

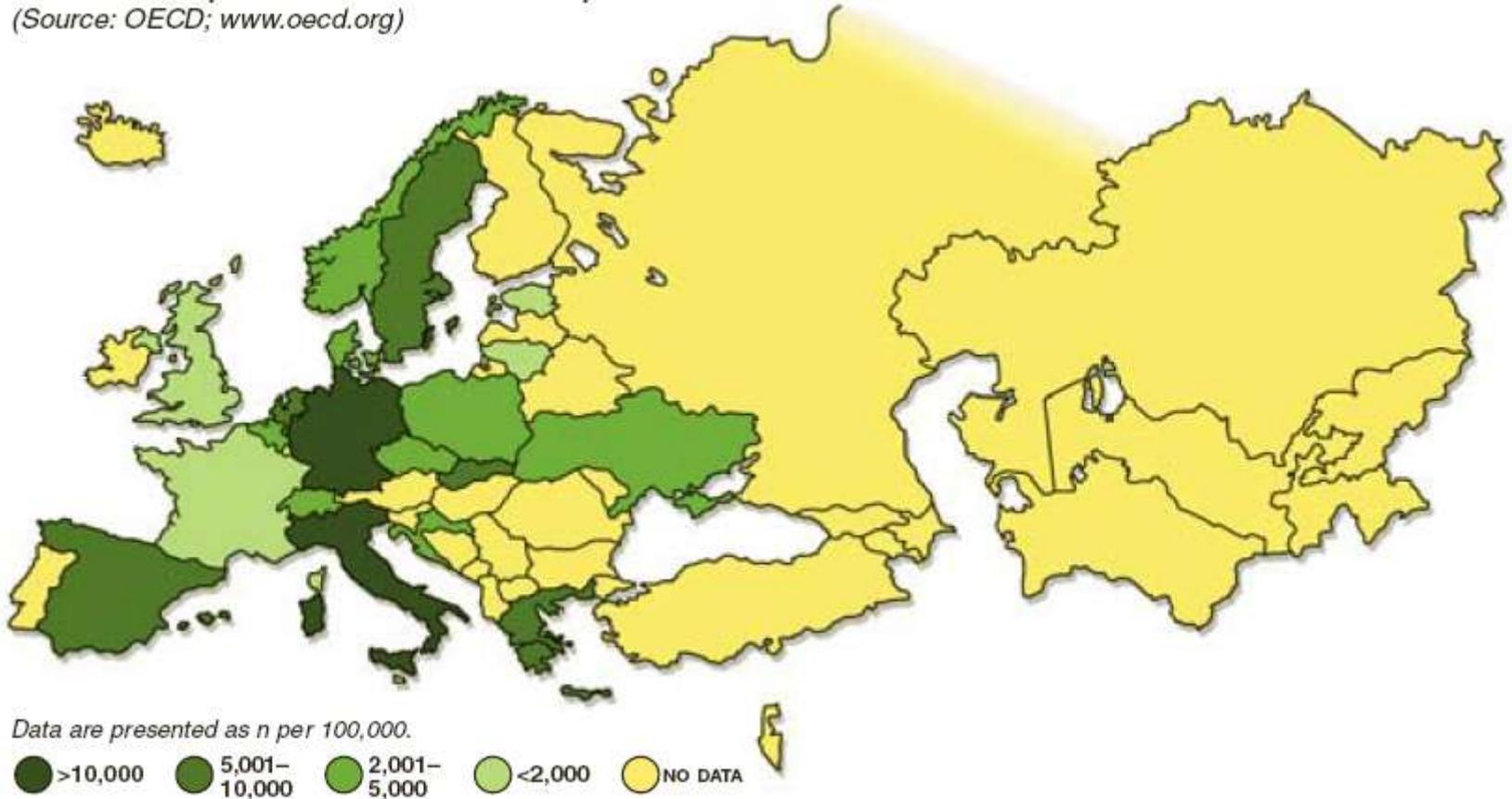
# **Chronic obstructive pulmonary disease**

## **COPD**

Pavol JOPPA, MD, PhD

# Prevalence

Latest data on prevalence of COPD in Europe  
(Source: OECD; [www.oecd.org](http://www.oecd.org))



Global Initiative for Chronic  
Obstructive  
Lung  
Disease



GLOBAL STRATEGY FOR THE DIAGNOSIS,  
MANAGEMENT, AND PREVENTION OF  
CHRONIC OBSTRUCTIVE PULMONARY DISEASE

2018 REPORT

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[www.goldcopd.org](http://www.goldcopd.org)

# Definition of COPD

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Chronic obstructive pulmonary disease (COPD) is a

- common, preventable and treatable disease characterized by **persistent respiratory symptoms**
- **AND**
- by **airflow limitation** that is due to airway and/or alveolar abnormalities usually caused by significant **exposure to noxious particles and gases**

# Risk Factors for COPD

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- Susceptibility genes
  - alpha-1 antitrypsin deficiency
- Exposure to inhaled particles:
  - Tobacco smoke (active and passive)
  - Indoor air pollution from heating and cooking with biomass in poorly ventilated dwellings
  - Occupational dusts, organic and inorganic
  - Outdoor air pollution
- Poor lung growth and development
- Oxidative stress
- Female gender
- Age
- Respiratory infections
- Low socioeconomic status
- Poor nutrition
- Comorbidities

# Smoking Is the Single Most Important Risk Factor for COPD in Industrialised Societies

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# Cumulative Exposure to Noxious Particles Is the Key Risk Factor for COPD

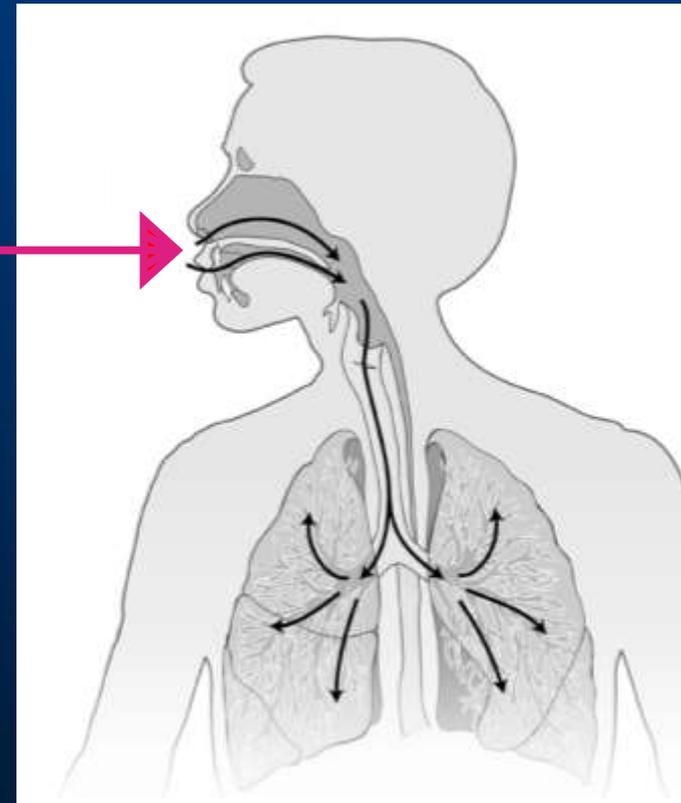
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Cigarette smoke

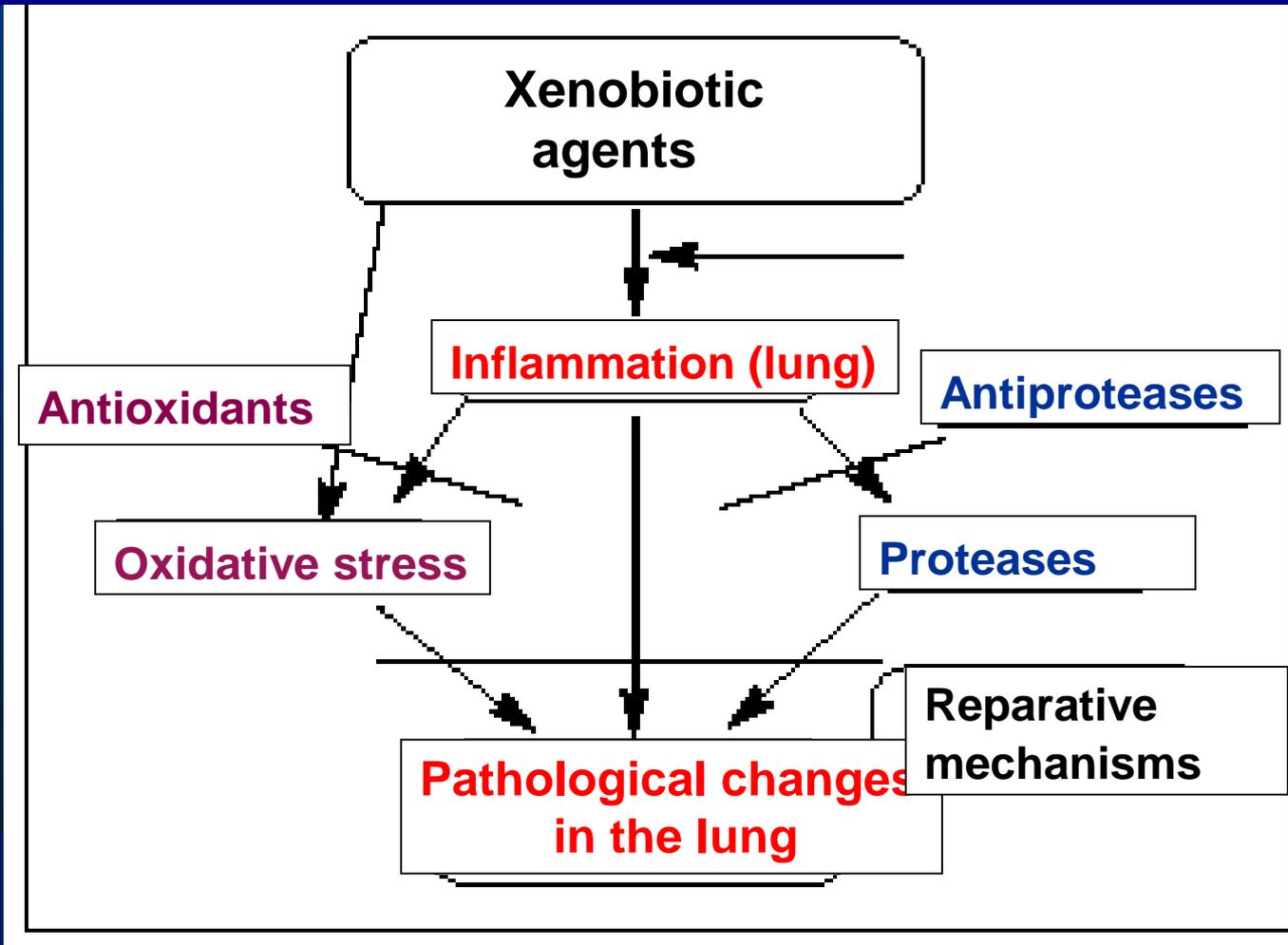
Indoor Air Pollution (biomass fuels, tobacco smoke)

Occupational dusts, organic and inorganic

Outdoor air pollution

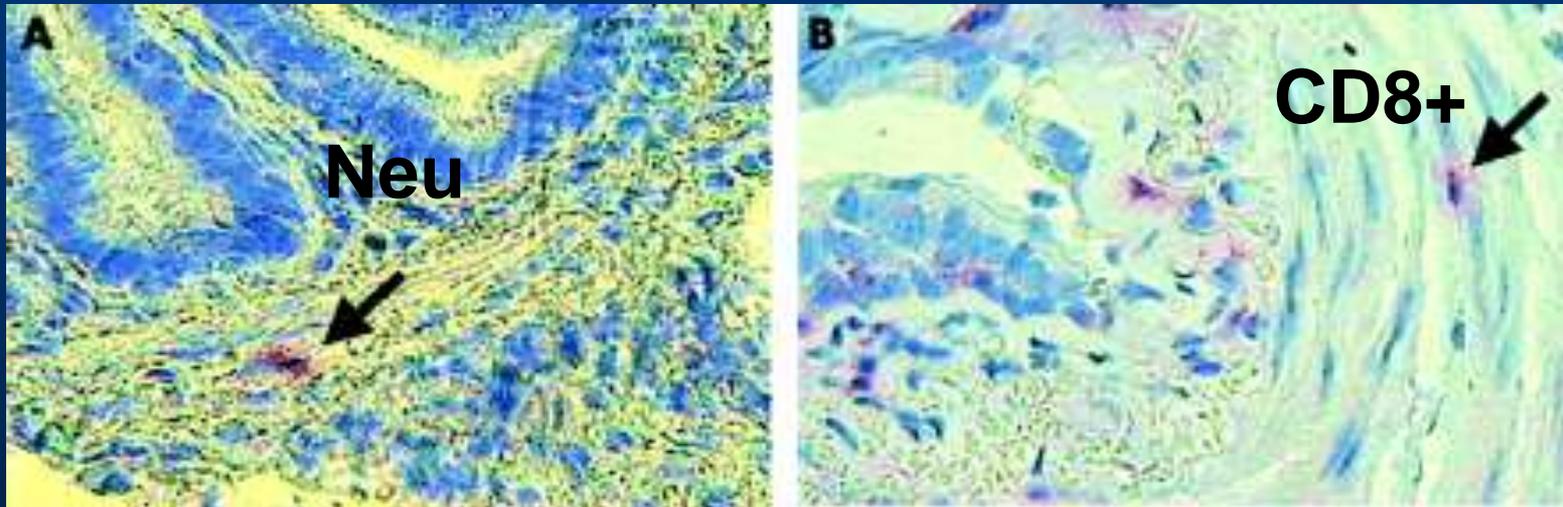


# Pathogenesis of COPD

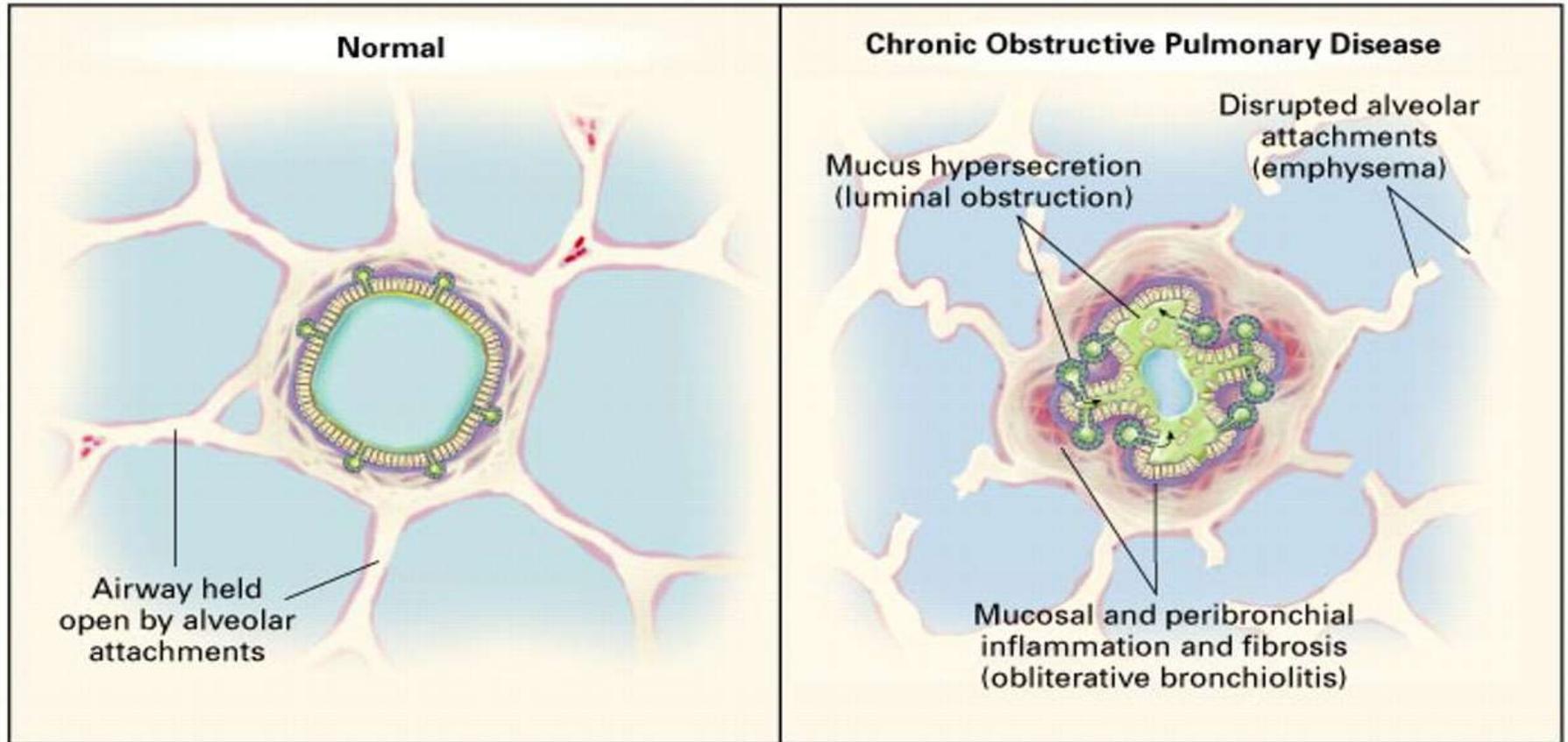


# Lung inflammation

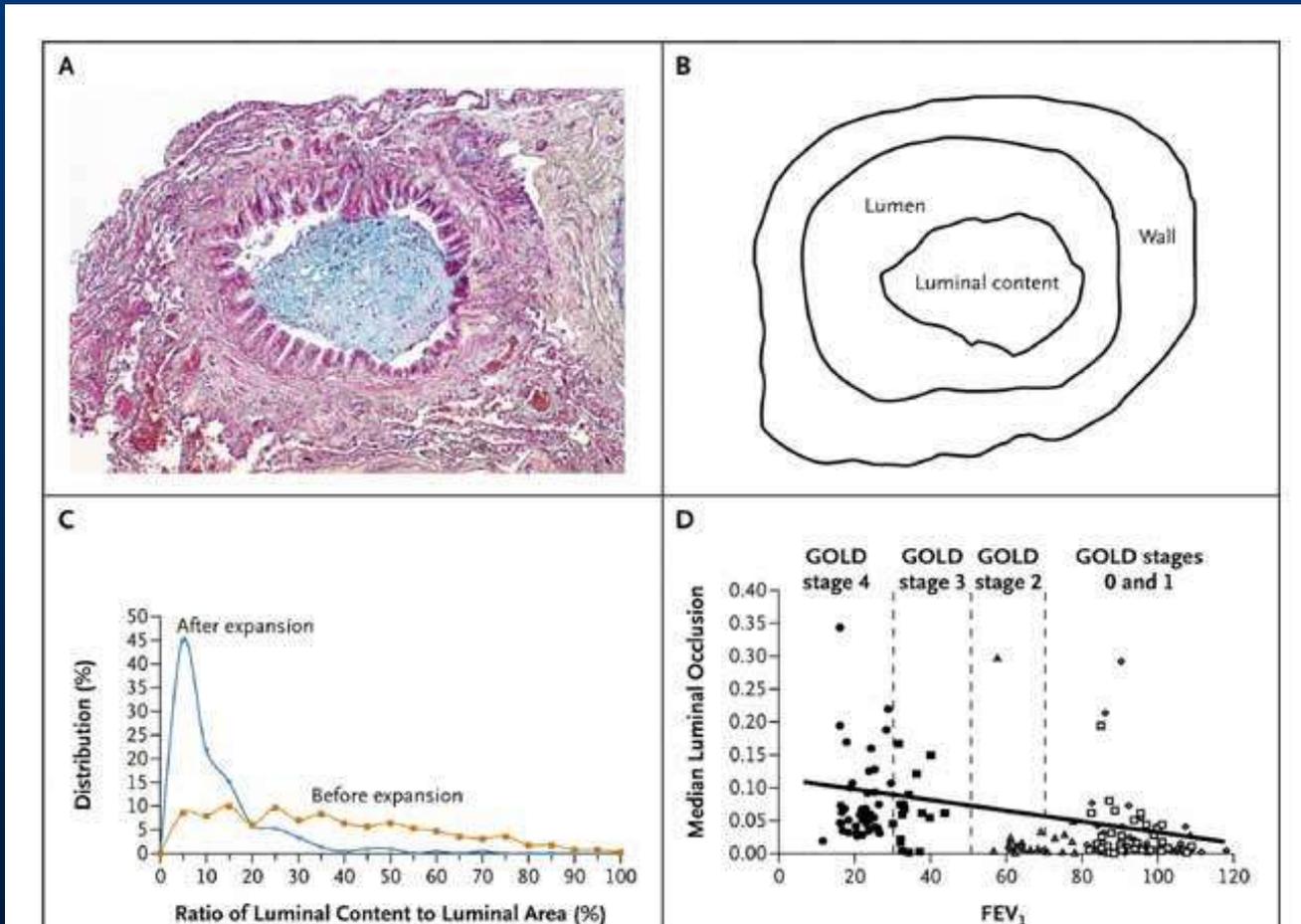
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# Airflow Limitation in COPD



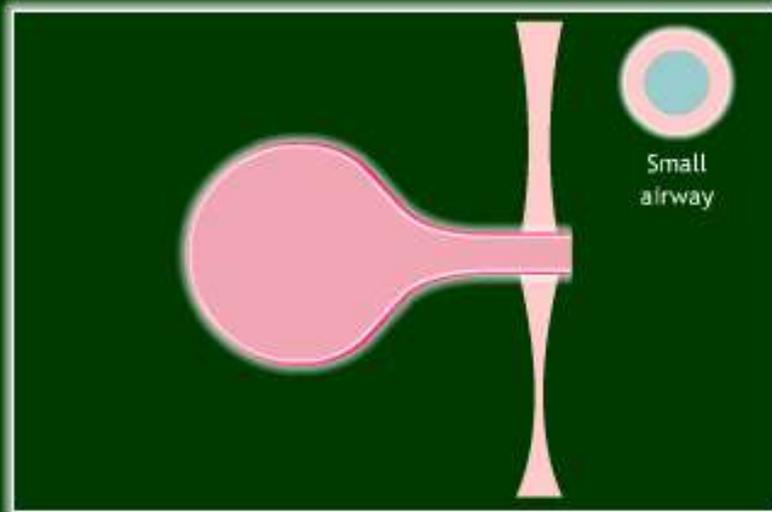
# Inflammation



# Normal alveoli

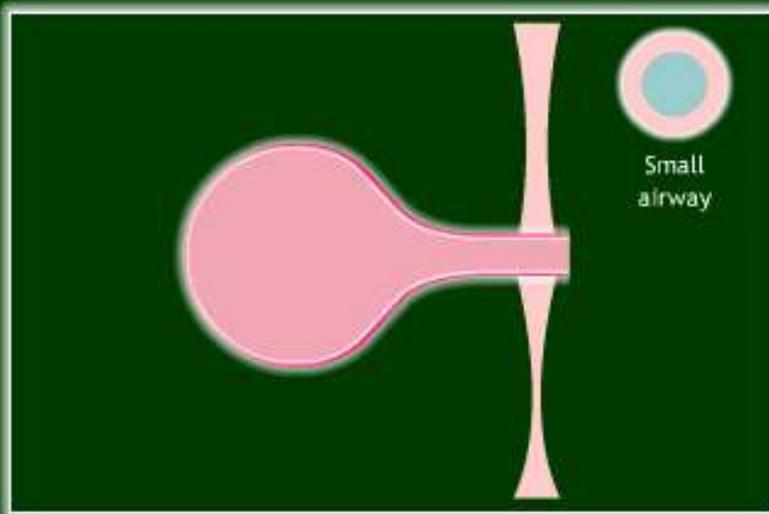
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Alveolar deflation in the normal state  
Cycle of deflation and inflation

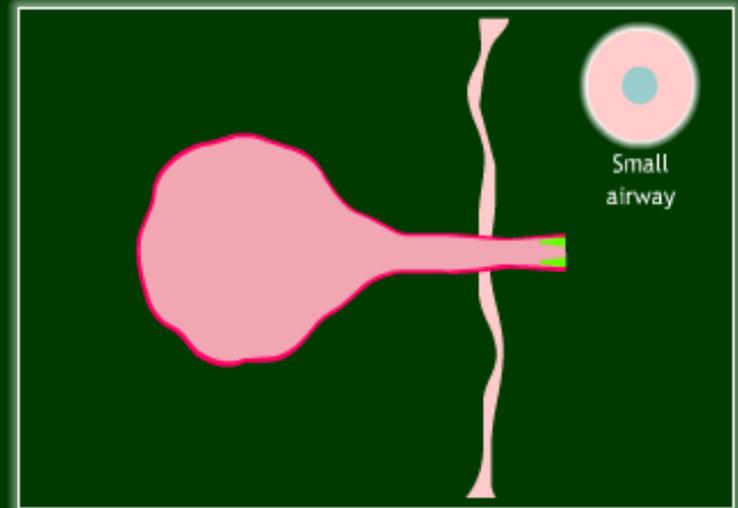


# Alveolar deflation during expiration

Alveolar deflation in the normal state  
Cycle of deflation and inflation



Alveolar deflation in COPD  
Cycle of deflation and inflation

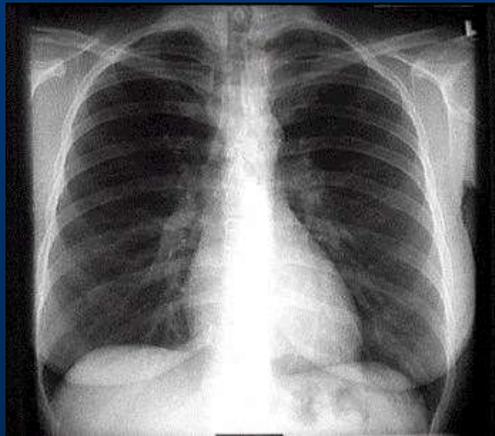


In COPD, alveoli lose their elasticity, in association with the loss of supportive structures  
↓  
Limitation of airflow

# Air trapping - hyperinflation

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Healthy



Hyperinflation



## Consequences

- Increased work of breathing
  - ▲ Mechanically disadvantageous work of respiratory muscles
  - ▲ Breathlessness (dyspnea)

# Key Indicators of COPD

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**Chronic cough:**

Present intermittently/every day often throughout the day

**Chronic sputum production:**

Any pattern

**Dyspnoea:**

Progressive, persistent, “an increased effort to breathe”, “heaviness”, “air hunger”, “gasping”, worse on exercise, worse during respiratory infections

**History of risk factor exposure:**

Tobacco smoke, occupational to dusts and chemicals, smoke from indoor cooking/heating fuels

# Screening for COPD

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- Consider COPD, and perform spirometry, if any of these indicators are present in an individual over age 40:
  - Dyspnoea that is progressive, usually worse with exercise, and persistent
  - Chronic cough (may be intermittent and unproductive)
  - Chronic sputum
  - History of tobacco smoke exposure
  - Exposure to occupational dusts and chemicals
  - Risk factors

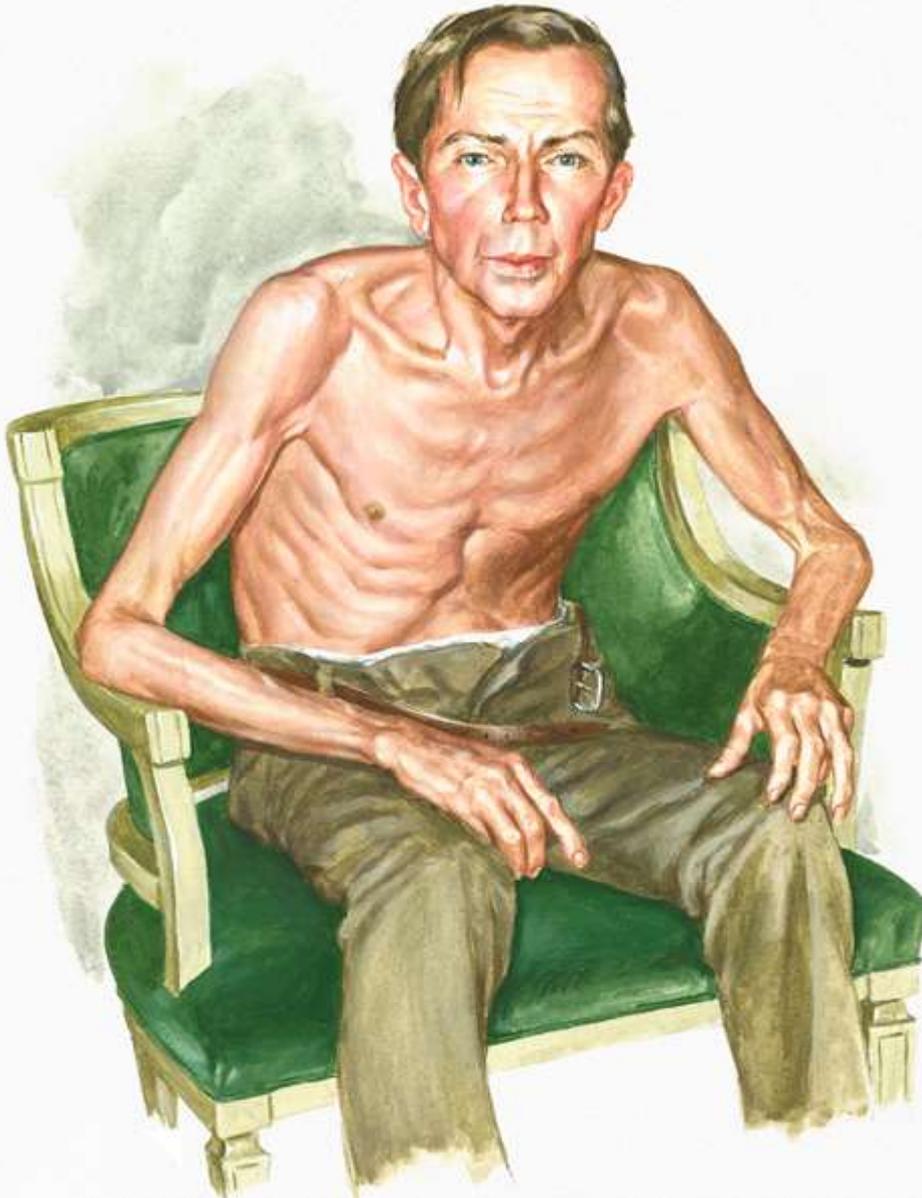
# Clinical Manifestation of COPD

„Blue bloater“



# Clinical Manifestation of COPD

„Pink puffer“



# Symptoms of COPD

„Blue bloater“



**BMI**  
**35,2 kg/m<sup>2</sup>**

„Pink puffer“

In both possibly  
same level  
of airflow limitation !

**BMI**  
**19,8 kg/m<sup>2</sup>**

# Diagnosis of COPD

## SYMPTOMS

Cough  
Sputum  
Shortness of breath

## EXPOSURE TO RISK FACTORS

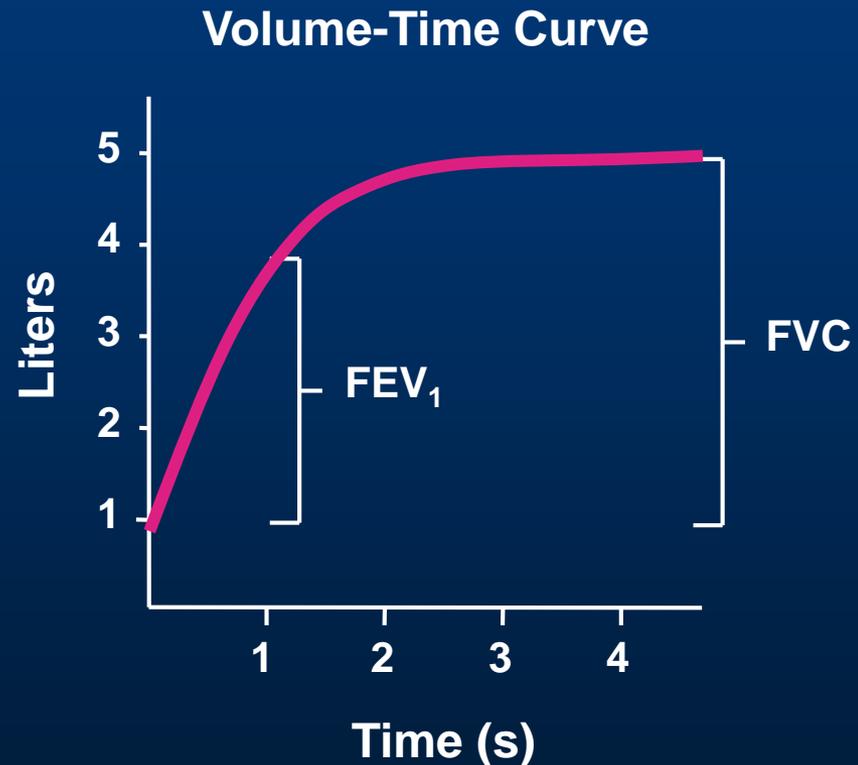
Tobacco  
Indoor air pollution  
Occupation  
Outdoor air pollution

**SPIROMETRY**

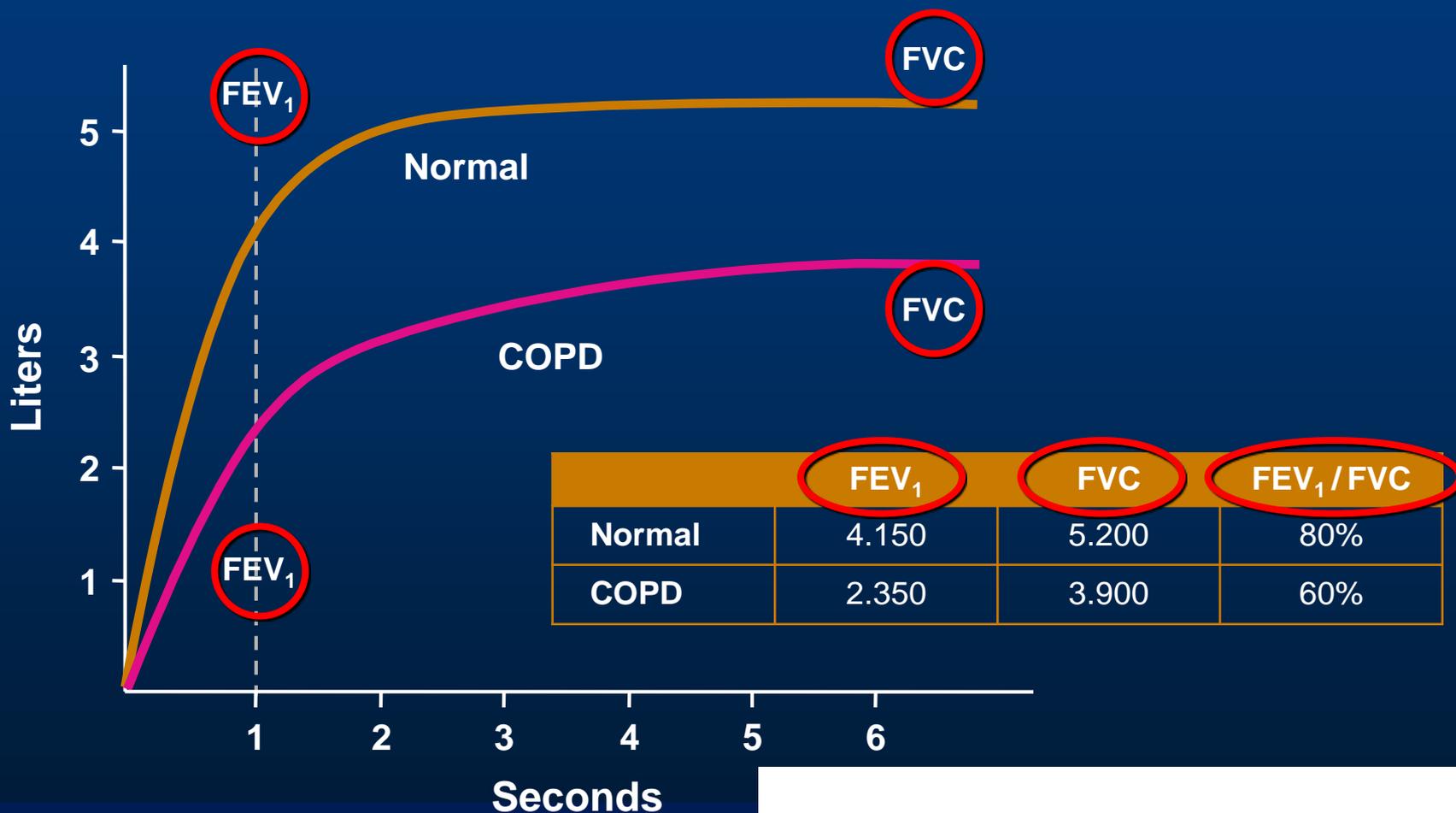


# Pulmonary Function Tests

- **Forced vital capacity (FVC):** total volume of air expired after a full inspiration. COPD: normal or only slightly decreased
- **Forced expiratory volume in 1 second ( $FEV_1$ ):** volume of air expired in the first second during maximal expiratory effort. The  $FEV_1$  is reduced in COPD
- **$FEV_1/FVC$ :** percentage of the vital capacity which is expired in the first second of maximal expiration  
COPD:  $FEV_1/FVC$  decreases and can be as low as 20-30%



# Pulmonary Function Tests



**Reversibility of  
Bronchodilator Response**

# Spirometry

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- Spirometry - after the administration of an adequate dose of a short-acting inhaled bronchodilator  
(4 puffs of a short-acting bronchodilator such as salbutamol)
- A post-bronchodilator  $FEV_1/FVC < 0.70$  confirms the presence of airflow limitation that is not fully reversible
- Where possible, values should be compared to age-related normal values to avoid over-diagnosis of COPD in the elderly

# Stages of airflow limitation in COPD

- COPD includes four stages of severity classified by spirometry:

Stage	Criteria*
1 Mild	$FEV_1/FVC < 0.70$ , $FEV_1 \geq 80\%$ predicted
2 Moderate	$FEV_1/FVC < 0.70$ , $50\% \leq FEV_1 < 80\%$ predicted
3 Severe	$FEV_1/FVC < 0.70$ , $30\% \leq FEV_1 < 50\%$ predicted
4 Very Severe	$FEV_1/FVC < 0.70$ , $FEV_1 < 30\%$ predicted

\* Post-bronchodilator

PATIENT GROUP		SYMPTOMS	
		Less symptoms mMRC=0-1 CAT<10	More symptoms mMRC≥2 CAT≥10
RISK	High risk GOLD 3-4 (i.e. FEV <sub>1</sub> <50%) Exacerbations ≥2/year	<b>C</b>	<b>D</b>
	Low risk GOLD 1-2 (i.e. FEV <sub>1</sub> ≥50%) Exacerbations ≤1/year	<b>A</b>	<b>B</b>

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Staging of COPD combining symptoms and risk of future exacerbations

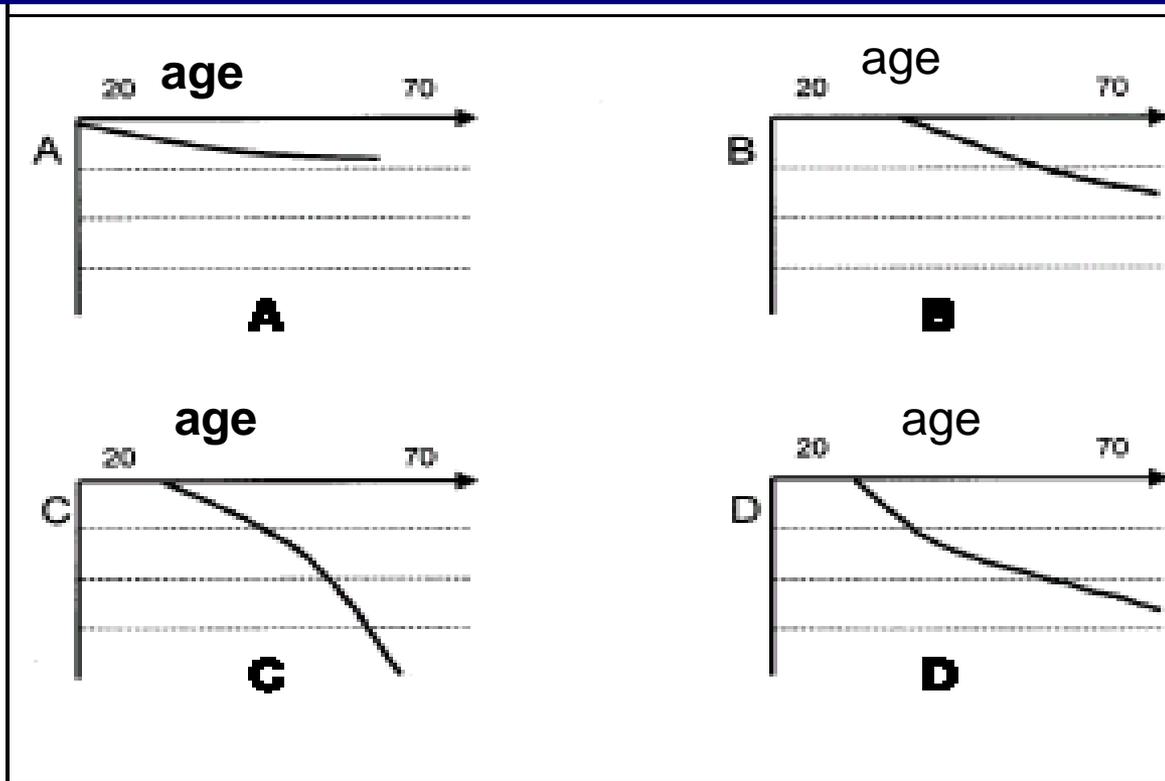
# Modified Medical Research Council breathlessness scale



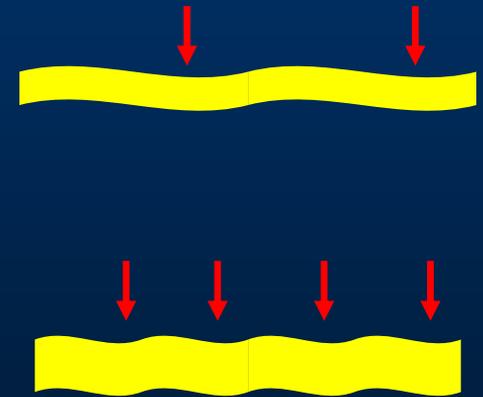
Grade	Description of Breathlessness
Grade 0	I only get breathless with strenuous exercise
Grade 1	I get short of breath when hurrying on level ground or walking up a slight hill
Grade 2	On level ground, I walk slower than people of the same age because of breathlessness, or I have to stop for breath when walking at my own pace on the level
Grade 3	I stop for breath after walking about 100 yards or after a few minutes on level ground
Grade 4	I am too breathless to leave the house or I am breathless when dressing



# Course of COPD



Exacerbations



# Differential Diagnosis: COPD and Asthma

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## COPD

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- Chronic cough
- Onset in mid-life
- Symptoms slowly progressive
- Long smoking history
- Exposure to biomass fuels
- Dyspnoea during exercise
- Largely irreversible airflow limitation

## ASTHMA

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- Onset early in life (often childhood)
- Symptoms vary from day to day
- Symptoms at night/early morning
- Allergy, rhinitis, and/or eczema also present
- Family history of asthma
- Largely reversible airflow limitation

# Combined features of both COPD and Asthma: **ACO (Asthma-COPD overlap)**

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## COPD

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- Persistent obstruction in spirometry: FEV1/FVC less than 0.7
- Symptoms slowly progressive
- Smoking history
- or exposure to biomass fuels

## ASTHMA

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- Greater variability of obstruction
- Allergy, rhinitis, and/or eczema also present
- Family history of asthma
- Higher eosinophil count
- Better response to corticosteroids

# Definition of COPD Exacerbations

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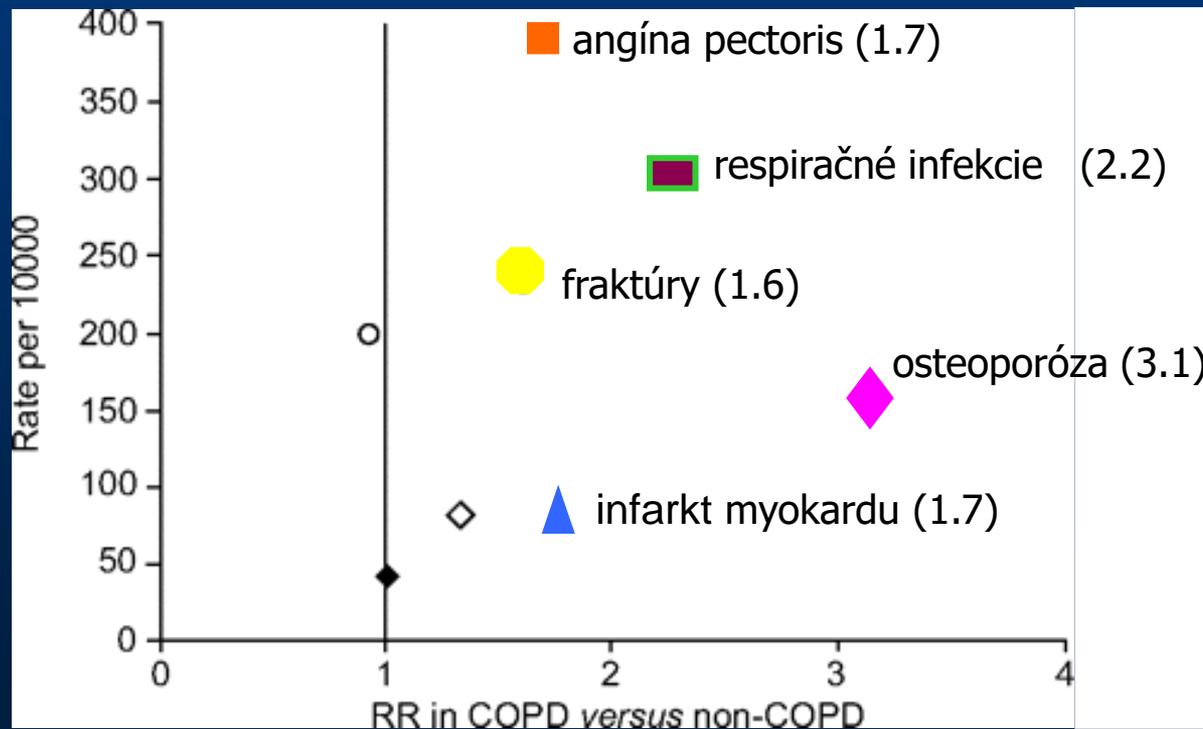
“An event in the natural course of the disease characterised by a change in the patient’s baseline dyspnoea, cough, and/or sputum that is beyond normal day-to-day variations, is acute in onset, and may warrant a change in regular medication in a patient with underlying COPD.”

# COPD and Comorbidities

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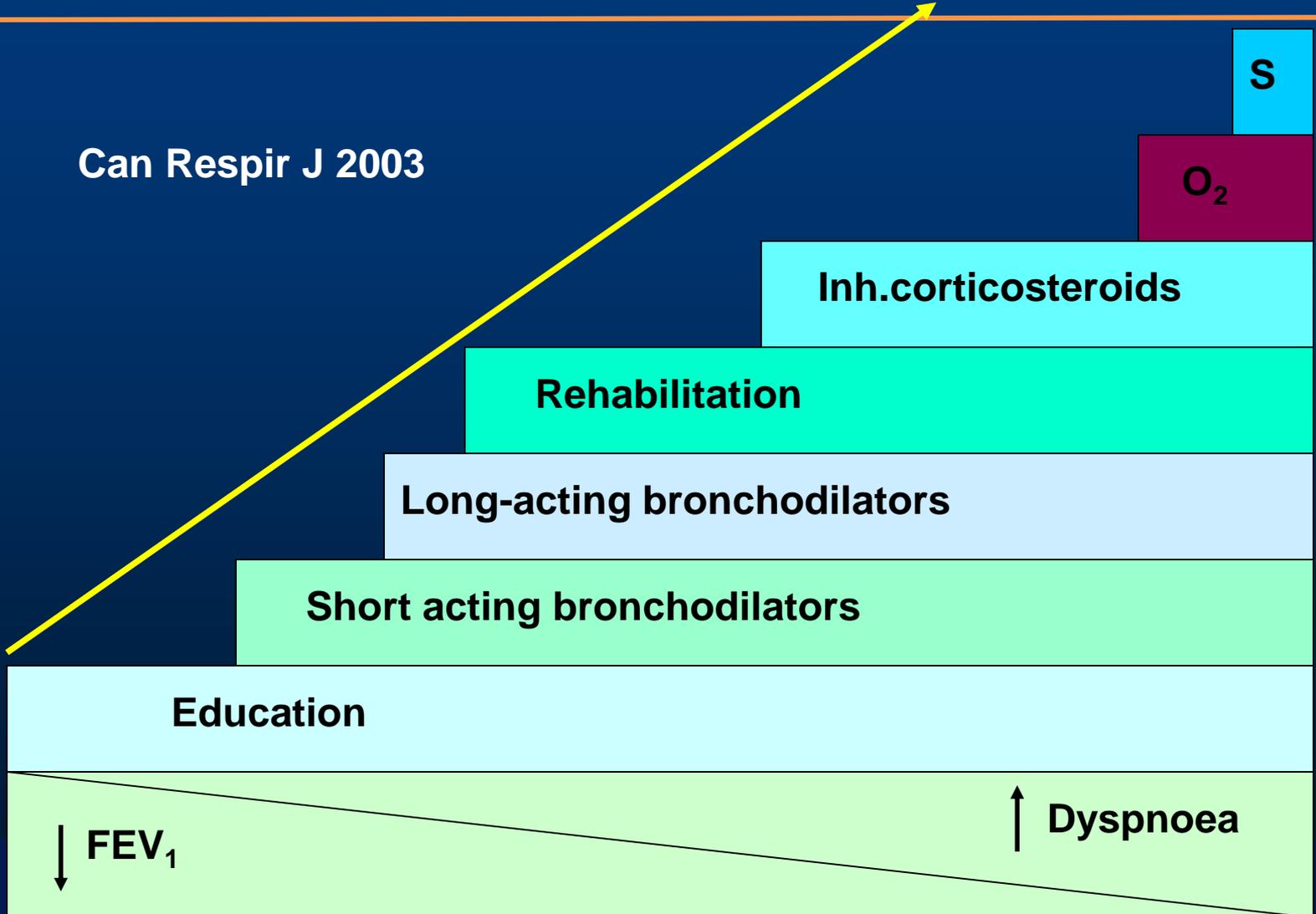
- COPD patients are at increased risk for:
  - Myocardial infarction, angina, peripheral vascular disease, other
  - Diabetes
  - Respiratory infection
  - Depression
  - Osteoporosis
  - Lung cancer
- COPD has significant extrapulmonary (systemic) effects including:
  - Weight loss/gain
  - Nutritional abnormalities
  - Skeletal muscle dysfunction
  - Sleep apnea

# Relative risk of comorbidities



# Therapy

Can Respir J 2003

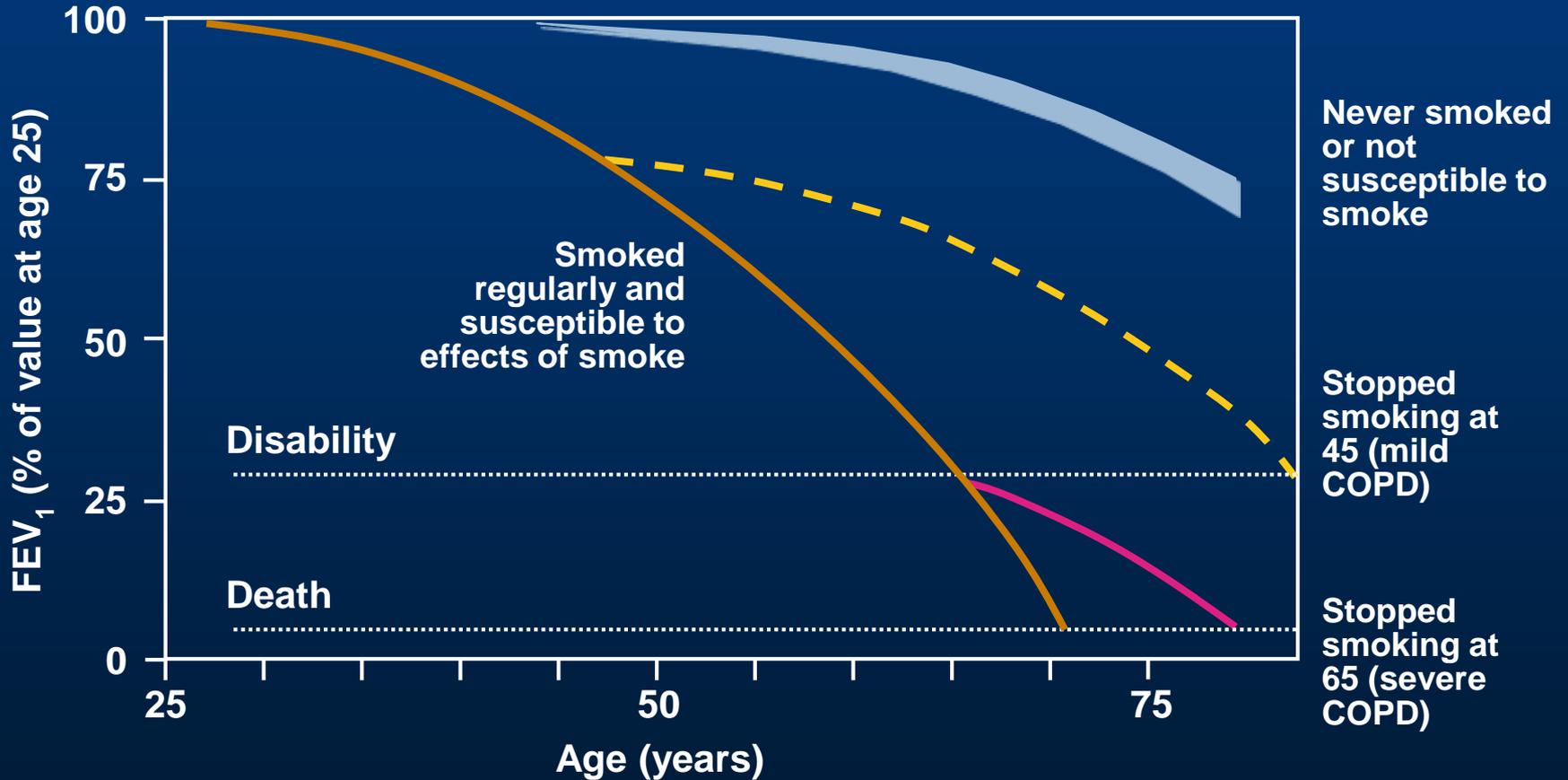


# Reduce Risk Factors

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- **Reduction of total personal exposure to tobacco smoke, occupational dusts and chemicals, and indoor and outdoor air pollutants** are important goals to prevent the onset and progression of COPD
- **Smoking cessation** is the single most effective — and cost effective — intervention in most people to reduce the risk of developing COPD and stop its progression

# COPD Risk and Smoking Cessation



# Bronchodilation therapy

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## **β2-agonists**

*Short acting* – **SABA** (4-6 h)

salbutamol (Ventolin), fenoterol, terbutalín

*Long acting* – **LABA** (12 h)

formoterol, salmeterol, indacaterol (24 hours)

## **Anticholinergics**

*Short acting* (7-9 hours) - **SAMA**

ipratropium bromid

*Long acting* (24 h) - **LAMA**

tiotropium, glycopyrronium, umeclidinium

## **Inhaled corticosteroids**

e.g. beclomethasone, fluticasone, budesonide

# Combined inhalation therapy

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## LABA + corticosteroid

- Formoterol + budesonide
- Salmeterol + fluticasone

## LABA + LAMA

- Indacaterol + glycopyrronium
- Olodaterol + tiotropium

Combined **triple** inhalation therapy (NEW):  
LABA + LAMA + corticosteroid

# Therapy of acute exacerbations

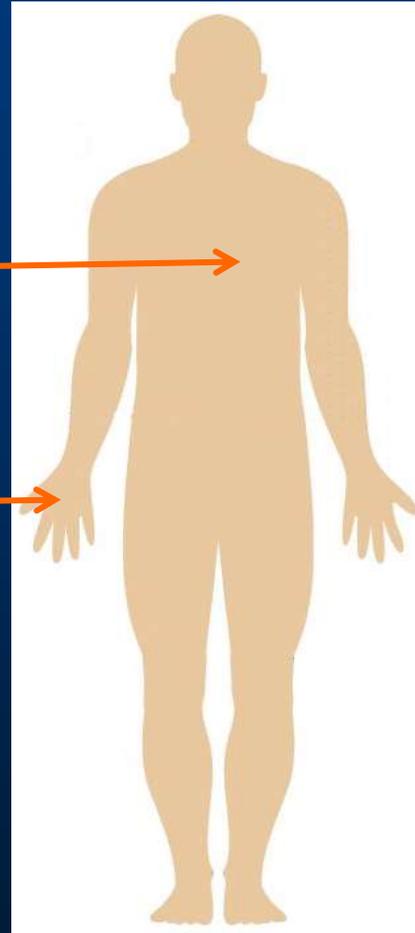
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- Assess **vital functions, intubation** when required based on arterial blood gases and pH (respiratory failure with acidosis)
- Supplementation of  $O_2$
- **Short-acting inhalation therapy** SABA + anticholinergic
- Xantine derivatives – theophylline (cave: arrhythmias)
- Systemic corticosteroids – temporarily, short course (5-7 days)
- Antibiotics (when bacterial infection, always in intubated pts.)
- Hydration
- Prevention of thrombembolic disease

# Potential Side Effects of COPD Therapy: $\beta_2$ -Agonists

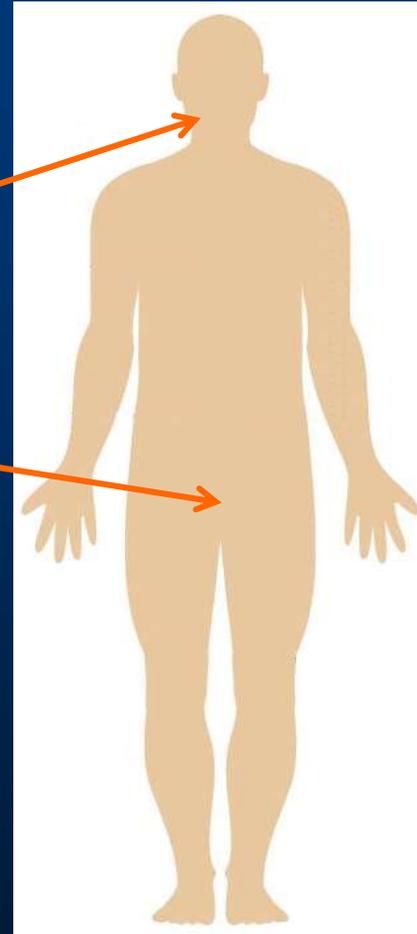
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- Side effects include:
  - Palpitations
  - Ventricular arrhythmias (rare)
  - Sleep disturbance/poor sleep quality
  - Tremor
  - Lowering potassium levels



# Potential Side Effects of COPD Therapy: Anticholinergic Agents

- Side effects are less common versus systemic agents (e.g., atropine)
- Dry mouth is most commonly reported adverse event
- Urinary retention may be a problem for patients with bladder outlet disease



## Respiratory insufficiency

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- **Respiratory failure** – a situation, when the respiratory system is unable to provide sufficient amount of oxygen to saturate the circulatory hemoglobin (and unable to clear CO<sub>2</sub> from blood to maintain normal pH).
  - Classification:
    0. Latent – *versus* – manifest
    1. Hypoxemic (type I, partial)
    2. Hypoxemic – hypercapnic (type II, global)
      - 2a) compensated (pH normal)
      - 2b) decompensated (reduced pH)
-

## Respiratory insufficiency

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- **Hypoxemic**

Reduction of PaO<sub>2</sub> below 8 kPa

(corresponding with SaO<sub>2</sub> below 90%)

- **Hypercapnic**

Increase of PaCO<sub>2</sub> (more than 6,0 kPa)

- **Acidosis**

pH less than 7,36

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## Acute *versus* chronic RI

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- Management of acute RI – to bridge the respiratory failure (by supplementary oxygen, NIV, mechanical ventilation) for the time needed to **diagnose and treat the underlying cause** – its reversal is assumed
- Management of chronic RI – attempt to correct **hypoxemia w/wo hypercapnia**, present due to known chronic end-stage respiratory disease with maximized pharmacologic and non-pharmacologic treatment

## Causes of chronic respiratory failure

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### ● Type I – hypoxemic –

- Lung parenchymal disease – interstitial lung diseases (fibrosis), pneumoconiosis, sarcoidosis, EAA, chronic graft rejection, post-tb. fibrosis, cystic fibrosis
  - Pulmonary vascular disease – pulmonary arterial hypertension
  - Treatment – long-term oxygen (LTOT)
  - Known diagnosis AND  $\text{PaO}_2 < 7,3 \text{ kPa}$
  - or  $\text{PaO}_2$  7,3 to 8,0 kPa + cor pulmonale (ECG, ECHO)
  - or  $\text{PaO}_2$  better than 8,0 kPa + PH in cardiac catheterization
-

## Causes of chronic respiratory failure

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- **Type II – hypoxemic-hypercapnic –**
    - Hypoventilation syndromes – OHS (obesity-hypoventilation syndrome), chest wall deformities (kyphoscoliosis), neuromuscular diseases (ALS, M. Duchenne etc.)
    - **COPD** – most frequent cause of RI; combines all 3 mechanisms (parenchymal disease + hypoventilation + pulmonary hypertension)
    - Treatment – **noninvasive ventilation (NIV BiPAP)** ± LTOT
    - PaCO<sub>2</sub> more than 6,0 kPa in hypoventilation syndromes
    - or PaCO<sub>2</sub> more than 7,3 kPa in COPD
-

## Consequences of chronic respiratory failure

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- Mortality
  - Poor quality of life
  - Cardiovascular complications:
    - Pulmonary hypertension and cor pulmonale
  - Polycythemia, blood hyperviscosity sy
  - Impaired glomerular filtration, sodium retention
  - Impaired sleep
  - Neuropsychiatric symptoms
    - Cognitive dysfunction, behavioral changes
    - Depression
-