforts

- Lack of full inspiration
- Lack of maximum effort
- Effort too short
- Presence of cough in first second
- Obstructed mouthpiece
- Unsatisfactory start, hesitation
- Excessive variability between efforts
Preparing the patient..

Patients are asked:
- Avoid smoking within 2 hrs of test
- Avoid drinking alcohol within 4 hours
- Avoid vigorous exercise within 30 minutes
- Avoid restrictive clothing
- Avoid eating substantial meal within 2 hours
- Avoid SABA within 4-6 hours
- Avoid LABA within 12 hours

Preparing and coaching

- Patient should sit (feet on floor) or stand with chair behind patient in case of dizziness (document if done standing, repeat with future testing)
- Loosen any restrictive clothing
- Reassure patient: help them feel relaxed
- Explain in simple terms what the test measures
- Explain the technique in simple terms and then demonstrate how it is done
- Make sure the mouthpiece is placed between the teeth and that the tongue and teeth do not occlude the mouthpiece.

Special considerations in pediatric patients

- Be creative
- Use incentives
- Even with the best of environments and coaching, a child may not be able to perform spirometry
- Patients need a calm, relaxed environment and good coaching. Patience is key
- Ability to perform spirometry dependent on developmental age of child, personality, and interest
Coach the patient!!!!

- BLAST IT OUT!!!
- BLOW!! BLOW!! BLOW!!
- SQUEEZE! SQUEEZE!! SQUEEZE!!!!
- PUSH! PUSH!! PUSH!!! PUSH!!!!
- KEEP GOING! KEEP GOING!

Troubleshooting

Examples - Unacceptable Traces

Unacceptable Trace: Poor Effort

- Variable expiratory effort
- Inadequate sustaining of effort
- May be accompanied by a slow start
Unacceptable Trace: Stop Early

Unacceptable Trace: Slow Start

Unacceptable Trace: Coughing 1st Second
Spirometry vs. Peak flow meter

- Peak Flow Meter is used for monitoring only
- Measures only large airway function
- No graphic display or printout
- No regular calibration

Spirometry reimbursement

- Cost of spirometry:
  - 94010 Spirometry test – FVC: $70.00
  - 94060 Pre-Post Bronchodilator Spirometry test: $145.00
Spirometry is a powerful diagnostic and assessment tool:
- provides clear documentation of lung function
- Spirometry is easy to use and accurate
  - can be carried out in the primary care setting
  - offers test results to include in patient’s chart
- Spirometry measures lung airflow
  - helps detect obstructive and restrictive lung disease
  - objectively measures and illustrates the severity of lung disease

Questions?

- MT Asthma Control Program
  - Jessie Fernandes, Program Manager
  - (406) 444-9155, jfernandes@mt.gov
- Dewey Hahlbohm, Medical Consultant
  - (406) 442-6934, hahlbohmd@earthlink.net