Clinical Approach to Obstructive and Restrictive Lung Diseases

Kevin P Simpson, MD
Pulmonary & Critical Care Medicine

aka…
“A Pulmonary Approach to Dyspnea”

General Categories of Dyspnea
- Cardiac
- Pulmonary
- Other:
  - Renal (Acidosis)
  - Anemia
  - Neuromuscular

Obstruction
Restriction
Pulmonary Hypertension
Specific Goals

- Obstructive Lung Disease
  1. Asthma
  2. COPD
  3. Emphysema
  4. Chronic Bronchitis
  5. Bronchiectasis

- Restrictive Lung Disease
  1. Interstitial Lung Disease
  2. Sarcoid
  3. UIP/IPF
  4. Chest Wall
  5. Neuromuscular

*Usual Interstitial Pneumonitis; Idiopathic Pulmonary Fibrosis

"Obstruction vs Restriction" Why Does It Matter?

- Both present with Dyspnea
- However...
  - Different Pathophysiology
  - Different Prognosis
  - Different Treatment Options

Obstruction
- Increased Raw
- Large Lungs

Restriction
- Abnl ER/Strength
- Small Lungs

Raw = Airways Resistance; ER = Elastic Recoil
Obstruction vs Restriction

Obstruction
- Increased Raw
- Large Lungs
- Wheezing
- ↓d FEV₁/FVC (flows)

Restriction
- Abnl ER/Strength
- Small Lungs
- Crackles
- Decreased TLC

ALL: SOB, DOE, Cough

Obstructive Lung Diseases

Asthma ~ COPD ~ Bronchiectasis

Symptoms: SOB/DOE, Cough, Tightness, Audible Wheezing
Signs: Poor Air Movement, Wheezing
CXR: Hyperinflation
PFT's: Decreased FEV₁/FVC ratio
Asthma

- Submucosal edema/inflammation, mucous gland hyperplasia, smooth muscle hypertrophy
  - Potential for "airway remodeling"
- 5% of adults...
  - occurs at any age
- Episodic ...
  - obstruction / bronchial hyper-reactivity
- Episodic ...
  - SOB/DOE
  - Wheezing
  - Cough
  - Chest Tightness

Asthma: Diagnosis

- Typical History and Physical Exam
  - Clinical Response to Treatment
- PFT’s
  - Obstruction with a significant Bronchodilator Response
  - Normal but a positive Methacholine Challenge Test

Classification...

- Mild Intermittent
  - <2*, <2, >80%, <20%
- Mild Persistent
  - 3-6, 3-4, >80, 20-30
- Moderate Persistent
  - Daily, >5, 60-80, >30
- Severe Persistent
  - Continual, Frequent, <60, >30
- Peak Flow < 80%
  - .... MORE Rx!
- Peak Flow < 50%
  - ....SEVERE!

*DAYTIME symptoms/wk, NIGHTTIME symptoms/mo, Baseline FEV1 or Peak Expiratory Flow Rate (PEFR), PEFR variability
Asthma: Treatment

“Relievers”
- PRN Use
- Bronchodilators

“Controllers”
- Regular Use
- Anti-Inflammatory

“Relievers”
- Mainly Short Acting β-agonists
  - Metered Dose Inhalers (MDI’s)

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  - Nebulizers
“Relievers”

- Mainly Short Acting β-agonists
  - Metered Dose Inhalers (MDI’s)
  - Nebulizers
  - Also PO, Subcutaneous, IV, per ETT

**ETT = Endotracheal Tube**

“Asthma: Controllers”

- First Line = Inhaled Corticosteroids
  - Beclomethasone, Budesonide, Ciclesonide, Fluticasone, Mometasone
  - Must be taken regularly
  - Common SE’s:
    - Oral-Pharyngeal (prevented with spacer)
  - SE’s of Unclear Significance:
    - HPA* Axis, Bone, Cataracts

*Hypothalamic-Pituitary-Adrenal*
Second Line Therapy (along WITH inhaled corticosteroids)

- Long Acting β-Agonists
  - salmeterol, formoterol
  - often combined with ICS's
- Anti-Leukotrienes
  - montelukast, zafirlukast, zileutin
- Less Common:
  - Cromolyn
  - Theophylline
  - Anti-Cholinergics
  - Omalizumab
- Last Resort:
  - Chronic oral steroids
- Experimental:
  - Thermoplasty

Special Considerations

- Cough-Variant Asthma
  - Sometimes the only symptom of asthma
  - 1 of the 3 most common causes of chronic cough, along with PND and GERD
Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma*
  - Increased minute ventilation results in mucosal ‘dehydration’ and mast cell degranulation
  - Worse in cold, dry air
  - Either exercise in humid conditions, or
  - Albuterol pre-exercise

*Sometimes called “EIB” for Exercise-Induced Bronchospasm
Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma
- Post-Nasal Drip
- GERD

Occupational Asthma
- Due to inhalational trigger in work environment
  - Sensitizer-induced specific immunologic response (IgE related)
  - Irritant-induced – not requiring sensitization
- Symptoms/PF’s worsen during work day/work week and improve weekends/vacations

Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma
- Post-Nasal Drip
- GERD
- Occupational Asthma

RADS (Reactive Airways Dysfunction Syndrome)
- NO prior asthma
- “big bang” exposure with others affected
- Rx: Steroids
- Typically better in 6 months

Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma
- Post-Nasal Drip
- GERD
- Occupational Asthma
- RADS

- Churg-Strauss Vasculitis
Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma
- Post-Nasal Drip
- GERD
- Occupational Asthma
- RADS
- Churg-Strauss Vasculitis
- Aspirin Sensitivity

\[ \text{Samter's Triad = Asthma + Nasal Polyposis + ASA Sensitivity (and other NSAIDs)} \]

Rx: anti-leukotrienes

Special Considerations

- Cough-Variant Asthma
- Exercise-Induced Asthma
- Post-Nasal Drip
- GERD
- Occupational Asthma
- RADS
- Churg-Strauss Vasculitis
- Aspirin Sensitivity
- ABPA

ABPA
Allergic Bronchopulmonary Aspergillosis

Rx: Steroids > Antifungals

Table 4: Study proposed diagnostic criteria for allergic bronchopulmonary aspergillosis

- Patient has clinical symptoms and objective evidence of aspergillosis
- Positive skin test or serum aspergillus
- Positive blood cultures
- Positive sputum culture
- Positive bronchoalveolar lavage
- Positive bronchial biopsies

Rx: Steroids > Antifungals

ABPA
Allergic Bronchopulmonary Aspergillosis
Asthma Summary
- Episodic:
  - Dyspnea
  - Wheezing
  - Cough
  - Chest Tightness
- Inflammatory Etiology
- Inhaled Corticosteroids
  - The Mainstay of Therapy

Chronic Obstructive Pulmonary Disease (COPD)
Chronic Obstruction 2°:
- Emphysema:
  - Permanent distention of the distal air spaces with destruction of alveolar septa
- Chronic Bronchitis:
  - Excessive sputum production

COPD: Emphysema vs Chronic Bronchitis
- Pink Puffer
- Blue Bloater
COPD: Emphysema vs Chronic Bronchitis

- **Pink Puffer**
  - Maintains a normal PaCO₂
  - "Huffs and Puffs"
  - "Burns calories"
  - Therefore, maintains a normal PaO₂
  - Appears "pink"

- **Blue Bloater**
  - "Accepts" Hypercapnea
  - Less tachypneic
  - Doesn’t burn calories
  - Results in Hypoxia (Cyanosis)
  - Appears "blue"
  - Hypoxic Pulmonary Vasoconstriction
  - Edematous
  - "Bloated"
  - Lots of Mucous

COPD
Presentation:
- Insidious onset of
  - SOB/DOE
  - Cough
- MINIMAL day to day variability
COPD

Diagnosis:
- Typical History and Physical
- Clinical Response to Therapy
- PFT's:
  1. Obstruction with minimal bronchodilator response
  2. Hyperinflation
  3. Reduced Diffusing Capacity

COPD…Treatment

1. STOP SMOKING

Smoking Cessation
COPD...Treatment

1. STOP SMOKING
2. Medications
   1. Short-Acting Bronchodilators (MDI or Neb)
   2. Long-Acting Bronchodilators (MDI or Neb)
   3. Other:
      1. Corticosteroids (inhaled > PO), Azithromycin, Theophylline

Bronchodilators

<table>
<thead>
<tr>
<th>Short Acting</th>
<th>Long-Acting</th>
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<tbody>
<tr>
<td>SABA</td>
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<tr>
<td>Formoterol</td>
<td>Formoterol</td>
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<tr>
<td>Ipratropium</td>
<td>Ipratropium</td>
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<tr>
<td>Terbutaline</td>
<td>Terbutaline</td>
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<tr>
<td>1. Nebulizer</td>
<td>1. Nebulizer</td>
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<tr>
<td>2. MDI</td>
<td>2. MDI</td>
</tr>
<tr>
<td>2. SAMA</td>
<td>2. SAMA</td>
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<tr>
<td>1. Nebulizer</td>
<td>1. Nebulizer</td>
</tr>
<tr>
<td>2. MDI</td>
<td>2. MDI</td>
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<tr>
<td>1. Combination</td>
<td>Combination</td>
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<tr>
<td>1. Nebulizer</td>
<td>1. Nebulizer</td>
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<tr>
<td>2. MDI</td>
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COPD: “Staging” and Treatment

<table>
<thead>
<tr>
<th>Stage 0</th>
<th>“At Risk”</th>
<th>Normal Spirometry</th>
<th>Smoking Cessation</th>
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### COPD: “Staging” and Treatment

<table>
<thead>
<tr>
<th>Stage</th>
<th>COPD Level</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt; % Pred</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Mild COPD</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC &lt; 0.70</td>
<td>Normal FEV&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Short-Acting Bronchodilator(s)</td>
</tr>
<tr>
<td>Stage II</td>
<td>Moderate COPD</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; 50-80% pred</td>
<td>Long-Acting Bronchodilator(s)</td>
<td></td>
</tr>
<tr>
<td>Stage III</td>
<td>Moderately Severe COPD</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; 30-50% pred</td>
<td>Add ICS’ s</td>
<td></td>
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</table>
COPD: “Staging” and Treatment

Stage IV  Severe COPD  FEV₁ < 30% pred  Methylxanthines

COPD: New Classification System*

COPD…Treatment

1. STOP SMOKING
2. Medications
3. Long-term Oxygen Therapy
Long-Term Oxygen Therapy

COPD...Treatment

1. STOP SMOKING
2. Medications
3. Long-term Oxygen Therapy
4. Cardiopulmonary Rehabilitation
COPD…Treatment

1. STOP SMOKING
2. Medications
3. Long-term Oxygen Therapy
4. Cardiopulmonary Rehabilitation
   - Other:
     - Transplantation
     - Check alpha-1-antitrypsin level

Bronchiectasis

- Pathology:
  - A suppurative lung disease characterized by permanent abnormal dilation of the bronchi

Pathogenesis:

Cole’s Vicious Cycle of Inflammation Model

- G-negatives
  - F. pneumophila
  - G. volubilis
  - H. influenzae
- G-positives
  - N. meningitidis
  - N. gonorrhoeae
  - S. pneumoniae
  - M. catarrhalis
  - S. aureus
  - S. pyogenes (group A streptococci)

Adapted from McShane et al, AJRCCM 188(6), p647-656, 2013.
Bronchiectasis

Symptoms:
- SOB/DOE
- Daily copious sputum production
  - Though occasionally “Dry Bronchiectasis”

Associated Causes:
- Pneumonia, Common Variable Immune Deficiency, ABPA, Cystic Fibrosis, Kartagener’s, Rheumatoid Arthritis
- Often coexistent sinusitis

Bronchiectasis

Diagnosis:
- Clinical
  - Obstructed PFT’s with Daily Copious Sputum
  - Radiographic demonstration of abnormal airways (CXR or CT)
    - “Signet Ring Sign”
      - The internal diameter of the bronchus is larger than that of its accompanying vessel
    - “Tram Tracking”
      - The bronchus fails to taper in the periphery of the chest.
### Bronchiectasis

**Goals of Therapy:**
- Break the vicious cycle of mucus stasis, infection, inflammation, and airway destruction
  - Airway Clearance Therapy
    - CPT (chest percussion therapy), 7% Hypertonic Saline, Bronchodilators
  - Antibiotic Therapy
    - Suppressive vs Eradication
  - Anti-inflammatory Therapy
    - Inhaled corticosteroids, Macrolides
- Transplantation

### Obstructive Lung Diseases

**The Big Three**
- Asthma
- COPD
  - Emphysema
  - Chronic Bronchitis
- Bronchiectasis

**Rare/Others**
- Bronchiolitis Obliterans
- Lymphangioleiomyomatosis (LAM)
- Toxic Inhalation

### Restrictive Lung Disease

**Definition** = ↓ TLC

**Three Categories**
- Interstitial Lung Disease (↑ Lung ER)
- Chest Wall Disease (↓ Chest Wall ER)
  - (ex, Kyphoscoliosis, Obesity, Ascites)
- Neuromuscular Disease
  - (normal FRC, ↓ TLC, ↑ RV)
  - (ex, ALS, Muscular Dystrophy, Myopathies)
Restrictive Lung Disease
- Restriction = ↓ TLC
- Three Categories
  - Interstitial Lung Disease (↑ Lung ER)
  - Chest Wall Disease (↓ Chest Wall ER)
    - (KS, Obesity, Ascites)
  - Neuromuscular Disease
    - (normal FRC, ↓ TLC, ↑ RV)
    - (ALS, MD, Myopathies)

95% Interstitial Lung Disease
(aka Diffuse Parenchymal Lung Disease)
Definition:
- Chronic, non-malignant, non-infectious inflammation and/or derangement of the alveolar walls
- “stuff in the interstitium”
- Increased Elastic Recoil

Interstitial Lung Disease
Includes:
- Pulmonary Fibrosis
- Sarcoidosis
- Pneumoconiosis
- Healed ARDS (“fibroproliferative phase”)
- Drug Toxicities
- Collagen Vascular Diseases
  ..........MANY....MANY....Others

ARDS = Adult Acute Respiratory Distress Syndrome
Pneumoconiosis
Greek: pneumo – lung, konis = dust
- Asbestosis
- Coal Worker’s Lung
- Farmer’s Lung
- Silicosis
- Talcosis
- Kaolinosis (clay)
- Stannosis (tin)
- Berylliosis
- Bagassosis (sugar cane)
- Popcorn Lung
- Pneumosparklyosis

What Is Glitter Lung?
Glitter lung, or pneumoconiosis, is a respiratory disease caused by the chronic inhalation of precision cut, indexable, metalized particles. Elementary school art teachers and transgernder "flying queen" entertainers are the populations most at risk.

- Airborne glitter enters the nose and mouth. First attracted to glue-like mucous membranes, the glitter then settles into the lungs.
- Glitter deposits cause scarring, inflammation, and breakdown of the lungs, leading to fibrosis—a condition in which alveoli are so sparsely that oxygen molecules are reflected away from the bloodstream.
- Eventually, the alveoli become completely scarred and are unable to function, leading to massive system failure due to oxygen deficiency. Although the dangers of glitter lung are just now becoming known, the body’s intolerance of shiny substances has been studied for decades (see “Symptoms and treatments of glittergosis,” New England Journal of Medicine, 1964).

Idiopathic Interstitial Pneumonias (IIP's)

<table>
<thead>
<tr>
<th>Histologic Patterns</th>
<th>Associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIP:</td>
<td>&quot;IPF&quot;</td>
</tr>
<tr>
<td>NSIP:</td>
<td>CTD, HP, Exposures (remember: ANA/RF are non-specific)</td>
</tr>
<tr>
<td>COP (aka BOOP):</td>
<td>CTD, Drugs, Radiation, Infection (responds to prednisone)</td>
</tr>
<tr>
<td>DIP:</td>
<td>Smokers</td>
</tr>
<tr>
<td>RB-ILD:</td>
<td>Smokers</td>
</tr>
<tr>
<td>AIP:</td>
<td>&quot;Hammon Rich Syndrome&quot;</td>
</tr>
<tr>
<td>LIP:</td>
<td>HIV, Lymphoma, Sjogren's</td>
</tr>
</tbody>
</table>

Usual Interstitial Pneumonitis, Non-Specific Interstitial Pneumonitis, Chronic organizing Pneumonitis, Bronchiolitis Dilemma with Extraordinary Fibrosis, Respiratory Bronchiolitis, Respiratory Bronchiolitis-Associated Interstitial Pneumonitis, Acute Interstitial Pneumonitis, Desquamative Interstitial Pneumonitis, Respiratory Bronchiolitis-Associated Interstitial Pneumonitis, Acute Interstitial Pneumonitis, Lymphocytic Interstitial Pneumonitis
Interstitial Lung Diseases

- Sarcoid
- Hypersensitivity Pneumonitis
- Idiopathic Pulmonary Fibrosis/ "IIPs"
- Tuberculosis / Tumor
- Fungal / Failure
- Aspiration / Asbestosis
- Connective Tissue Diseases / (Cancer)
- Environmental
- Drugs
  - Amiodarone, Nitrofurantoin, Bleomycin
- Plus Pneumoconioses

Interstitial Lung Diseases

- S
- H
- I
- T
- F
- A
- C
- E
- D

Interstitial Lung Disease

Presentation:
- SOB/DOE and Cough

Signs:
- Crackles, Small Lungs, +/- Clubbing

CXR:
- Reduced Volumes
- "Interstitial Markings"

PFT's:
- Decreased TLC
  - (Normal or Increased FEV₁/FVC ratio)
  - (FEV₁ and FVC are BOTH decreased)
Interstitial Lung Disease

Diagnosis:
- Restrictive PFT’s
- Consistent CXR/HRCT
  - If no evidence of ILD on HRCT, consider the other two categories of restrictive lung disease:
    - Chest Wall Disease
    - Neuromuscular Disease
- Biopsy:
  - Transbronchial (TBBx)
  - Open Lung
  - Thoracoscopic

Sarcoid

- Non-Specific Tissue Reaction
- Non-Caseating Granulomata
- Any age, sex, race
  - (↑ young, female, African American)
- Pulmonary Involvement:
  - Lymphadenopathy
  - Interstitial Lung Disease
- Non-Pulmonary Involvement:
  - Ocular, Cardiac, CNS, Bone, Skin, Hypercalcemia

CXR “Staging”

| Stage 0 | Normal |
| Stage 1 | Lymphadenopathy (LAD) |
| Stage 2 | LAD + ILD* |
| Stage 3 | ILD* |
| Stage 4 | ESLD with honeycombing |

*Classically an upper lobe predominance
Sarcoid: Treatment

- Options:
  - Corticosteroids
  - Other: Methotrexate, cyclosporine, azathioprine
- When:
  - CNS, Ocular, Cardiac, Hypercalcemia, Disfiguring Skin Changes
  - Pulmonary SYMPTOMS or Worsening PFT's
  - NOT just for asymptomatic lymphadenopathy

Idiopathic Pulmonary Fibrosis (IPF)

- Etiology Unknown
- Middle-Aged/Elderly
- Insidious DOE progressing to SOB at rest
- Cough (can be quite severe)
- Mean Survival = 2.5 to 5 years

IPF: Diagnosis

- “Typical” Presentation:
  - Typical Patient, Symptoms, Exam, PFT’s
  - Typical HRCT* findings:
    - Sub-pleural fibrosis progressing to honeycomb

*High Resolution CT
IPF: Diagnosis

- "Typical" Presentation:
  - Typical Patient, Symptoms, Exam, PFT's
  - Typical HRCT findings:
    - Sub-pleural fibrosis progressing to honeycomb
- Biopsy if atypical clinical presentation
  - VATS* or Open Lung Biopsy
    - (Not by TBBx)
  - Pathology = "U.I.P."

*Video-Assisted Thoracoscopic Surgery

IPF: Treatment

- Symptomatic / Palliative Care
  - i.e., oxygen, opiates, anti-tussives
- PREVIOUSLY no proven therapy
  - Many agents tried without evidence:
    - Steroids, Colchicine, Cyclophosphamide, Azathioprine, Interferon, NAC (N-acetyl cysteine)
- NOW (as of November 2014):
  - Pirfenidone
  - Nintedanib
  - Consider Transplantation

Clinical Approach to Dyspnea

Summary:

- **History**
  - SOB:
    - Always vs Intermittent
    - At Rest, With Exertion (? Intensity), At Night
  - Associated Cough, Sputum, Chest Pain
  - Tobacco or Occupational Risks
- **Physical**
  - Big Lungs vs Small Lungs
  - Crackles vs Wheezing
- **Work-Up**
  - CXR
    - Hyperinflation vs Small Lungs
    - "Extra Lines and Dots"
  - PFT's
    - Obstruction (FEV1/FVC) vs Restriction (~TLC)
Today’s Goals……

Recognize the following diseases, their pathophysiology, and treatment options:
- Asthma
- COPD
  - Emphysema
  - Chronic Bronchitis
- Bronchiectasis
- Interstitial Lung Disease

Differentiate Clinically:
- Obstruction vs Restriction
- Asthma vs COPD
- Emphysema vs Chronic Bronchitis