# Chronic Obstructive Pulmonary Disease

Jim Allen, MD  
Professor of Internal Medicine  
Division of Pulmonary & Critical Care Medicine  
The Ohio State University Wexner Medical Center

## Impact of COPD in U.S.

- 12 million people diagnosed  
- 715,000 hospital admissions per year  
- 134,000 deaths/year  
- Annual cost up to $50 billion  
  - $30 billion direct  
  - $20 billion indirect
Prevalence of COPD 2011

COPD based on an affirmative response to the question: “Has a doctor, nurse, or other health professional ever told you that you have COPD, emphysema, or chronic bronchitis?”
Prevalence age-adjusted to the 2000 U.S. standard population.

COPD: Mortality by gender, 1999-2009

Source: U.S. Centers for Disease Control
Risk Factors For COPD

- Tobacco smoke
- Occupational exposures
- Air pollution
- Genetics
- Low birth weight
- Recurrent infections
- Chronic asthma

Inherited Emphysema

- Alpha-1 antitrypsin deficiency
  - Consider in young patients with COPD and those with lesser smoking histories
  - Diagnosed by A1AT levels
  - Accounts for 2-3% of COPD
  - Average of 3 doctors and 7 years from symptom onset to diagnosis
- Other genetic conditions???
<table>
<thead>
<tr>
<th>One End Of The COPD Spectrum: Emphysema</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Emphysema Image" /></td>
</tr>
<tr>
<td><img src="image2.png" alt="CT Scan Image" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>The Other End Of The COPD Spectrum: Chronic Bronchitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Bronchitis Image" /></td>
</tr>
</tbody>
</table>
Five Components Of COPD Management:

1. Diagnosis and staging
2. Reduce risk factors
3. Manage stable COPD
4. Manage exacerbations
5. Reduce readmissions

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Diagnosis of COPD

- Symptoms of COPD:
  - Dyspnea
  - Cough
  - Sputum production
- Risk factor for COPD
- Obstruction on spirometry:
  - Post-bronchodilator FEV1/FVC ratio < 70%
  - Severity of obstruction based on FEV1

www.goldcopd.org
### COPD Mimics:

<table>
<thead>
<tr>
<th>Wheezing:</th>
<th>Obstruction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Airway tumors</td>
<td>• Chronic obstructive asthma</td>
</tr>
<tr>
<td>• Vocal cord dysfunction</td>
<td>• Tracheostenosis</td>
</tr>
<tr>
<td>• Foreign body aspiration</td>
<td>• Bronchiectasis</td>
</tr>
<tr>
<td>• Heart failure</td>
<td>• Bronchiolitis obliterans</td>
</tr>
</tbody>
</table>

### Classification of Obstruction*

<table>
<thead>
<tr>
<th>Classification</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt; Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOLD I: Mild</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; &gt; 80%</td>
</tr>
<tr>
<td>GOLD II: Moderate</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; = 50-80%</td>
</tr>
<tr>
<td>GOLD III: Severe</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; = 30-50%</td>
</tr>
<tr>
<td>GOLD IV: Very Severe</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt; &lt; 30%</td>
</tr>
</tbody>
</table>

*GOLD criteria: Assumes an FEV1/FVC < 70%
Spirometry

Can you have emphysema with normal spirometry?

Yes!

• Suspect in at-risk patients with dyspnea and either:
  – Hyperinflation by lung volumes
  – Low diffusing capacity
• Confirmation by high resolution chest CT
### COPD Co-Morbidities:

- Myocardial ischemia
- Heat failure
- Osteoporosis
- Respiratory infection
- Depression
- Diabetes
- Lung cancer

### COPD is a systemic disease

- Weight loss
- Malnutrition
- Skeletal muscle dysfunction
- Depression
Five Components Of COPD Management:

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5. Reduce readmissions

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Reduce Risk Factors

- Smoking cessation!!!
- Eliminate environmental tobacco smoke
- Reduce air pollution exposure
- Reduce occupational dust & chemical exposure
Prevalence Of Adult Smokers In The United States

Centers for Disease Control

Who Smokes In The United States?

GED
High School Degree
Some College
Associate Degree
College Degree
Graduate Degree

Centers for Disease Control
Life expectancy for smokers and non-smokers

The average smoker loses 15 minutes of life for every cigarette smoked

Smoking cessation slows the loss of lung function

The Five A’s Of Smoking Cessation

<table>
<thead>
<tr>
<th>Ask</th>
<th>“Do you smoke?” – every visit!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advise</td>
<td>smokers to quit</td>
</tr>
<tr>
<td>Assess</td>
<td>willingness to quit smoking</td>
</tr>
<tr>
<td>Assist</td>
<td>by prescribing and counseling</td>
</tr>
<tr>
<td>Arrange</td>
<td>follow-up</td>
</tr>
</tbody>
</table>
Smoking Cessation Resources

- Individual physician counseling
- Inpatient counseling service
- Outpatient counseling
- Nicotine replacement
  - Patches
  - Lozenges
  - Inhalers
  - Gum
  - Electronic cigarettes
- Wellbutrin
- Varenicline
- Cytisine (not in U.S.)

Five Components Of COPD Management:

1. Diagnosis and staging
2. Reduce risk factors
3. Manage stable COPD
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5. Reduce readmissions

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Management of Stable COPD

- Stepwise, symptom based approach
- Inhaled medications are preferred
- Bronchodilator treatment central to symptomatic management
- Consider inhaled steroids for patients with FEV1 < 60% predicted
- Combination inhaled therapy often more effective than single inhaled drug

Global Initiative for Chronic Obstructive Lung Disease, 2013

Management of Stable COPD (continued)

- Avoid chronic treatment with oral steroids
- All COPD patients benefit from exercise training programs
- Influenza vaccine – all patients
- Pneumococcal vaccine – patients > 65 years or FEV1 < 40%
- Mucolytics are marginally effective in some patients
- Oxygen prolongs life in hypoxemic patients

Global Initiative for Chronic Obstructive Lung Disease, 2013
Goals of COPD Management

1. Relieve symptoms
2. Prevent disease progression
3. Improve exercise tolerance
4. Improve health status
5. Prevent and treat complications
6. Prevent and treat exacerbations
7. Reduce mortality

Re-Defining GOLD Groups

<table>
<thead>
<tr>
<th>FEV1</th>
<th>Symptoms</th>
<th>mMRC Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &gt; 50%</td>
<td>Less</td>
<td>0-1</td>
</tr>
<tr>
<td>B &gt; 50%</td>
<td>More</td>
<td>≥ 2</td>
</tr>
<tr>
<td>C &lt; 50%</td>
<td>Less</td>
<td>0-1</td>
</tr>
<tr>
<td>D &lt; 50%</td>
<td>More</td>
<td>≥ 2</td>
</tr>
</tbody>
</table>

www.goldcopd.org
### mMRC Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Only breathless with strenuous activity</td>
</tr>
<tr>
<td>1</td>
<td>Short of breath when hurrying on ground level or walking up a slight hill</td>
</tr>
<tr>
<td>2</td>
<td>Walk slower than people of similar age on level ground or have to stop walking at my own pace</td>
</tr>
<tr>
<td>3</td>
<td>Stop for breath after walking 100 yards or a few minutes on level ground</td>
</tr>
<tr>
<td>4</td>
<td>Too breathless to leave the house or breathless when dressing</td>
</tr>
</tbody>
</table>

### Non-Pharmacologic Management

<table>
<thead>
<tr>
<th>Group</th>
<th>Smoking Cessation</th>
<th>Flu &amp; Pneumonia Vaccine</th>
<th>Physical Activity</th>
<th>Pulmonary Rehab</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>B, C, D</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

[www.goldcopd.org](http://www.goldcopd.org)
# Pharmacologic Management of Stable COPD

<table>
<thead>
<tr>
<th>Group</th>
<th>First Choice</th>
<th>Second Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Albuterol prn or Ipratropium prn</td>
<td>Long-acting beta agonist or Long-acting anti-cholinergic</td>
</tr>
<tr>
<td>B</td>
<td>Long-acting beta agonist or Long-acting anti-cholinergic</td>
<td>Long-acting beta agonist + Long-acting anti-cholinergic</td>
</tr>
</tbody>
</table>

**Long-acting beta agonists:**
- Salmeterol (“Serevent”)
- Arformoterol (“Brovana”)
- Formoterol (“Foradil”)
- Indacaterol (“Arcapta”)

**Long-acting anticholinergics:**
- Tiotropium (“Spiriva”)
- Aclidinium (“Tudorza”)

<table>
<thead>
<tr>
<th>Group</th>
<th>First Choice</th>
<th>Second Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>ICS/LABA or Long-acting anticholinergic</td>
<td>Long-acting beta agonist + Long-acting anticholinergic</td>
</tr>
<tr>
<td>D</td>
<td>ICS/LABA or Long-acting anticholinergic</td>
<td>(1) Long-acting beta agonist + Long-acting anticholinergic (2) Inhaled corticosteroid + Long-acting anti-cholinergic (3) ICS/LABA + Long-acting anticholinergic (4) + Roflumilast</td>
</tr>
</tbody>
</table>

**ICS/LABA = Inhaled corticosteroid + Long-acting beta agonist combination:**
- Budesonide/formoterol (“Symbicort”)
- Fluticasone/salmeterol (“Advair”)
- Mometasone/formoterol (“Dulera”)

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**Lets make it simple:**

- Occasional symptoms:
  - Albuterol PRN
- Frequent symptoms and FEV1 > 50%:
  - Add long-acting anticholinergic
- Frequent symptoms and FEV1 < 50%:
  1. Add steroid + long-acting beta agonist combo
  2. Add roflumilast

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**Tiotropium versus Salmeterol in COPD**

Aclidinium is similar to tiotropium

Pharmacologic Therapy: Corticosteroids

- Inhaled steroids for:
  - FEV1 < 60%
  - Patients with frequent exacerbations
- Inhaled steroid + Long-acting beta agonist more effective than inhaled steroid alone
- Inhaled steroids may be associated with more frequent pneumonia
- Avoid chronic oral steroids
“Triple Therapy” is effective (Steroid/LABA + Tiotropium)

Circles = budesonide/fomoterol + tiotropium
Squares = placebo + tiotropium

Am J Respir Crit Care Med 2009; 180:741-50
Roflumilast in COPD

- **Study design:**
  - Roflumilast: n=1,537
  - Placebo: n=1,554
- **Exacerbations/year:**
  - Roflumilast: 1.14
  - Placebo: 1.37
- **FEV1 increased 48 ml more with roflumilast than placebo**

Lancet 2009; 374: 685-94

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Correct use of common inhalers

Ruthann Kennedy, CNP
### Oxygenation Assessment

- Resting pulse oximetry
- Arterial blood gas
- 6 minute walk test
- Oxygen titration study
- Overnight oximetry
- High altitude hypoxia simulation test

### 6 Minute Walk Test

- Oxygen saturation
- Distance walked
- Heart rate
- Dyspnea scale (Borg scale)
Oxygen Titration Study

- Baseline oxygen saturation
- Add oxygen when $\text{SaO}_2 \leq 88\%$
- Increase FiO2 based on oxygen saturation
- Used to determine oxygen flow rate prescription

**Now required for all oxygen prescriptions in the United States**

Normal Overnight Oximetry

98% 97% 96% 95% 94% 93% 92%
Nocturnal Hypoxemia

91% 89% 87% 85% 83% 81% 79% 77% 75%

High Altitude Hypoxia Simulation Test

• Simulates to 8,000 ft elevation
  – 15% FiO2
  – Commercial aircraft cabin oxygen pressure
• Arterial blood gas
  – pO2 < 55 - oxygen needed at altitude
  – pO2 < 50 - oxygen needed in flight
## Home Oxygen Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concentrators</strong></td>
<td>- Standard (5 L flow)</td>
</tr>
<tr>
<td></td>
<td>- High-Flow (10 L flow)</td>
</tr>
<tr>
<td></td>
<td>- Portable (4-6 L pulse flow)</td>
</tr>
<tr>
<td><strong>Compressed oxygen gas</strong></td>
<td>- E tank (4.4 hours at 2 L flow)</td>
</tr>
<tr>
<td></td>
<td>- D tank (2.5 hours at 2 L flow)</td>
</tr>
<tr>
<td><strong>Liquid oxygen</strong></td>
<td>- Reservoir (4-6 weeks)</td>
</tr>
<tr>
<td></td>
<td>- Portable tank (8 hours at 2 L flow)</td>
</tr>
</tbody>
</table>

## Pulmonary Rehabilitation

- 8 week program
- 3 days per week
- 2 hours per session
- Focus on:
  - Education
  - Aerobic conditioning
  - Quality of life
Psychologic contributions to the perception of dyspnea

- Pain
- Anxiety
- Depression
- Anger

Sensation Of Dyspnea → Perception Of Dyspnea

Improving Dyspnea Perception

- Education
- Relaxation
- Desensitization
- Pharmacologic therapy:
  - Anti-depressants
  - Anxiolytics
  - Pain control
# Lung Reduction Surgery

<table>
<thead>
<tr>
<th>Patients who benefit:</th>
<th>Medicare guidelines:</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Localized upper lobe emphysema</td>
<td>– FEV1 &lt; 45%</td>
</tr>
<tr>
<td>– Low exercise capacity</td>
<td>– RV &gt; 150%</td>
</tr>
<tr>
<td></td>
<td>– BMI &lt; 31 (M); 32 (F)</td>
</tr>
<tr>
<td></td>
<td>– pO2 &gt; 45 mm</td>
</tr>
<tr>
<td></td>
<td>– pCO2 &lt; 60 mm</td>
</tr>
<tr>
<td></td>
<td>– Exercise capacity:</td>
</tr>
<tr>
<td></td>
<td>&lt; 25 watts (F)</td>
</tr>
<tr>
<td></td>
<td>&lt; 40 watts (M)</td>
</tr>
</tbody>
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# Lung Transplantation

**Amy Pope-Harman, MD**  
Medical Director, Lung Transplantation

**Bryan Whitson, MD, PhD**  
Surgical Director, Lung Transplantation

OSU Lung Transplant Center: 614-293-5822
Five Components Of COPD Management:

1. Diagnosis and staging
2. Reduce risk factors
3. Manage stable COPD
4. Manage exacerbations
5. Reduce readmissions

Identifiable Risks For Exacerbations

- Viruses: 30-70%
- Bacteria: 30-50%
- Pollution: 20-30%

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### COPD Exacerbations

- Sputum cultures not usually necessary
- Antibiotics if increased sputum volume, dyspnea, or sputum purulence
- Bronchodilators (albuterol +/- ipratropium)
- Oral/IV steroids (prednisone 40 mg/day x 10 days)
- Non-invasive ventilation (if severe)

### Bacteria causing COPD exacerbations

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemophilus influenza</td>
<td>13-50%</td>
</tr>
<tr>
<td>Moraxella catarrhalis</td>
<td>9-21%</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>7-26%</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>1-13%</td>
</tr>
</tbody>
</table>
Which Antibiotic?

- **Uncomplicated COPD exacerbation:**
  - Doxycycline
  - Trimethoprim-sulfamethoxazole
  - Macrolide
  - Cephalosporin

- **Complicated COPD exacerbation:**
  - Amoxicillin-clavulanate
  - Fluoroquinolone

- **Risk for pseudomonas:**
  - Ciprofloxacin

Pulmonary embolism and COPD exacerbations:

- **20% of COPD exacerbations are accompanied by PE**
  - 25% of hospitalized patients
  - 3% of emergency department patients

- **Signs and symptoms are similar**

- **Suspect PE in:**
  - Patients failing to respond to treatment
  - Patients with increased risk of PE

Chest 2009; 135:786
Mortality After Hospitalization for COPD

Kaplan-Meier survival curves in 135 patients hospitalized for acute exacerbation of COPD

P Almagro et al, Chest 2002; 121:1441-1448

Mortality After Hospitalization for COPD

Causes of Death

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Disease</td>
<td>32 (50)</td>
</tr>
<tr>
<td>Cardiovascular Disease</td>
<td>12 (19)</td>
</tr>
<tr>
<td>Cancer</td>
<td>4 (6)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (5)</td>
</tr>
<tr>
<td>Unknown</td>
<td>13 (20)</td>
</tr>
</tbody>
</table>

P Almagro et al, CHEST 2002; 121:1441-1448
### Mortality Risk Post-COPD Exacerbation

**Independent predictors:**
- Dyspnea
- Depression
- Re-admission
- Co-morbidity
- Marital status

P Almagro et al, CHEST 2002; 121:1441-1448

### New Concepts in COPD Management

- Faster is better
  - Antibiotics
- Continuous is better
  - Azithromycin
- Less is better
  - Oxygen

- More is not better
  - Steroids
- Longer is not better
  - Steroids
**Faster is better: antibiotics in COPD exacerbations**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Early Antibiotic</th>
<th>Late Antibiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical ventilation</td>
<td>1.07%</td>
<td>1.80%</td>
</tr>
<tr>
<td>Mortality</td>
<td>1.04%</td>
<td>1.59%</td>
</tr>
<tr>
<td>Treatment failure</td>
<td>9.77%</td>
<td>11.75%</td>
</tr>
<tr>
<td>30-Day readmission</td>
<td>7.91%</td>
<td>8.79%</td>
</tr>
</tbody>
</table>

N = 84,621 patients

Rothberg et al. JAMA 2010; 303:235-42

**Continuous is better: azithromycin reduces COPD exacerbations**

- Azithromycin 250 mg/day
- Exclusion: QTc > 450
- Total subjects:
  - 1,142 azithromycin
  - 572 placebo
- Exacerbations per year:
  - 1.48 azithromycin
  - 1.83 placebo

Less is better – oxygen in COPD exacerbations

- 405 patients transported to hospital with presumed COPD exacerbation
- Randomized to:
  - High flow oxygen by mask regardless of O2 saturation
  - Oxygen by nasal prongs titrated to keep O2 saturation 88-92%
- 58% reduction in mortality in patients treated with low flow titrated oxygen

Austin et al. BMJ 2010; 341:c5462

More is not better: dosing of steroids

- 79,985 hospitalizations for acute COPD exacerbation
- High dose IV versus low dose oral steroids
- No difference in outcomes

Lindenauer, et al. JAMA 2010; 303: 2358-67
Longer is not better: dosing of steroids

- 314 patients presenting to the emergency department with acute COPD exacerbation
- 5-day versus 14-day oral prednisone 40 mg per day
- No difference in outcomes

JAMA. 2013; 309:2223-31

Five Components Of COPD Management:

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**Medicare re-hospitalization rates**

30-day readmission rates:
- All: 21.0%
- CHF: 26.9%
- Pneumonia: 20.1%
- COPD: 22.6%

Total Cost: $17.4 billion


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**Center for Medicare & Medicaid Services**

- Developed plan to fine hospitals for high readmission rates:
  - 2012 Diagnoses:
    - Heart failure
    - Myocardial infarction
    - Pneumonia
  - 2015 Diagnoses:
    - COPD
    - Coronary artery bypass grafting
    - Urinary tract infection
    - Coronary angioplasty

- In 2013:
  - 1% of Medicare payment maximum penalty
  - 71% of hospitals were penalized (2217)
  - Estimate $850 million total penalties

- In 2014:
  - 2% of Medicare payment maximum penalty

- In 2015:
  - 3% of Medicare payment maximum penalty
Who gets re-admitted?

- Patients without physician follow-up within 30 days of discharge
  - (Hernandez, JAMA 2010;303:1716-22)
- African Americans
  - (Joynt, JAMA 2011; 305:675-81)
- Older patients

Why do they get re-admitted?

- Insufficient outpatient follow-up
- Medication errors
- Inadequate post-discharge support
- Poor transfer of information to primary care providers
- Poor healthcare literacy
- Inability to pay for medications
Disease management program for COPD

- Intervention:
  - 1-1.5 hour education session
  - Self-treatment action plan
  - Monthly follow up calls
- Hospital Admission & Emergency Department Visits:
  - 0.82 usual care group
  - 0.48 intervention group

Rice Am J Respir Crit Care Med 2010; 182:890-6

The problem with uninsured and underinsured in the United States
Uninsured In The United States

Source: U.S. Census Bureau
Inhaler costs:

$50  $250

Albuterol  Steroid + LABA Anticholinergics

COPD Admissions At OSU East Hospital

- High risk population:
  - Elderly
  - African American
  - Low income
- 33% of patients at OSU East are current smokers
- Length of stay:
  - OSU East: 4.40 days
  - Benchmark: 4.37 days
**CarePoint East Pulmonary Transition Clinic**

**Pulmonary COPD Transition Clinic Using A Nurse Practitioner Pulmonary Specialist**

- Clinic appointment within 5 working days of discharge
- Assess response to treatment
- Follow up lab and radiology tests
- Arrange pulmonary function tests
- Medication reconciliation
- Refer to indigent patient medication program
- Arrange pulmonary rehabilitation
- Smoking cessation
- Insure correct use of inhaler
Preliminary results of the OSU East Pulmonary Transition Clinic

- Began summer 2011
- Jointly funded by hospital and physician practice group
- However, 46% no-show rate
- High percentage of patients with:
  - No insurance
  - No Medicare part D
  - Concurrent use of street drugs

30-Day Readmission Rates for Participants Versus No-Shows

Key Points about COPD

1. Increasing incidence and death rate
2. Spirometry necessary for diagnosis
3. Beware of co-morbid diseases
4. Utilize GOLD group-based treatment plan
5. Pulmonary rehabilitation is underutilized
6. Incidence of PE in exacerbations is high
7. Reducing readmissions is a priority