

# Chronic Obstructive Pulmonary Disease (COPD)





# THE Guideline

Global Initiative for Chronic  
Obstructive Lung Disease (GOLD),  
World Health Organization (WHO),  
National Heart, Lung and  
Blood Institute (NHLBI)



# Definition of COPD

- COPD is a **preventable** and **treatable** chronic lung disease characterized by airflow limitation that **is not fully reversible**
- The airflow limitation is usually progressive and associated with an abnormal **inflammatory response** of the lung to noxious particles or gases, primarily caused by **cigarette smoking**
- Although COPD affect the lungs, it also produces significant **systemic consequences**

Adapted from the Global Initiative for Chronic Obstructive Lung Disease 2007

● ATS/ERS Guidelines 2004

# Epidemiology of COPD

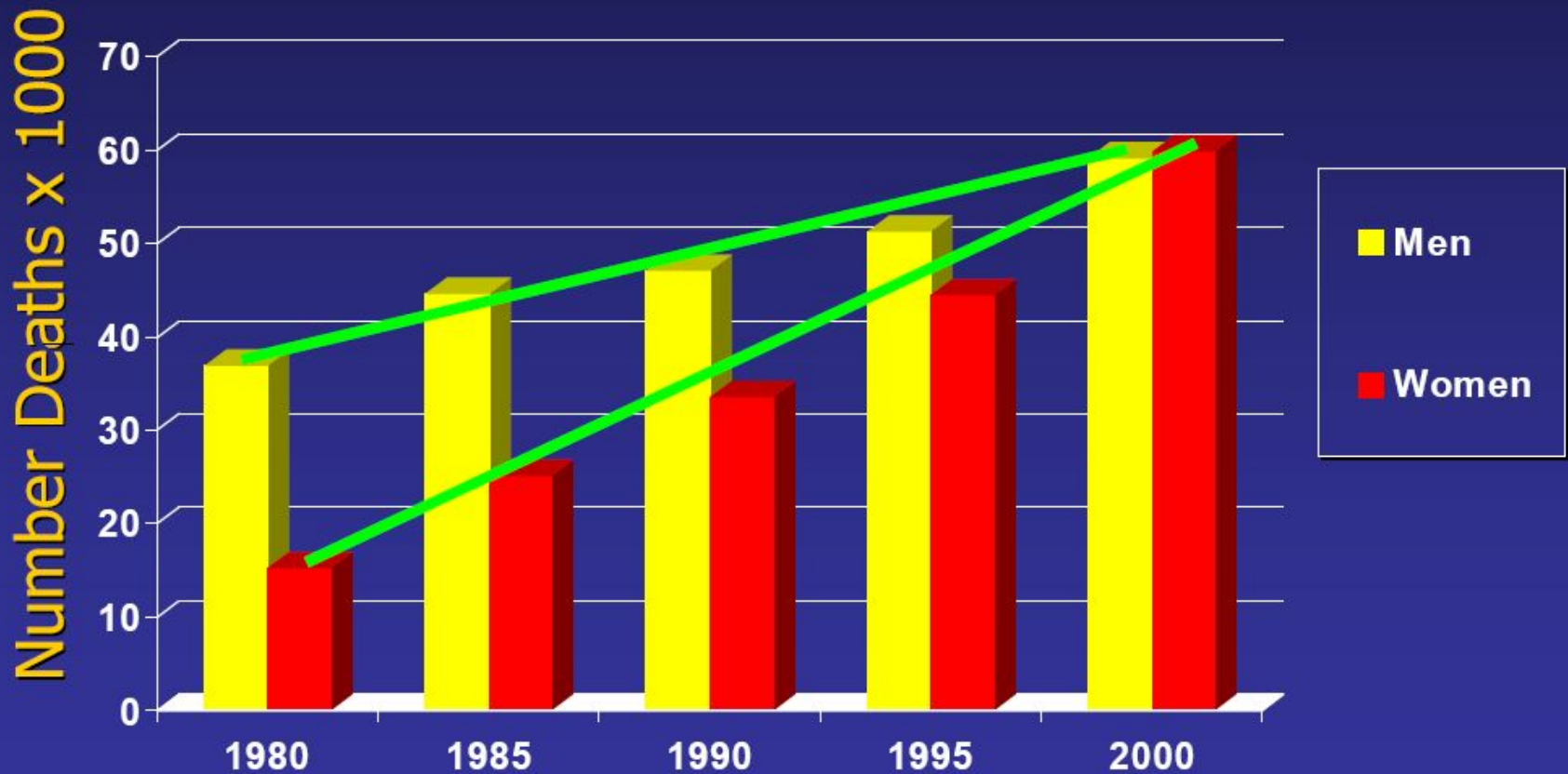
- 4th leading cause of death in world
- 4th leading cause of death in U.S.A.
- 3rd most common reason for hospitalization.
- Rare under 40, common in elderly
- greater in men than in women.

Prevalence of 9.34/1,000 in men and 7.33/1,000 in women (Global Burden of Disease Study, 2007).

# COPD includes:

- chronic bronchitis
- chronic bronchiolitis  
(small air way disease)
- Emphysema

# COPD Mortality by Gender, U.S., 1980-2000



Source: US Centers for Disease Control and Prevention, 2002



# COPD Prevalence

**Diagnosed  
COPD  
2.4 - 7 million**

**Estimated  
total COPD  
16 million**

**56 - 85%**

**Undiagnosed/misdiagnosed**



# Risk Factors for COPD

## Host factors

- Alpha-1-antitrypsin deficiency
- airway hyperresponsiveness
- Disordered lung development

## Environmental factors

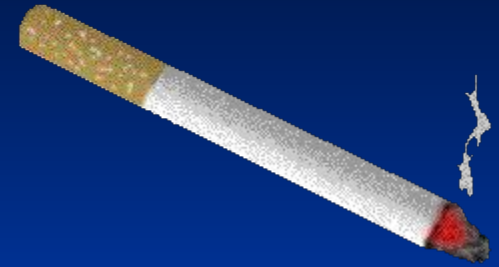
- *Tobacco smoke*
- Occupational dusts/chemicals
- Air pollution
- Childhood infections





# Risk factors

- cigarette smoking remains the most important.
- Susceptibility to cigarette smoke varies but both the dose and duration of smoking appear to be important and it is unusual to develop COPD with less than 10 pack years.
- (1 pack year = 20 cigarettes / day /year).



# Alpha-1-antitrypsin deficiency

- $\alpha$ 1-Antitrypsin is a proteinase inhibitor which is produced in the liver, secreted into the blood and diffuses into the lungs.
- Mechanism of action: an inhibition of proteolytic enzymes such as neutrophil elastase, which are capable of destroying alveolar wall connective tissue.

# Pathophysiology

COPD has both

- Pulmonary components
- Systemic components

# Pulmonary components:

- Mucus secretion An enlargement of mucous secreting glands and an increasing number of goblet cells in the large airways → increase mucous that causes chronic bronchitis
- Loss of elastic tissue surrounding the smaller airways combined by inflammation and fibrosis in the airway wall → **airflow limitation.**

# Pulmonary components:

- Premature airway closure leads to gas trapping and hyperinflation →  
↓ pulmonary and chest wall compliance. (during exercise the time available for expiration shortens resulting in progressive hyperinflation)

# Pulmonary components:

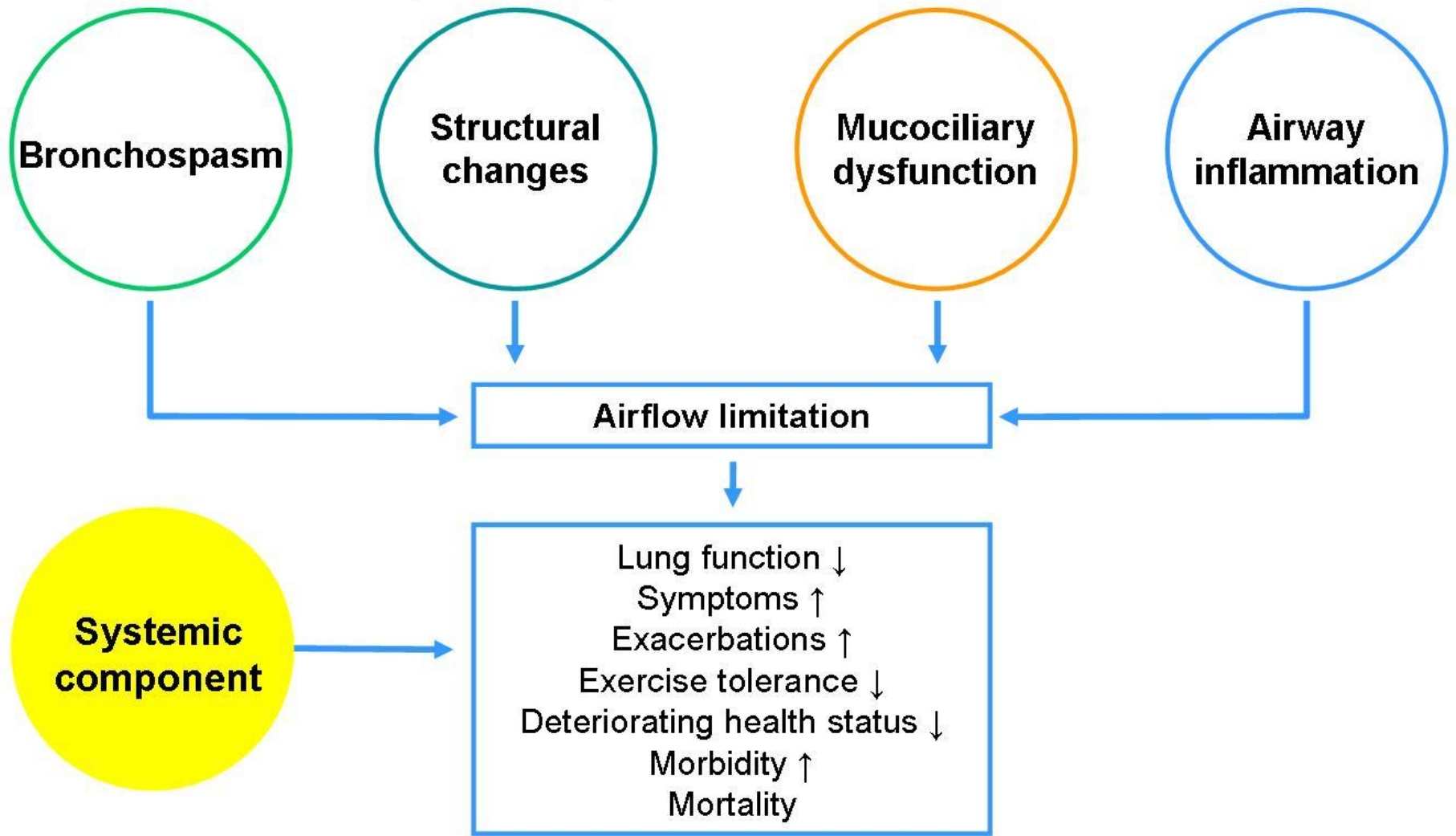
- Flattening of the diaphragmatic muscles and increase horizontal alignment of the intercostals muscles → mechanical disadvantage of respiratory muscles → increase work of breathing first on exercise but then at rest.



# Pulmonary components:

- In the alveolar capillary units the unopposed action of proteases and oxidants → destruction of the alveoli → bullae formation in some individuals which → impaired gas exchange and respiratory failure.

# Pathophysiological features of COPD



# Systemic components:

1. Skeletal muscle weakness.
2. Increase circulating inflammatory markers.
3. Impaired salt and water excretion leading to peripheral edema.
4. Altered fat metabolism contributing to weight loss.
5. Increase prevalence of osteoporosis.

# Pathophysiology of COPD: systemic component

## Systemic component

Systemic inflammation  
Poor nutritional status  
Reduced BMI  
Impaired skeletal muscle  
– weakness  
– wasting  
Impact on other organs  
e.g. cardiovascular  
disease



# Pathophysiological features of COPD

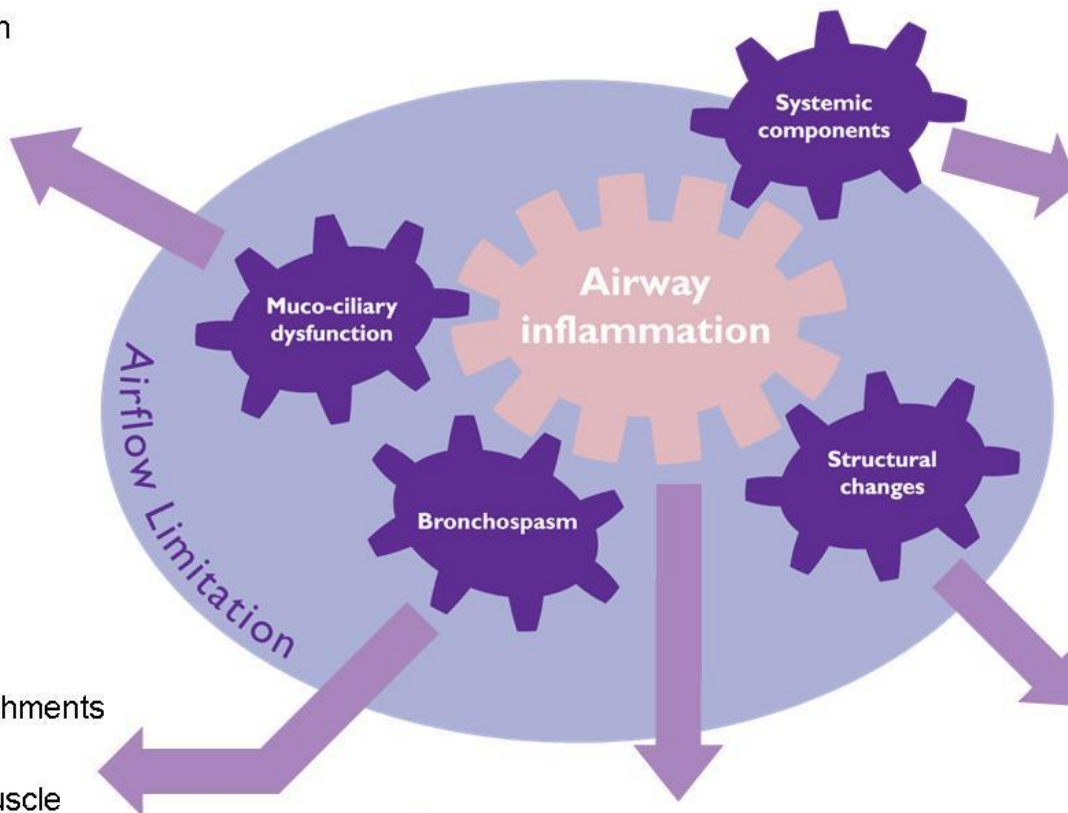
- Mucus hypersecretion
- Reduced mucociliary transport
- Mucosal damage

- Loss of alveolar attachments
- Loss of elastic recoil
- Increased smooth muscle contraction

- Increased numbers of inflammatory cells/activation
- Elevated inflammatory mediators: IL-8, TNF- $\alpha$ , LTB-4 and oxidants
- Protease/anti-protease imbalance

- Poor nutritional status
- Reduced BMI
- Impaired skeletal muscle
  - weakness
  - wasting

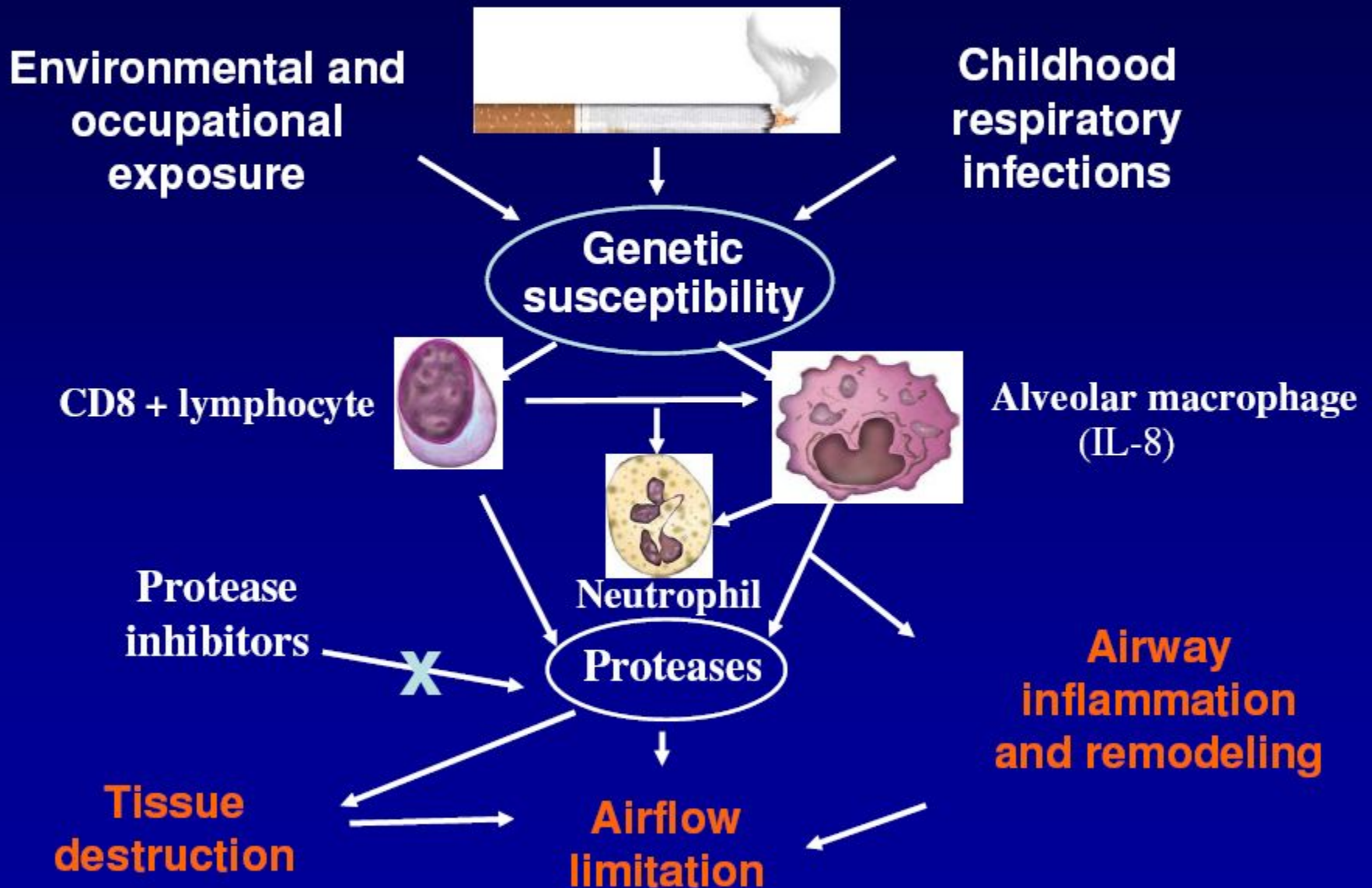
- Goblet cell hyperplasia/metaplasia
- Mucous gland hypertrophy
- Increased smooth muscle mass
- Airway fibrosis
- Alveolar destruction



IL = interleukin  
 LTB-4 = leukotriene B4  
 TNF- $\alpha$  = tumour necrosis factor- $\alpha$



# COPD Pathogenesis



# Pathophysiology (conclusion)

inflammation, bronchial wall edema, mucous secretion, hyperinflation and air trapping

Increase in proteinases & free radicals lead to parenchymal destruction

Changes in pulmonary vasculature lead to ventilation-perfusion mismatching, pulmonary hypertension

cor  
pulmonale



# INFLAMMATION IN COPD

```
graph TD; A[INFLAMMATION IN COPD] --> B[Small airway disease]; A --> C[Parenchymal destruction]; B --> D[AIRFLOW LIMITATION]; C --> D;
```

## Small airway disease

Airway inflammation  
Airway remodeling

## Parenchymal destruction

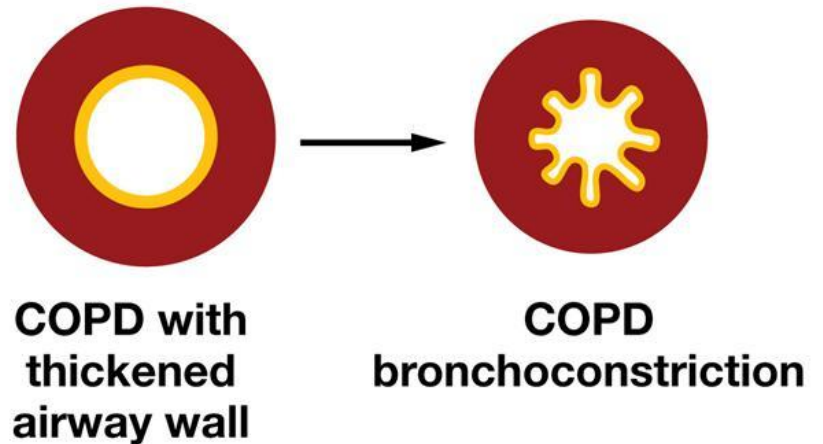
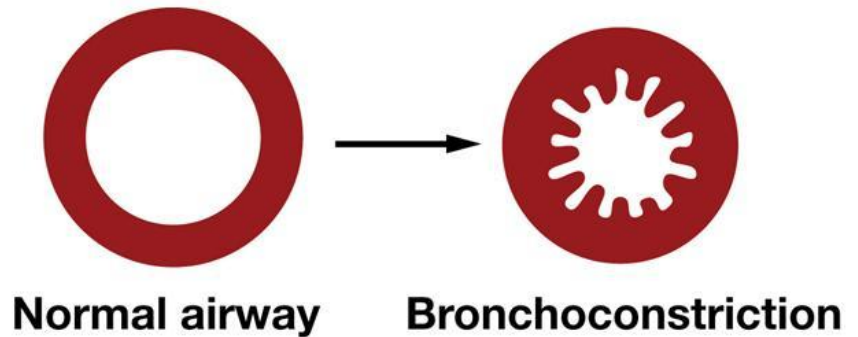
Loss of alveolar attachments  
Decrease of elastic recoil

# AIRFLOW LIMITATION

# Pathophysiology of COPD: bronchospasm

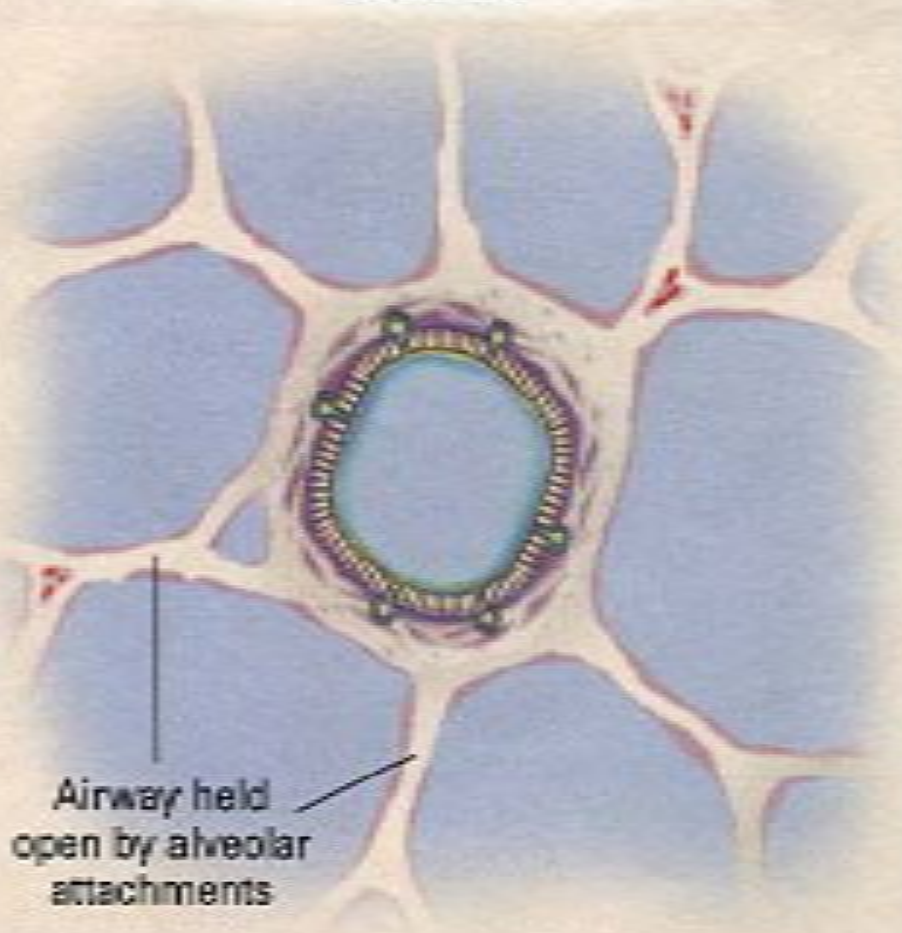


- Smooth muscle contraction
- Increased cholinergic tone
- Bronchial hyper-reactivity
- Loss of elastic recoil
- Inflammation
- Structural changes

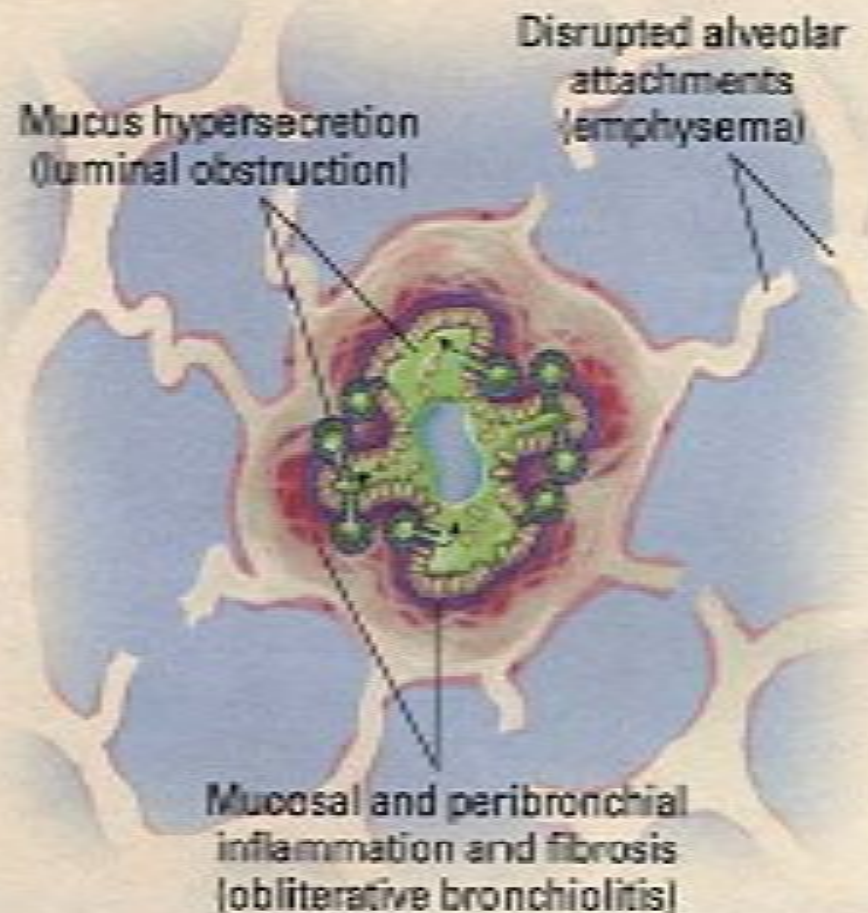


# COPD: Pathology

Normal



Chronic Obstructive Pulmonary Disease

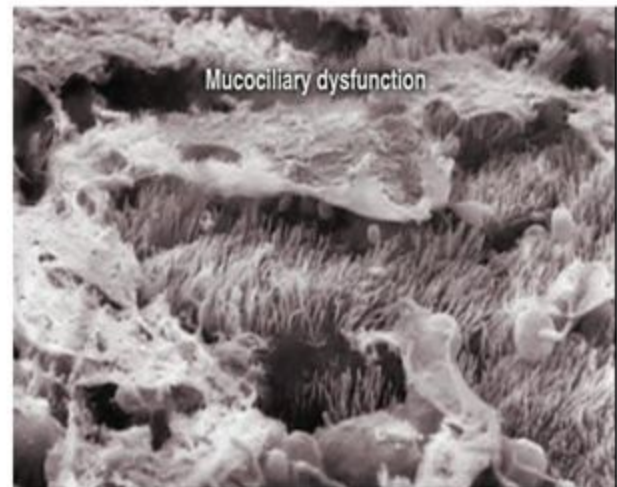
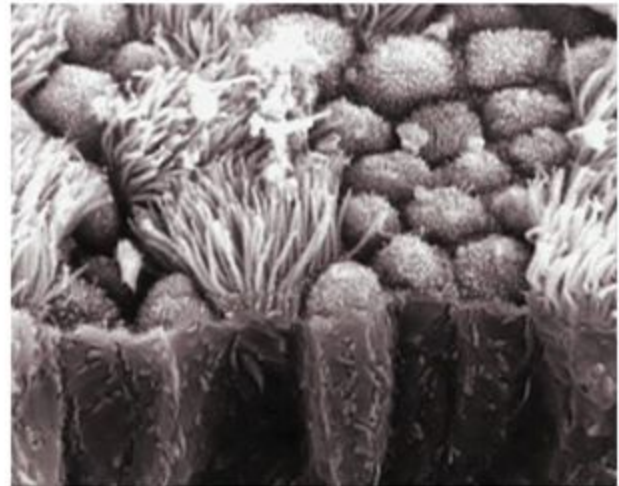




# Pathophysiology of COPD: mucociliary dysfunction

## Mucociliary dysfunction

Mucus hypersecretion  
Increased mucus  
viscosity  
Reduced mucociliary  
transport  
Mucosal damage



# Pathophysiology of COPD: structural changes

## Structural changes

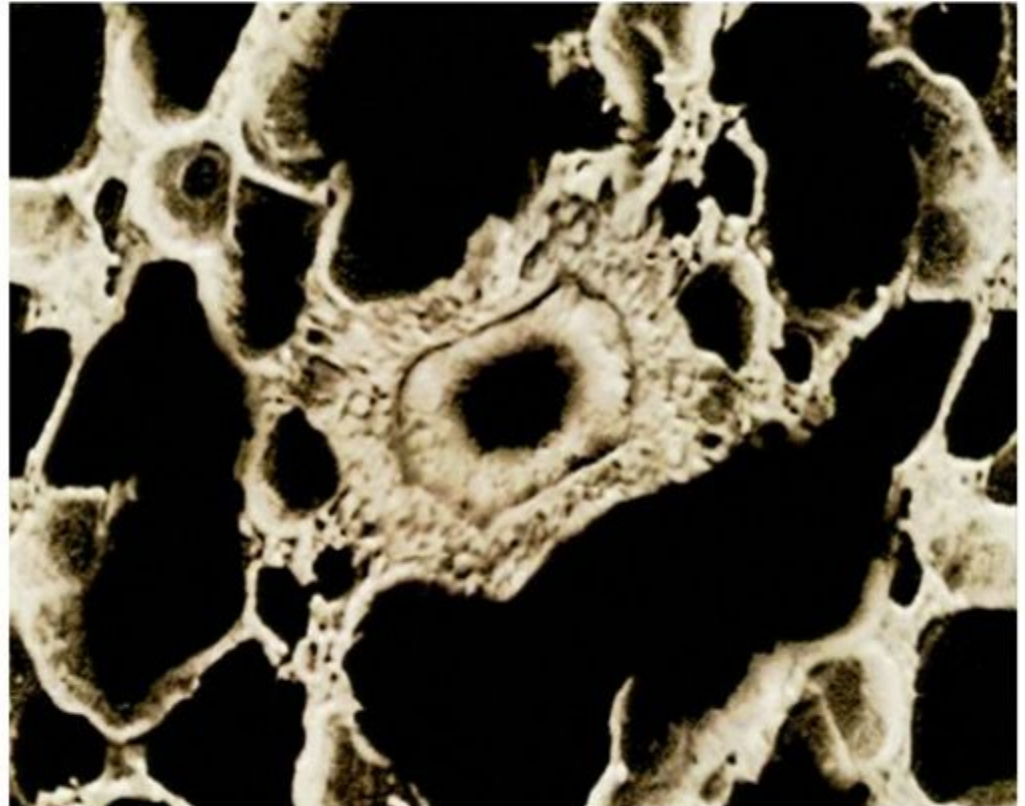
Alveolar destruction

Epithelial hyperplasia

Glandular hypertrophy

Goblet cell metaplasia

Airway fibrosis



Visual reproduced with permission from GlaxoSmithKline

Jeffery. Thorax 1998

# Causes of Airflow Limitation

## Irreversible

- Fibrosis and narrowing of the airways
- Loss of elastic recoil due to alveolar destruction
- Destruction of alveolar support that maintains patency of small airways

## Reversible

- Accumulation of inflammatory cells, mucus and plasma exudate in bronchi
- Smooth muscle contraction in peripheral and central airways
- Dynamic hyperinflation during exercise



# *Assess for COPD:*

## ■ Cough

- intermittent or daily
- present throughout day, seldom only nocturnal

## ■ Sputum

- Any pattern of chronic sputum production

## ■ Dyspnea

### ■ *Progressive and Persistent*

"increased effort to breathe" "heaviness" "air hunger" or "gasping"

- Worse on exercise
- Worse during respiratory infections



# COPD:

## Symptoms and Findings

- Chronic cough
- Sputum production
- Dyspnea (shortness of breath)
- Exercise Intolerance
- Fatigue
- Decreased quality of life
- Hypoxemia
- Hypercapnia
- Pulmonary hypertension
- Cor pulmonale
- Weight loss
- Effort intolerance
- Waking at night
- Ankle swelling
- Fatigue

# Diagnosis of COPD

- Considered in patients with cough, sputum production, or dyspnoea +/- risk factors.
- Confirmed by *spirometry*.
- FEV1/FVC <70% + postbronchodilator FEV1 <80% of predicted value.
- A low peak expiratory flow has poor specificity for the diagnosis of COPD.

# Classification of COPD

- *Stage 0*      *At Risk*
- *Stage I*      *Mild*
- *Stage II*      *Moderate*
- *Stage III*      *Severe*
- *Stage IV*      *Very Severe*

## Figure 1-2. Spirometric Classification of COPD Severity Based on Post-Bronchodilator FEV<sub>1</sub>

Stage I: Mild	FEV <sub>1</sub> /FVC < 0.70 FEV <sub>1</sub> ≥ 80% predicted
Stage II: Moderate	FEV <sub>1</sub> /FVC < 0.70 50% ≤ FEV <sub>1</sub> < 80% predicted
Stage III: Severe	FEV <sub>1</sub> /FVC < 0.70 30% ≤ FEV <sub>1</sub> < 50% predicted
Stage IV: Very Severe	FEV <sub>1</sub> /FVC < 0.70 FEV <sub>1</sub> < 30% predicted or FEV <sub>1</sub> < 50% predicted plus chronic respiratory failure

FEV<sub>1</sub>: forced expiratory volume in one second; FVC: forced vital capacity; respiratory failure: arterial partial pressure of oxygen (PaO<sub>2</sub>) less than 8.0 kPa (60 mm Hg) with or without arterial partial pressure of CO<sub>2</sub> (PaCO<sub>2</sub>) greater than 6.7 kPa (50 mm Hg) while breathing air at sea level.

# *Stage 0 At Risk*

- Normal spirometry
- +/- Chronic symptoms (cough, sputum, production)





# *Stage I Mild COPD*

- FEV1/FVC <70%
- FEV1  $\geq$ 80% predicted
- With or without chronic symptoms (cough, sputum production)



# *Stage II Moderate COPD*

- FEV1/FVC <70%
- $50\% \leq \text{FEV1} < 80\%$  predicted
- With or without chronic symptoms (cough, sputum production)





# *Stage III Severe COPD*

- $FEV_1/FVC < 70\%$
- $30\% \leq FEV_1 < 50\%$  predicted
- With or without chronic symptoms (cough, sputum production)



# *Stage IV Very Severe COPD*

- FEV1/FVC <70%
- FEV1 <30% predicted *or* FEV1 <50% predicted plus
- chronic respiratory failure



# Spirometric Classification of COPD

## Severity Based on Post-Bronchodilator $FEV_1$

**Stage I : Mild**

**$FEV_1/FVC < 0.70$**

**$FEV_1 \geq 80\%$  predicted**

**Stage II : Moderate**

**$FEV_1/FVC < 0.70$**

**$50\% \leq FEV_1 < 80\%$  predicted**

**Stage III : Severe**

**$FEV_1/FVC < 0.70$**

**$30\% \leq FEV_1 < 50\%$  predicted**

**Stage IV : Very Severe**

**$FEV_1/FVC < 0.70$**

**$FEV_1 < 30\%$  predicted or  $FEV_1 < 50\%$**

**predicted plus chronic respiratory failure**

# Diagnosis of COPD

## SYMPTOMS

cough  
sputum  
shortness of breath

## EXPOSURE TO RISK FACTORS

tobacco  
occupation  
indoor/outdoor pollution

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graph TD; A[SYMPTOMS] --- B[EXPOSURE TO RISK FACTORS]; B --> C[SPIROMETRY];
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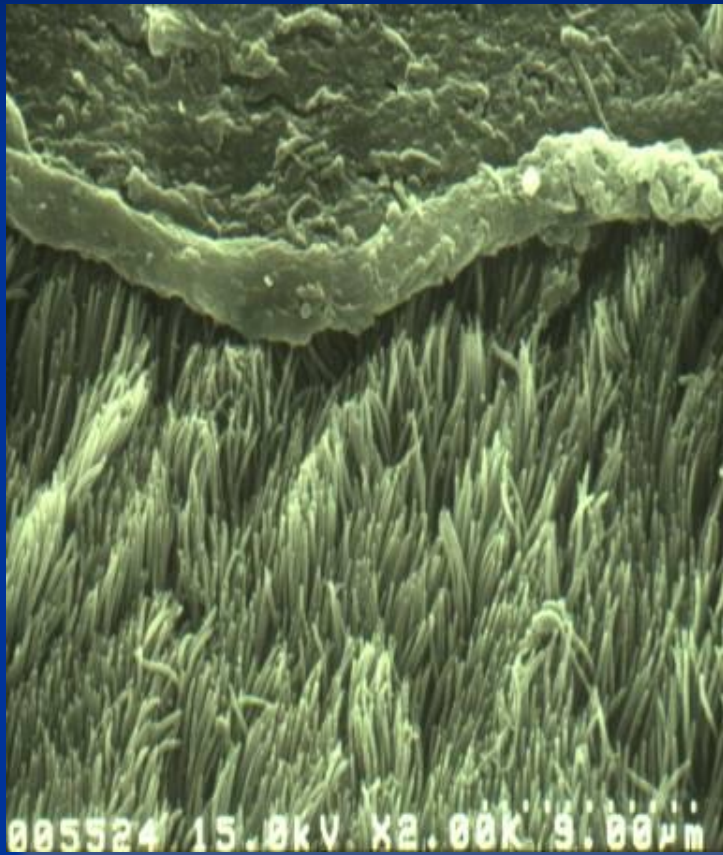
**SPIROMETRY**

# Diagnosis of COPD





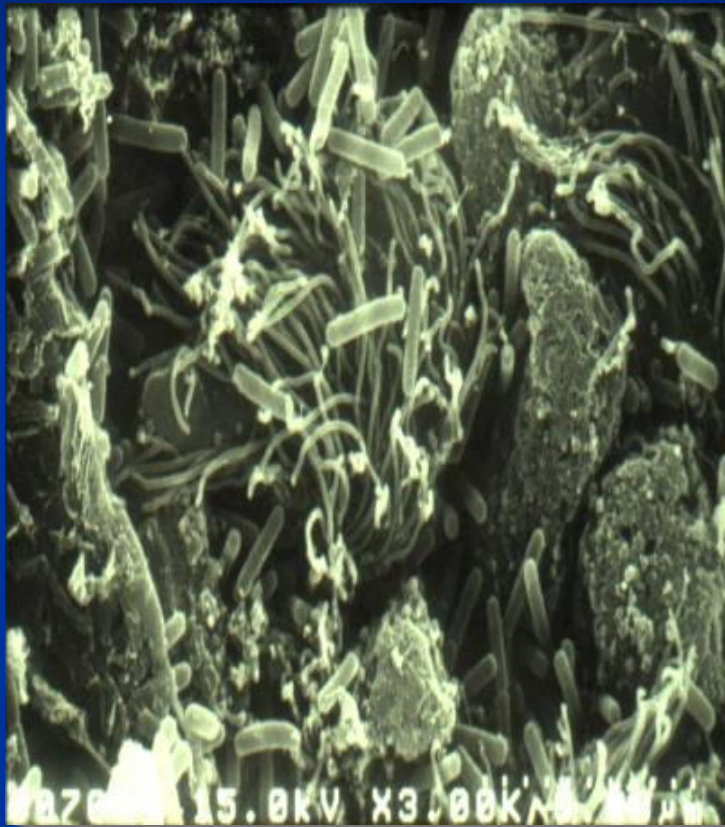
# Healthy Respiratory Mucosa



- This electron micrograph shows the respiratory mucosa in a healthy state
- The cells are fully ciliated
- The cilia beat in a co-ordinated fashion to move mucus out of the airways (mucociliary transport)

Scanning electron micrograph showing a sheet of mucus being moved along by the cilia

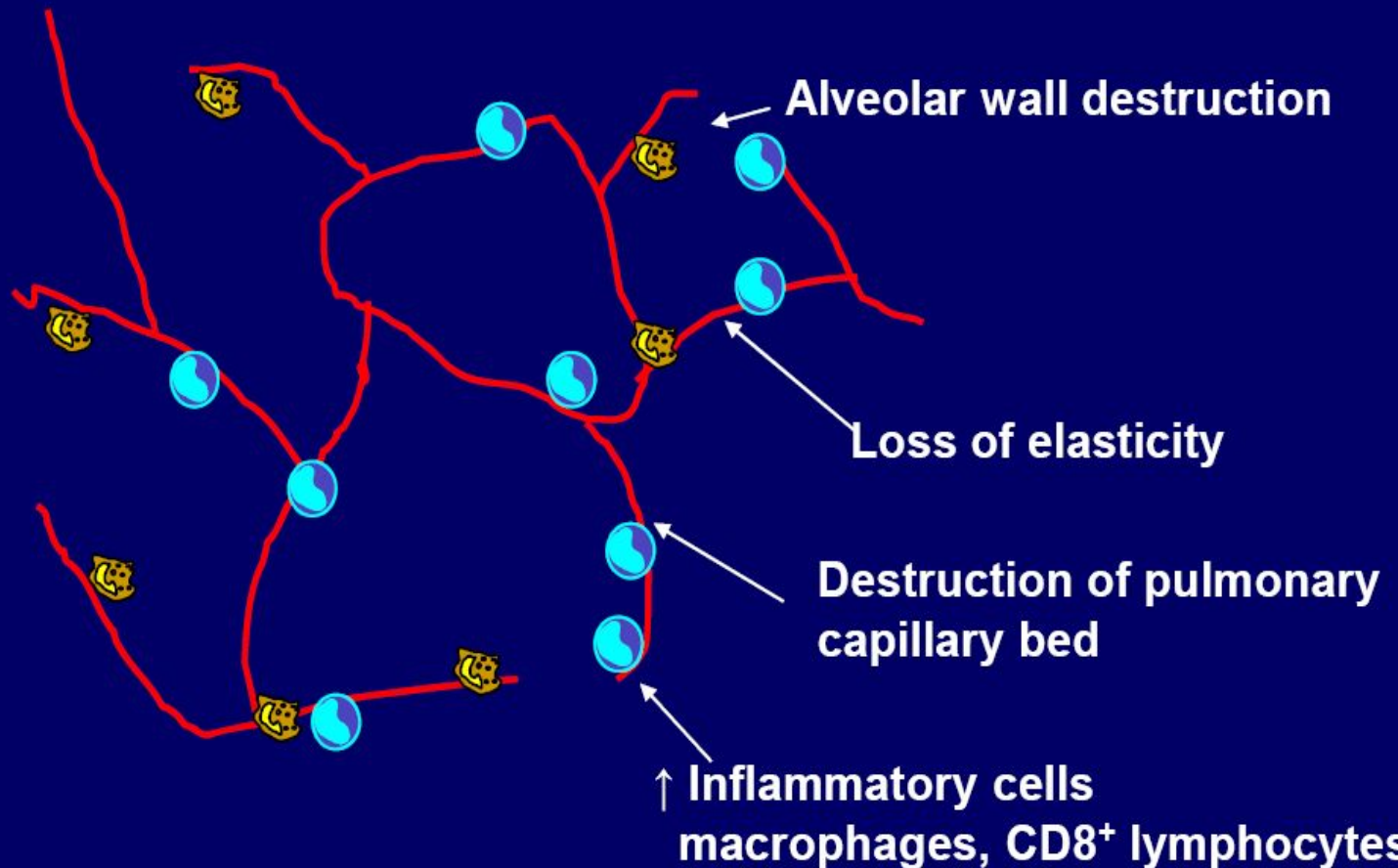
# Damaged Respiratory Mucosa



- Damage to the cilia and epithelium occur as a result of disease processes in COPD. This can also occur as a result of bacterial damage
- This slide shows the result of bacterial infection stripping away the cilia from the mucosa
- The damage to the cilia means they are less effective in removing mucus from the airways



# Changes in Lung Parenchyma





# smokers lung – Emphysema



# Emphysema

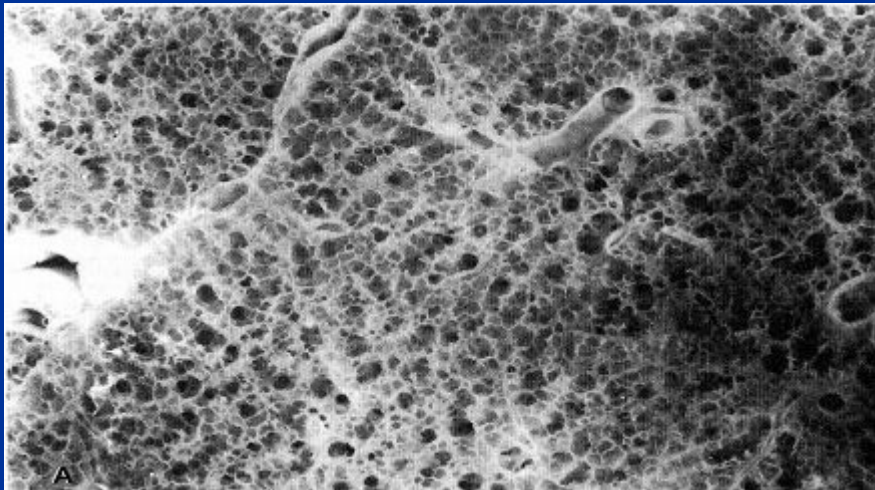
Dilation of alveolar wall

↓ alveolar capillary network, loss of guy rope effect

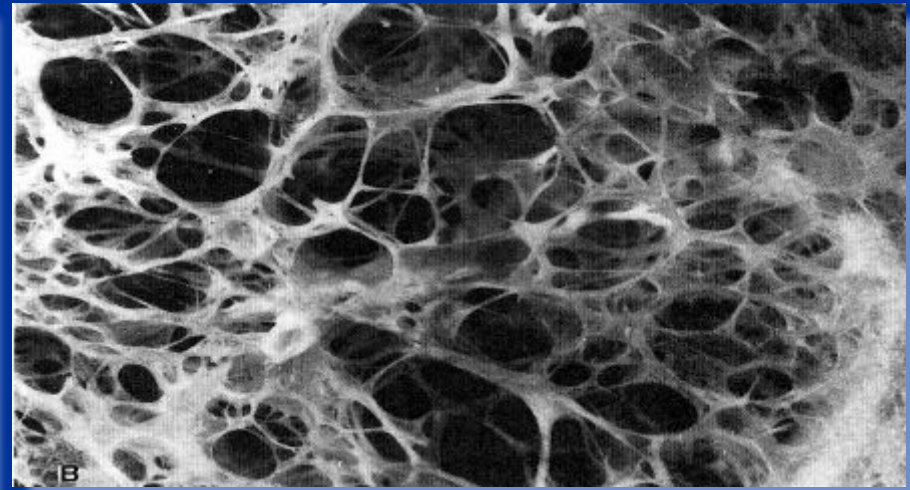
↓ lung tissue elasticity

Caused by smoking » irritation » inflammation » neutrophils and macrophages » release neutrophil elastase (type of proteases)

## Normal Lung



## Emphysema



# Emphysema

- is defined pathologically as dilatation and destruction of the lung tissue distal to the terminal bronchiole.

# classification

- Centri-acinar emphysema.
- Pan-acinar emphysema.
- Irregular emphysema.

# Centri-acinar emphysema

- Distension and damage of lung tissue is concentrated around the respiratory bronchioles, whilst the more distal alveolar ducts and alveoli tend to be well preserved
- is associated with substantial airflow limitation

# Pan-acinar emphysema

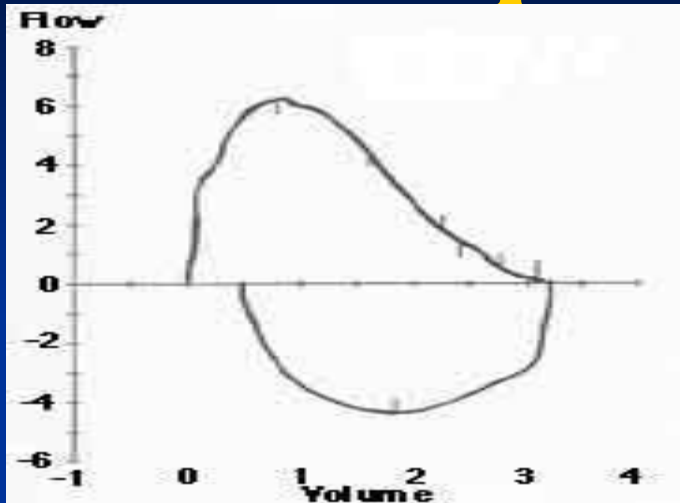
- Distension and destruction appear to involve the whole of the acinus, and in the extreme form the lung becomes a mass of bullae.
- Occurs in  $\alpha$ 1-antitrypsin deficiency



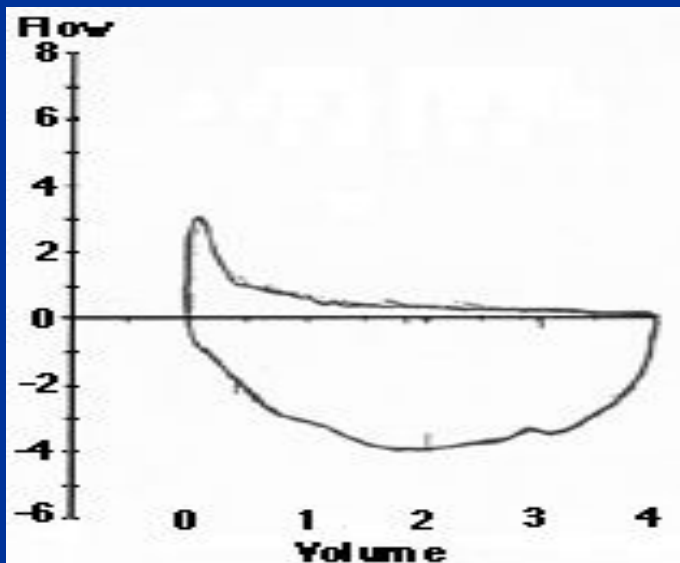
# Irregular emphysema

- scarring and damage affect the lung parenchyma patchily without particular regard for acinar structure

# Spirometry



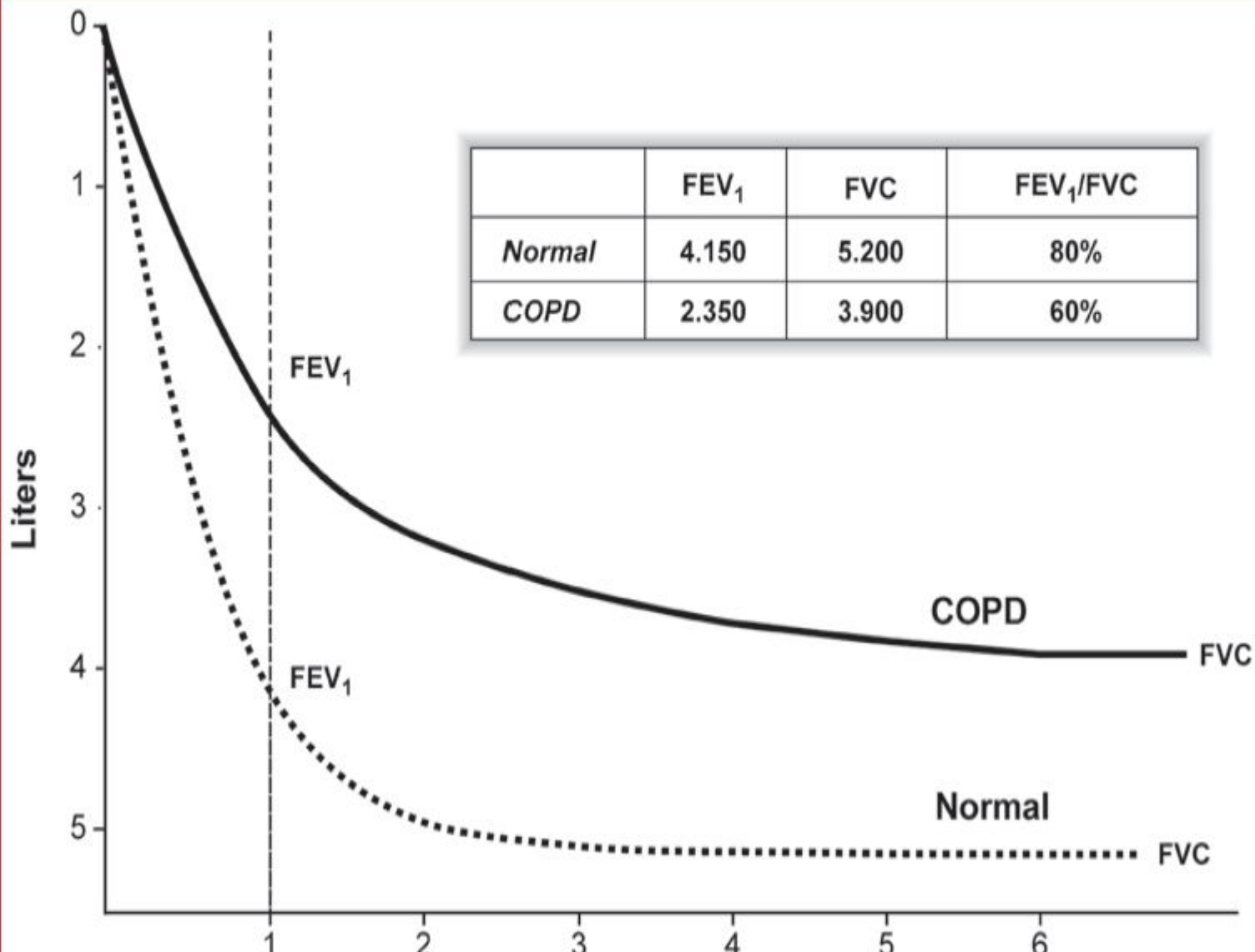
- Normal flow-volume loop



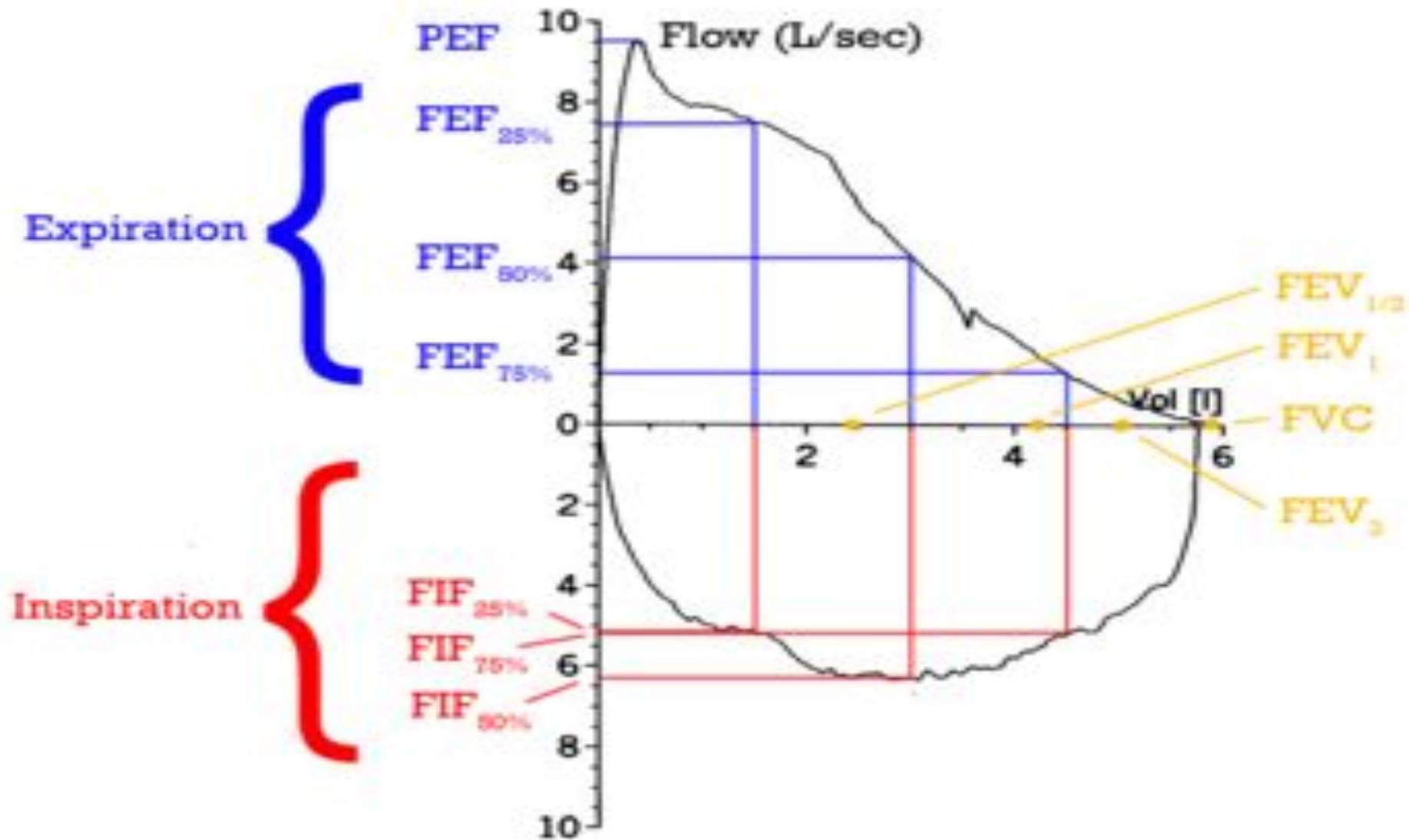
- Flow-volume loop in severe COPD



# Spirometry: Normal and Patients with COPD



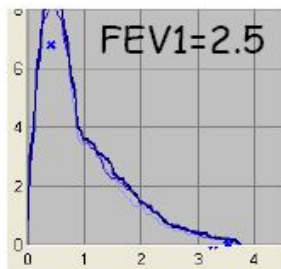
# Pulmonary Function Tests



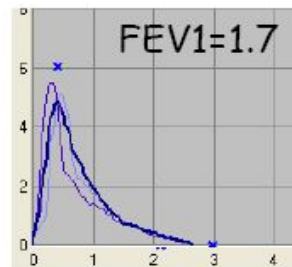
# Differential Diagnosis: Spirometry

- FVC: the forced vital capacity, the volume delivered during an expiration
- FEV<sub>1</sub>: the forced expiratory volume in 1 second
- FEV<sub>1</sub>/FVC: the ratio of forced vital capacity to forced expiratory volume in 1 second

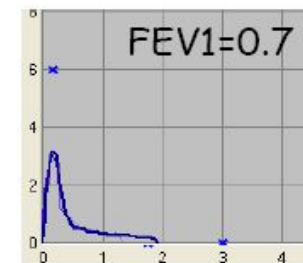
# The best outcome measure depends on COPD severity (recruiting/inclusion/exclusion criteria)



mild



moderate



severe



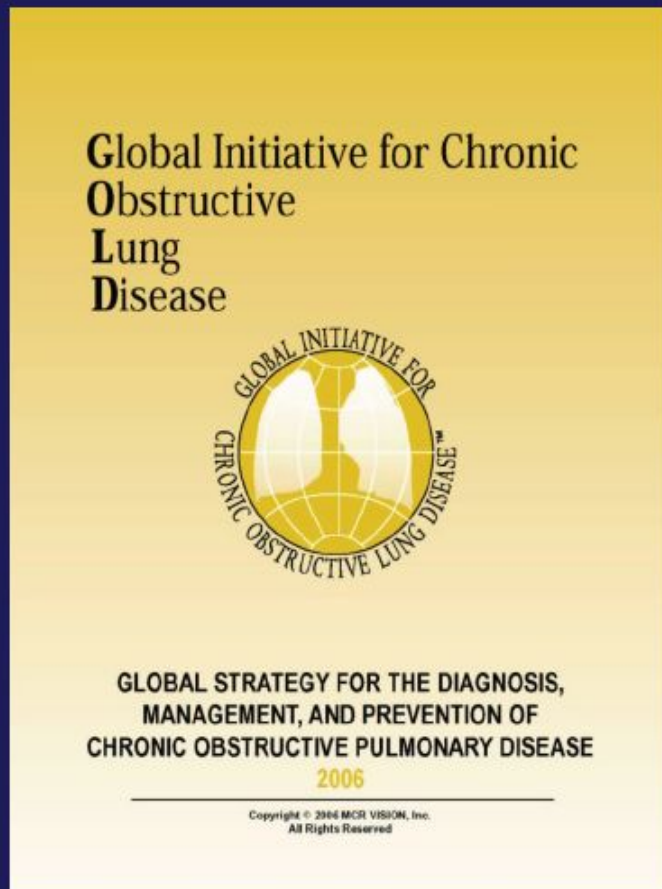
## *Assess:*

# Measure Airflow Limitation

- Patients with COPD typically show a decrease in both FEV1 and FVC
- Postbronchodilator FEV1 < 80% predicted + FEV1/FVC < 70% confirms the presence of airflow limitation that is not fully reversible
- FEV1/FVC < 70% is an early sign of airflow limitation in patients whose FEV1 remains normal ( $\geq 80\%$  predicted).



# Four Components of COPD Management



1. Assess and monitor disease
2. Reduce risk factors
3. Manage stable COPD
  - Education
  - Pharmacologic
  - Non-pharmacologic
4. Manage exacerbations

# COPD Therapy Based on Symptoms and Staging

Symptoms	Asymptomatic	Mild	Moderate	Severe	Very Severe
Staging	0 At Risk	I Mild	II Moderate	III Severe	IV Very Severe
	Avoidance of risk factor(s); influenza vaccination				
	<b>Add</b> short-acting bronchodilators when needed – either LABAs or anticholinergics				
				<b>Add</b> regular Rx c $\geq$ 1 long-acting bronchodilator. <b>Add</b> rehabilitation	
				<b>Add</b> inhaled corticosteroids if repeated exacerbations	
				<b>Add</b> oxygen <b>Consider</b> surgery	

# GOALS of COPD MANAGEMENT

- Relieve symptoms
- Prevent disease progression
- Improve exercise tolerance
- Improve health status
- Prevent and treat complications
- Prevent and treat exacerbations
- Reduce mortality



# **Avoidance/reduction of risk factors**

- **Reduction of total personal exposure to:**
  - tobacco smoke
  - occupational dusts
  - Chemicals
  - indoor and outdoor air pollutants
- **Smoking cessation is the single most cost-effective intervention for reducing the risk of developing COPD and stop its progression**



# General Points

- Only smoking cessation and O<sub>2</sub> therapy have been shown to prolong survival
- Other therapies aimed at relieving symptoms, improving quality of life, reducing exacerbations and need for hospitalizations

- Exacerbation management
- Chronic stable management
- Adjuvant therapy

# Therapy at Each Stage of COPD: Stages I and II

Staging	0 At Risk	I Mild	II Moderate	III Severe	IV Very Severe
		<b>Add</b> short-acting bronchodilators when needed – either LABAs or anticholinergics			
			<b>Add</b> regular Rx c $\geq$ 1 long-acting bronchodilator. <b>Add</b> rehabilitation		

## Recommendations:

1. Inhaled bronchodilators relieve, prevent, and reduce symptoms (A)  
Beta<sub>2</sub>-agonists, anticholinergics, theophylline\*: alone or combination
2. Long-acting bronchodilators: more effective, more convenient, more expensive (A)
3. Combining bronchodilators: may improve efficacy and decrease risk of side effects compared with increasing dose of single agent (A)

\* Not FDA-approved for treating COPD.

Adapted by the author from the Global Initiative for Chronic Obstructive Lung Disease. Global strategies for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2005. Retrieved August 16, 2006, from the World Wide Web: <http://www.goldcopd.com/Guidelineitem.asp?11=2&12=1&intId=989>.





# Management of Stable COPD

## Pharmacotherapy: Bronchodilators

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- Bronchodilator medications are central to the symptomatic management of COPD (**Evidence A**). They are given on an as-needed basis or on a regular basis to prevent or reduce symptoms and exacerbations.
- The principal bronchodilator treatments are  $\beta_2$ -agonists, anticholinergics, and methylxanthines used singly or in combination (**Evidence A**).
- Regular treatment with long-acting bronchodilators is more effective and convenient than treatment with short-acting bronchodilators (**Evidence A**).

# Beta2-Agonists

## Short acting B2-Agonists:

- Salbutamol ( albuterol )(4-6hrs)
- fenoterol (4-6hrs)
- levalbuterol (6-8hrs)
- terbutaline(4-6hrs)

## Long acting B2-Agonists (LABA ) -

Therapy for Stage 2 , 3 and stages 4 of COPD.

- salmeterol (12+ hrs)
- formoterol (12+hrs)

# Beta2-Agonists

- Excellent bronchodilator and quick effect. Therapy for all stages, mostly rescue and as needed dosing every 4 to 6 hours for shortness of breath.
- Relax airway smooth muscles by stimulation of B2- adrenergic receptors which increases cyclic AMP and produce antagonist effect to bronchoconstriction.
- Excess doses cause tremors, anxiety, tachycardia, arrhythmias, hypokalemia



# Anticholinergics

## Short acting Anticholinergics

- **ipratropium bromide** (6-8 hrs) now nebulised and inhaler
- **oxitropium bromide** (7-9hrs) in solution and inhaler

**Research** brought quaternary compound of atropine

## Long acting

- **Tiotropium inhaled** (24+hrs) aerolised powder.  
ipratropium bromide/salbutamol (Combivent)  
fenoterol/ipratropium bromide (Berodual)

# *Anticholinergics* (Tiotropium)

- Block muscarinic receptors and prevent smooth muscle contraction while ↓ release of secretion from submucosal glands.
- Ipratropium bromide, devoid of systemic effects, the nebulization dosage is 0.5mg every 4 hours

- Drug therapy for COPD begins with long acting anticholinergics and beta-2 agonist bronchodilators. These provide symptom relief but do not stop progression of the disease

# Therapy at Each Stage of COPD

## Stage II-IV

Staging	0 At Risk	I Mild	II Moderate	III Severe	IV Very Severe
			<b>Add</b> regular Rx c $\geq$ 1 long-acting bronchodilator. <b>Add</b> rehabilitation		

### Recommendation: Add pulmonary rehabilitation (

- Improves exercise capacity, quality of life
- Reduces breathlessness, hospitalization, anxiety, depression
- Include exercise training, nutrition counseling, education
- Patients at all stages may benefit from exercise training
- Minimum length is two months; longer programs are best



# Stages III and IV

Staging	0 At Risk	I Mild	II Moderate	III Severe	IV Very Severe
				<b>Add</b> ICS if repeated exacerbations	

## Recommendations:

1. Add ICS if frequent exacerbations. (A)

Reduces exacerbations, improves health status  
(beclomethasone\*, budesonide\*, fluticasone\*, triamcinolone\*  
or combination LABA + glucocorticosteroids:  
formoterol/budesonide\*, salmeterol/fluticasone

2. Oral glucocorticosteroids are not recommended in COPD (A)

\*A-approved for treating COPD.

# Inhaled Glucocorticoids in COPD

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- Improve lung function, dyspnea and health status
- Reduce exacerbations for patients with more advanced COPD and repeated exacerbations
- Combined with LABA, reduce exacerbation rates versus monotherapy with either agent
- COPD natural history not substantially modified (e.g., little or no change in rate of FEV<sub>1</sub> decline)
- As in asthma, side effects depend on dose and type





## Pharmacotherapy: Glucocorticosteroids

- The addition of regular treatment with inhaled glucocorticosteroids to bronchodilator treatment is appropriate for symptomatic COPD patients with an FEV<sub>1</sub> < 50% predicted (*Stage III: Severe COPD and Stage IV: Very Severe COPD*) and repeated exacerbations (**Evidence A**).
- An inhaled glucocorticosteroid combined with a long-acting  $\beta_2$ -agonist is more effective than the individual components (**Evidence A**).



- The dose-response relationships and long-term safety of inhaled glucocorticosteroids in COPD are not known.
- Chronic treatment with systemic glucocorticosteroids should be avoided because of an unfavorable benefit-to-risk ratio (**Evidence A**).

# Inhaled Steroids

- Front line therapy for COPD stages 3 and 4
- Budesonide Nebulizer
- Inhaled fluticasone
- Inhaled triamcinolone
- Inhaled beclomethasone
- Inhaled budesonide
- LABA and budesonide mixed in inhaler





## Management of Stable COPD

### Other Pharmacologic Treatments

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- **Antibiotics:** Only used to treat infectious exacerbations of COPD
- **Antioxidant agents:** No effect of n-acetylcysteine on frequency of exacerbations, except in patients *not* treated with inhaled glucocorticosteroids
- **Mucolytic agents, Antitussives, Vasodilators:** Not recommended in stable COPD

# Therapy at Each Stage of COPD: Stage IV

Staging	0 At Risk	I Mild	II Moderate	III Severe	IV Very Severe
					<b>Add</b> long-term O <sub>2</sub> if chronic respiratory failure

## Recommendation: Add oxygen therapy (A)

- Increases survival in COPD
- Improves hemodynamics, hematologic characteristics, exercise capacity, lung mechanics, mental state

Goal: PaO<sub>2</sub> at rest to 60 mm Hg at sea level and rest or SaO<sub>2</sub> at  $\geq 90\%$

Prescribed based on oxygen desaturation (eg, PaO<sub>2</sub> below 55 mm Hg)

Given continuous, nocturnal, or with exercise

# Treatment of Stable COPD

## Other Medications

- **Chronic oral Prednisone**
- Use in chronic COPD is controversial. No effect on survival. May improve symptoms and reduce hospitalizations in some patients already at maximum treatment
- **Mucolytics & Expectorants**
- Relieves symptoms from copious, viscous secretions
- **Oral Theophylline** (If inhalers not sufficient )  
Side effects are common



# *Methylxanthines*

- Multiple modes of action : bronchodilatation, ↑ dia-phragmatic contractility, stimulation of respiratory drive, inotropism, ↑ mucociliary clearance, and synergy with  $\beta$ 2-Agonists and Anticholinergics
- 5mg/kg IV over 10 to 15 min then 0.5mg/kg/hr if normal liver function
- 1mg/kg IV elevate a 2 $\mu$ g/ml in blood level (await blood level results before IV dose when patient on oral aminophylline)
- Lower dosing : Alcoholism, old age, chronic liver disease, CHF, fever, erythromycin. ciprofloxacin or H2-blocker

# *Mucokinetic Medications*

- Nebulized water and saline and oral expectorants **guaifenesin** and saturated iodide *are of no benefit*
- Acetylcysteine cause reflex bronchoconstriction
- Clinical improvement with oral iodinated glycerol but can cause thyroid dysfunction
- Simple oral hydration is the easiest and safest agent

# Treatment of Stable COPD: Home Oxygen Therapy

- $\geq 15$  hours/day reduces mortality
- Criteria for O<sub>2</sub> therapy
  - Pa O<sub>2</sub>  $\leq 55$  mm Hg (O<sub>2</sub> saturation  $\leq 88\%$ ) at rest or during exercise or sleep or
  - Pa O<sub>2</sub>  $< 60$  mm Hg and hematocrit  $> 52\%$

# COPD Medications

## Typically Used in the US

<p><math>\beta_2</math>-agonists (short-acting)</p> <ul style="list-style-type: none"><li>■ Albuterol</li><li>■ Levalbuterol</li><li>■ Metaproterenol</li></ul>	<p>Combination short-acting <math>\beta_2</math>-agonist plus inhaled anticholinergic:</p> <ul style="list-style-type: none"><li>■ Albuterol/Ipratropium</li></ul>
<p><math>\beta_2</math>-agonists (long-acting)</p> <ul style="list-style-type: none"><li>■ Salmeterol</li><li>■ Formoterol</li></ul>	<p>Inhaled Corticosteroids</p> <ul style="list-style-type: none"><li>■ Flunisolide</li><li>■ Triamcinolone</li><li>■ Fluticasone</li><li>■ Budesonide</li><li>■ Mometasone</li></ul>
<p>Anticholinergic (short-acting)</p> <ul style="list-style-type: none"><li>■ Ipratropium bromide</li></ul>	<p>Combination inhaled corticosteroid plus long-acting <math>\beta_2</math>-agonist</p> <ul style="list-style-type: none"><li>■ Fluticasone 250 mcg/ salmeterol 50 mcg</li></ul>
<p>Anticholinergic (long-acting)</p> <ul style="list-style-type: none"><li>■ Tiotropium</li></ul>	

# Exacerbations in COPD

## *Etiology*

### ■ **Primary**

- viral and bacterial infections
- air pollution
- discontinuation of medications
- unknown reasons

### ■ **Secondary**

- pneumonia, pulmonary embolism, heart failure  
pneumothorax,



# COPD Exacerbations

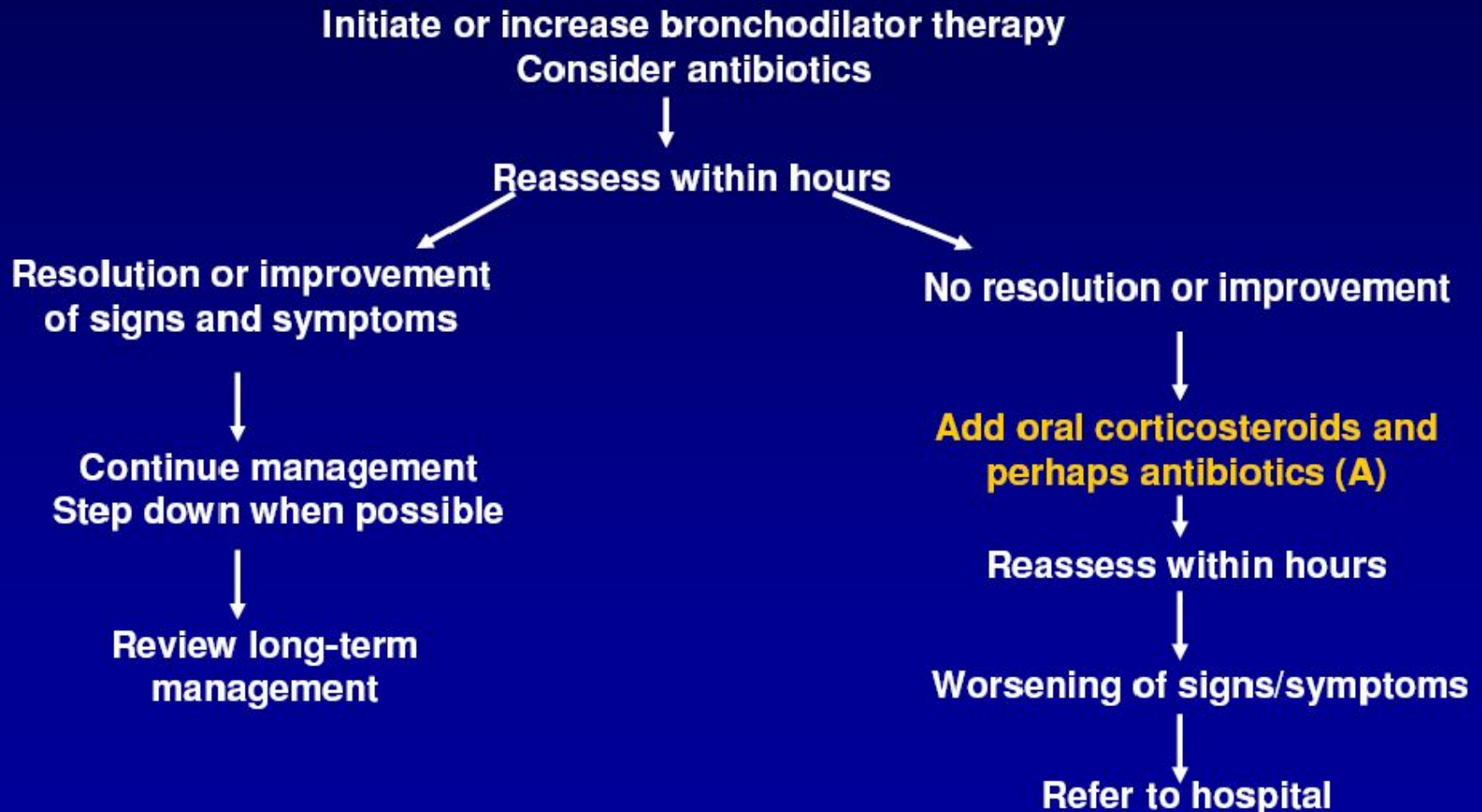
- Primary symptom—increased dyspnea —may be accompanied by wheezing and tightening of chest, increased cough and volume of sputum, a change in the color of sputum
- Possible malaise, insomnia, sleepiness, fatigue, fever, depression, confusion
- Most commonly caused by infection of the airways and air pollution
- Diagnosed through a targeted history and physical, spirometry, arterial blood gases or pulse oximetry

# COPD Exacerbations: Indications for Hospital Assessment or Admission

- Impaired level of consciousness
- Acute confusion
- Sudden onset of resting dyspnea
- Severe COPD history
- Failure to respond to initial medical management of exacerbation
- Cyanosis or peripheral edema
- Significant co-morbidity
- Newly occurring arrhythmias
- Uncertain diagnosis
- Older age
- Bed confinement
- Insufficient home support

# **COPD Exacerbations\***

*Requires reassessment within hours*





# Managing COPD Exacerbations

- Bronchodilators
  - Short-acting, inhaled  $\beta_2$ -agonists are the preferred treatment
  - If no response, an anticholinergic is recommended
  - The role of long-acting inhaled bronchodilators in conjunction with short-acting agents has not been assessed
  - Use of aminophylline is controversial
  - In the case of a severe exacerbation or inadequate response, methylxanthine may be considered, but requires careful monitoring

# Managing COPD Exacerbations

## ■ Corticosteroids

- Used in addition to bronchodilator therapy, for the COPD patient with an exacerbation who is admitted to the hospital or who is an outpatient with significant increase in breathlessness
- Safe and efficacious dose: 30 to 40 mg oral prednisone daily for 10 to 14 days
- Long-term use not advised



# Management Options for Acute Exacerbations of COPD

- Inhaled bronchodilators (beta<sub>2</sub>-agonists and/or anticholinergics)
- In patients with signs of infection, antibiotics
- Theophylline\* or aminophylline\* (?)
- Systemic, preferably oral, glucocorticoids
- Oxygen
- Hospitalization
- Noninvasive positive pressure ventilation

\* Not FDA-approved for treating COPD.

# Bronchodilators in Acute Exacerbations of COPD

- Initiate or increase dose of short-acting inhaled beta<sub>2</sub>-agonists (e.g., albuterol\*)
- Add anticholinergic (e.g., ipratropium) if no prompt response
- Role of methylxanthines (aminophylline\*, theophylline\*) is controversial: some benefits as third-line drug, but side effects and drug interactions
- Delivery method (nebulization or metered dose) can be individualized

\* Not FDA-approved for treating COPD.

Information taken from: Global Initiative for Chronic Obstructive Lung Disease. Global strategies for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2005. Retrieved August 16, 2006, from the World Wide Web: <http://www.goldcopd.com/GuidelineItem.asp?11=2&12=1&intId=989>.

# Antibiotics

- Have proven beneficial in treating acute infective exacerbations of COPD
- Should be used in patient with 2 or more symptoms :
  - worsening dyspnea
  - increased sputum volume
  - increased sputum purulence

# Antibiotics in Acute Exacerbations of COPD

- Traditional regimen: three to 14 days of tetracycline, amoxicillin or fluorquinolone
- Choice of agent should reflect local patterns of antibiotic sensitivity among *S. pneumoniae*, *H. influenzae* and *M. catarrhalis*
- Exacerbations have been linked to new strains of these organisms
- Treatment may include amoxicilin, macrolide, quinilone or tetracycline

# Inpatient Treatment of Acute Exacerbations

- Oxygen to keep O<sub>2</sub> sat >90%
- Nebulizer treatments with bronchodilators
- Steroids (40 to 60 mg daily for 7 to 14 days, IV or PO)
- Antibiotics Fluids



# Mucolytic Therapy

- Mucus is a nearly universal complaint in COPD patients
- Mucolytics increase expectorations of sputum by reducing viscosity or hypersecretion
- Mucokinetic or mucoregulator agents include ambroxol, erdosteine, carbocysteine, iodinated glycerol, uridine 5'-triphosphate
- Use in COPD is controversial, not recommended in GOLD 2006 update of guidelines

# Oxygen therapy

- Generally only considered in severe (stage III) COPD patients with  $\text{PaO}_2 < 55 \text{ mmHg}$
- Goal: to increase  $\text{PaO}_2$  to  $60 \text{ mmHg}$  or an  $\text{SaO}_2$  of  $>90\%$
- Administration: long-term continuous therapy, during exercise, or to relieve dyspnoea
- Benefits: long-term administration ( $>15 \text{ h/day}$ ) increases survival, improves haemodynamics, exercise capacity, lung mechanics and mental state
- Limitations: cost of supplemental home delivery is high

# **Future Treatments for COPD**

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# Phosphodiesterase-4 Inhibition (Roflumilast)

- Inhibition raises intracellular levels of cAMP resulting in downregulation of signaling pathways in inflammatory cells
- Major isoenzyme in inflammatory cells implicated in inflammatory airway disease

# Roflumilast

Dosing	500 $\mu$ g PO once daily
Pharmacokinetics	Oral bioavailability = 79% Peak plasma concentration in 1hr Mean half-life = 17hrs
Metabolism	Metabolized by cytochrome P450 3A4 and CYP 1A2 isozymes Active metabolite roflumilast N-oxide, accounts for 90% of pharmacologic effect
Adverse Effects	Diarrhea, nausea, headache



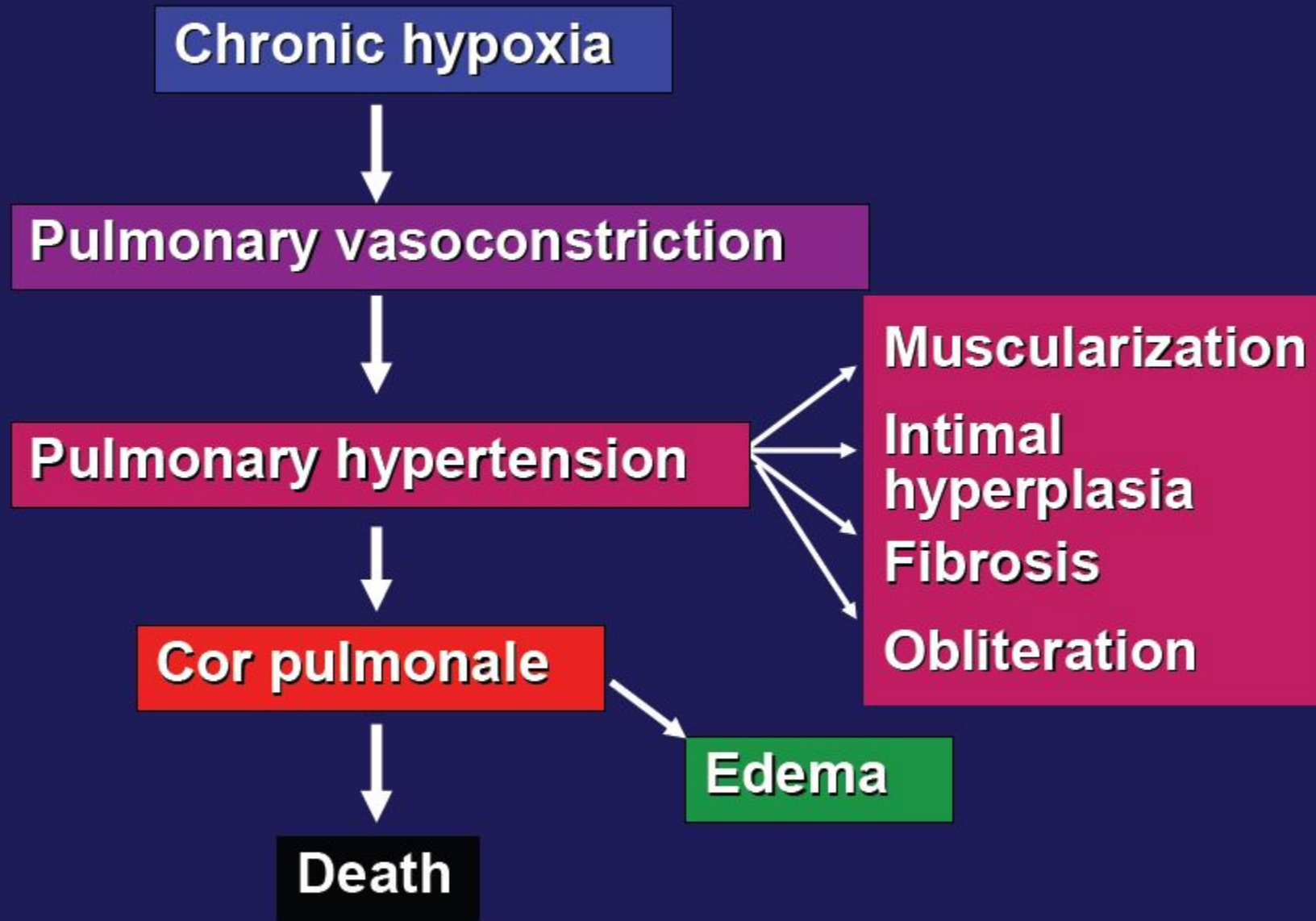
# PDE-4 Inhibitors

## *Effects on Fibroblast Activity and Tissue Remodeling*

- PDE-4 inhibitors may alter fibroblast activity in damaged lungs
- Fibroblasts produce scarring and distortion associated with fixed airway obstruction
- Specific PDE-4 inhibitors cilomilast and rolipram suppress fibroblast chemotaxis
- Thus, PDE-4 inhibitors may combine bronchodilator, anti-inflammatory and tissue remodeling actions



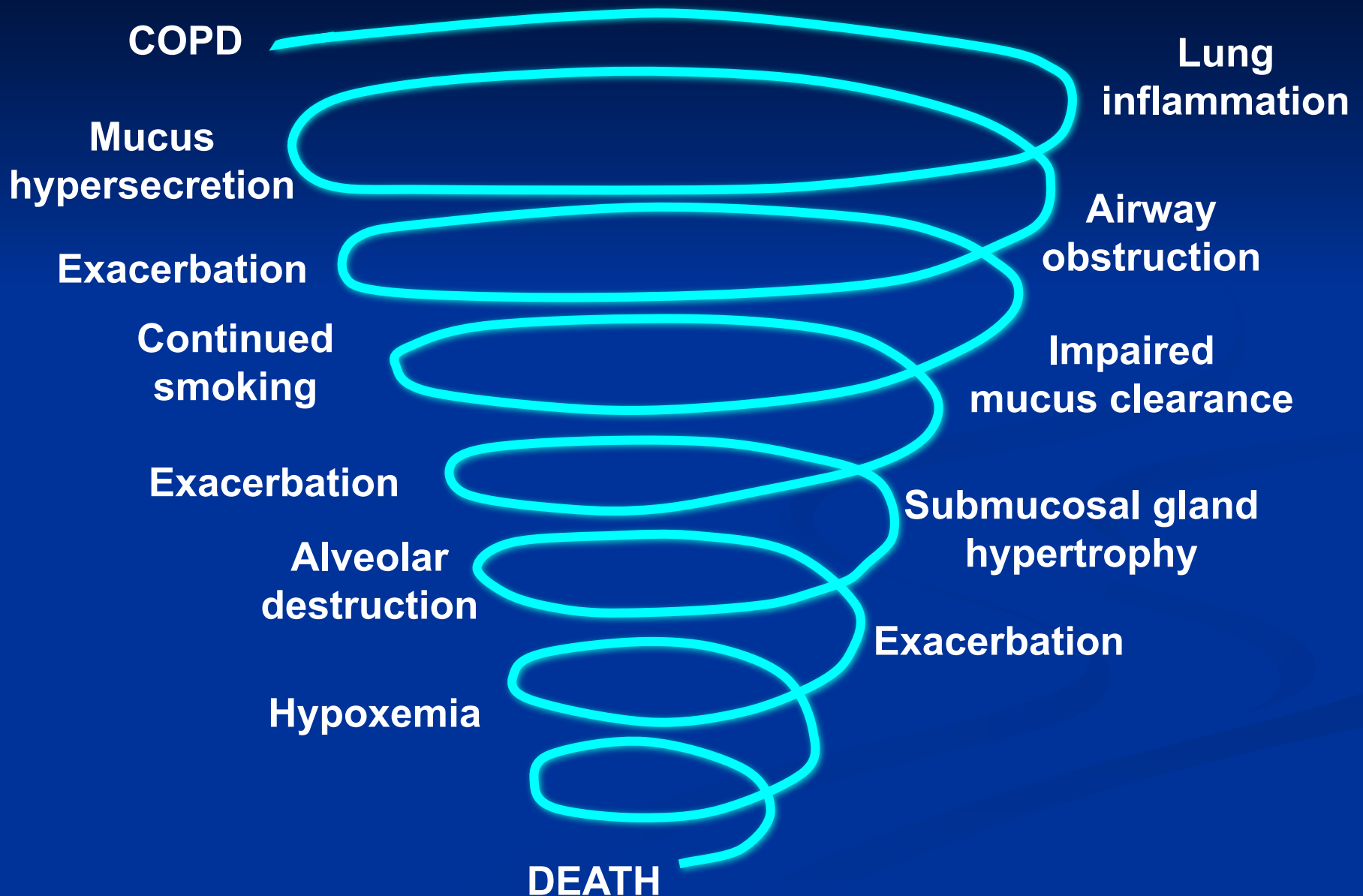
# Pulmonary Hypertension in COPD



*Smoke and Mirrors*



# “The Downward Spiral”





# SMOKERS

*“Hope and expect for the best.  
Prepare for the worst.”*

Back AL, Arnold RM, Quill TE. Hope for the best, and prepare for the worst. *Ann Intern Med* 2003;138:439-43.



NEXT STAGE...



# PREVENT COPD



# PREVENT COPD

**Smoking**



**CURES CANCER**





Thanks for your kind attention

