Swiss Re

Lung Function and Underwriting Respiratory Cases

Dr. Monica Wilson, Swiss Re Life and Health, CIU 2019

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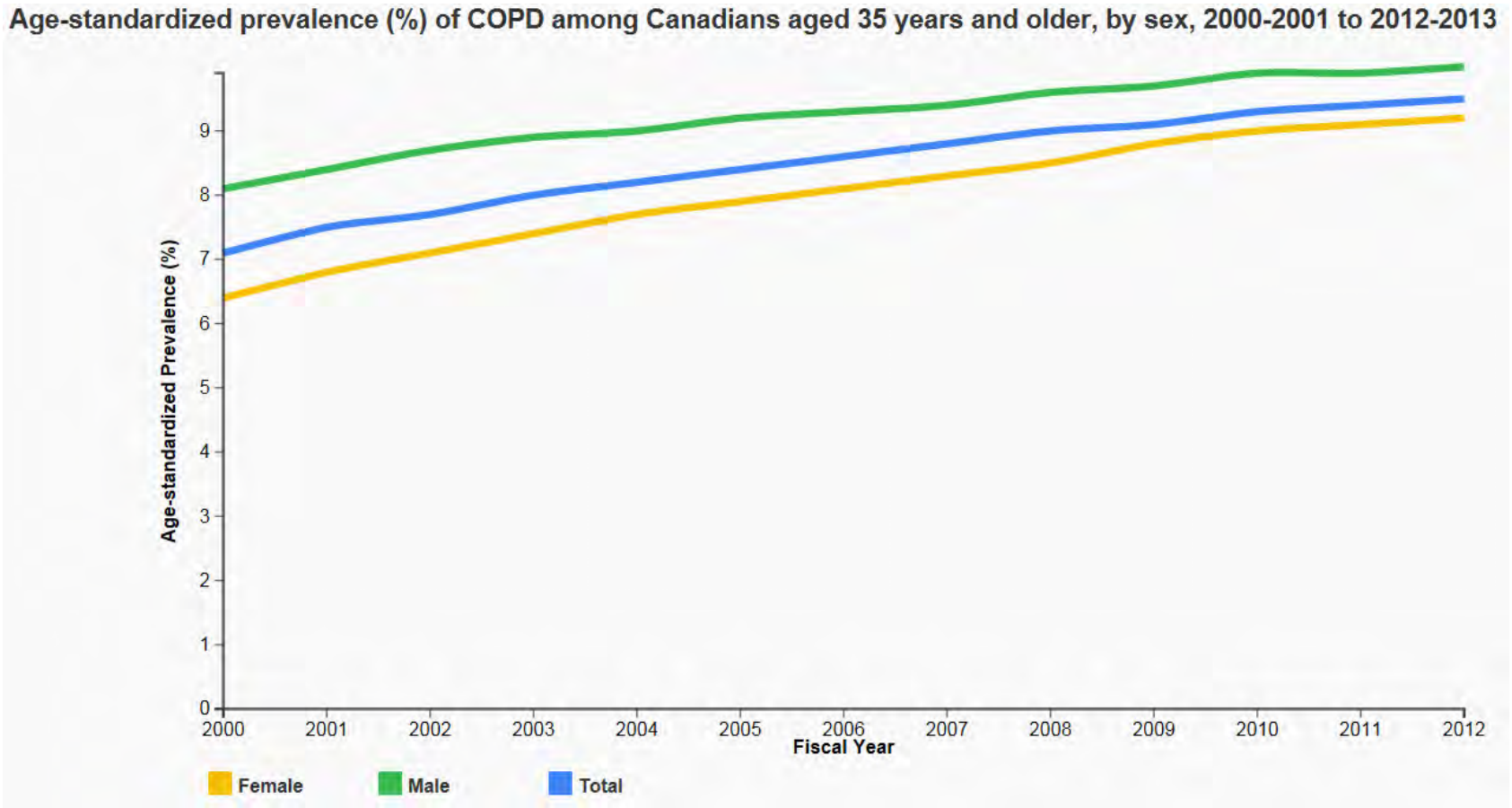
- Epidemiology
- Spirometry
- Asthma
- Chronic Obstructive Pulmonary Disease COPD
- Asthma COPD Overlap Syndrome

Epidemiology

Obstructive Lung Disease

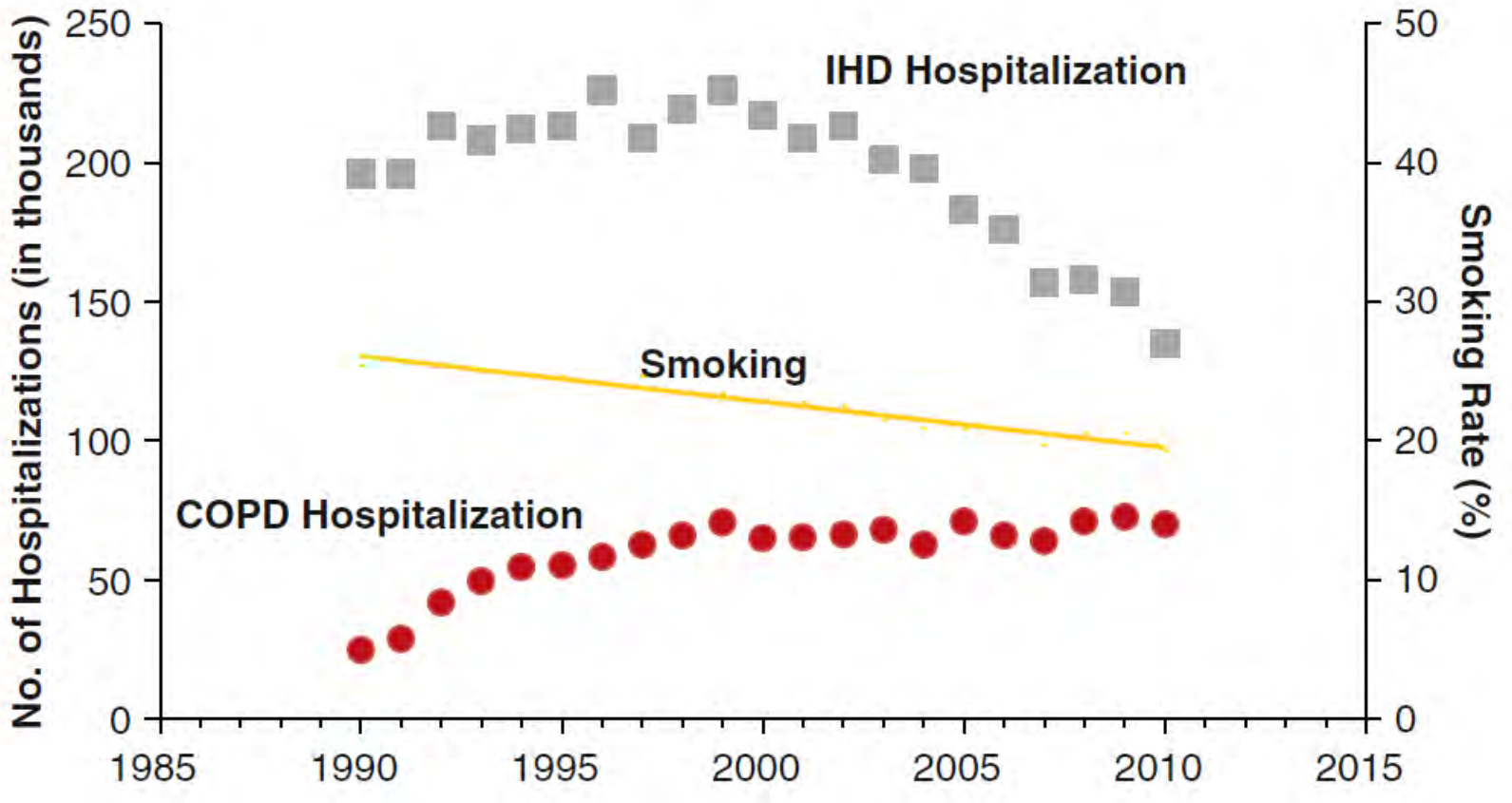
- Asthma
- 334 million people worldwide (Global Burden of Disease Study 2012)
- Prevalence 11.2%
- Chronic Obstructive Pulmonary Disease
- 3rd leading cause of death worldwide (WHO 2012)
- 3rd leading cause of death US (CDC 2013)
- 4% Canadians age 35 and older were diagnosed with COPD

Prevalence of COPD in Canada



https://infobase.phac-aspc.gc.ca/datalab/copd-blog-en.html

Hospitalizations for IHD, COPD and Smoking rates USA



AJRCCM Vol195 Number 3 | February 1 2017

Article

Estimating the prevalence of COPD in Canada: Reported diagnosis versus measured airflow obstruction

by Jessica Evans, Yue Chen, Pat G. Camp, Dennis M. Bowie and Louise McRae

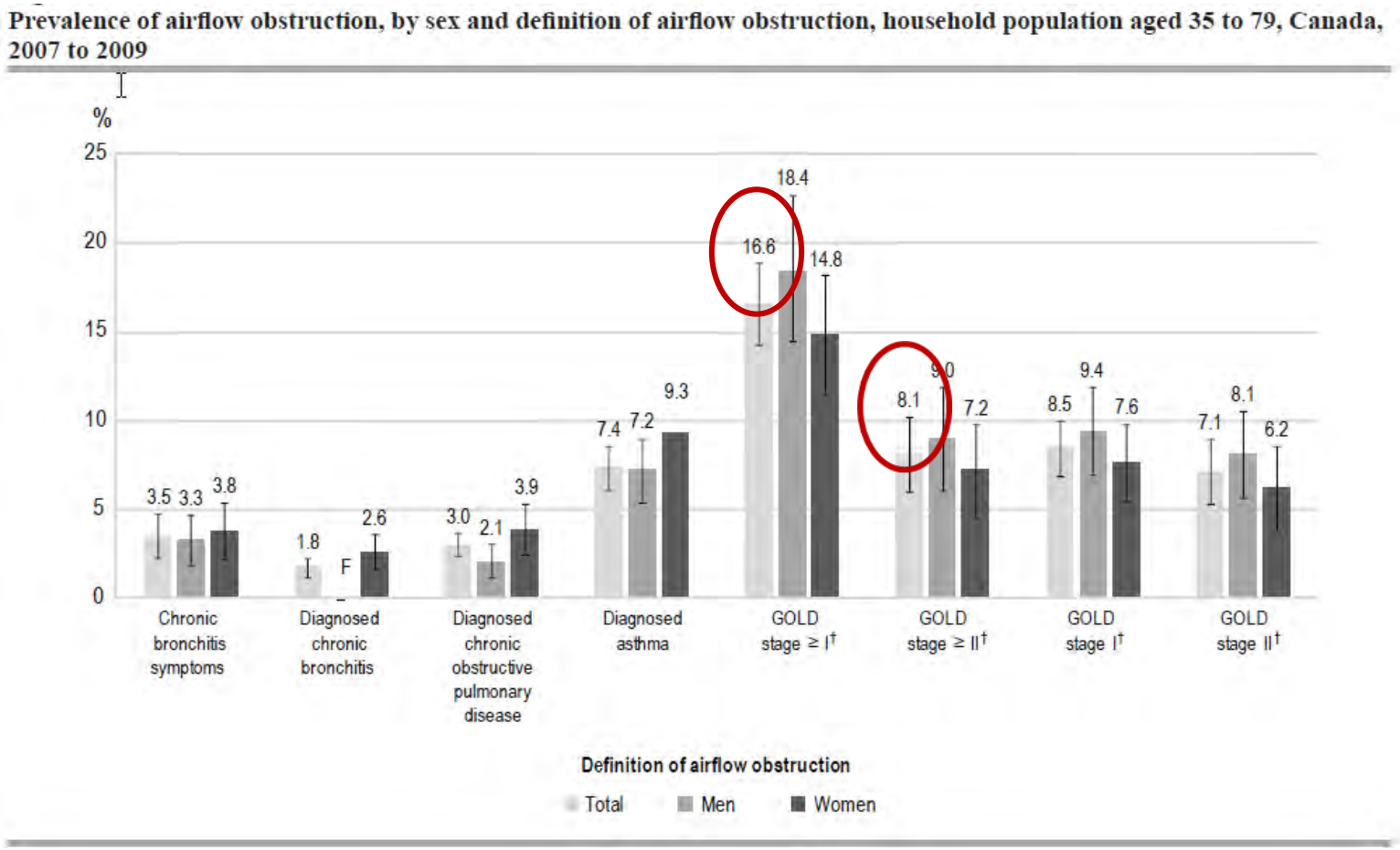
March, 2014

Statistics Canada Statistique Canada

Canada

Statistics Canada, Catalogue no. 82-003-X • Health Reports, Vol. 25, no. 3, pp. 3-11, March 2014

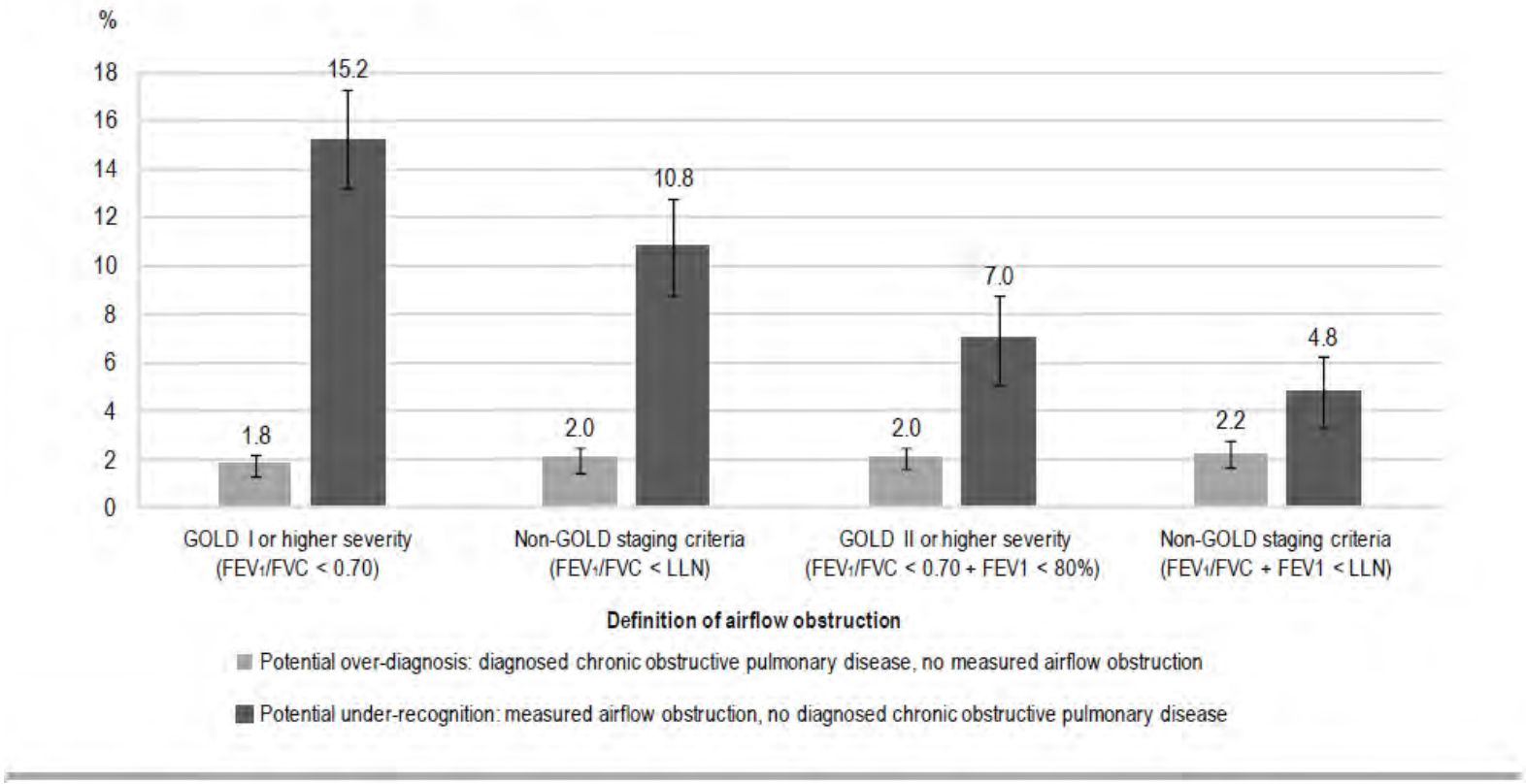
Prevelance of COPD in Canada



Statistics Canada, Catalogue no. 82-003-X • Health Reports, Vol. 25, no. 3, pp. 3-11, March 2014

Prevelence of COPD in Canada

Prevalence of potential over-diagnosis and under-recognition of COPD, by definition of airflow obstruction,† household population aged 35 to 79, Canada, 2007 to 2009



Statistics Canada, Catalogue no. 82-003-X • Health Reports, Vol. 25, no. 3, pp. 3-11, March 2014

Spirometry

Pulmonary Function Testing

Obstructive Ventilatory defects

- Asthma
- Chronic Obstructive Pulmonary Disease

Restrictive Ventilatory defects

- Intrinsic Restrictive Lung Disorders

➢ sarcoidosis, tuberculosis, pneumonectomy, pneumonia

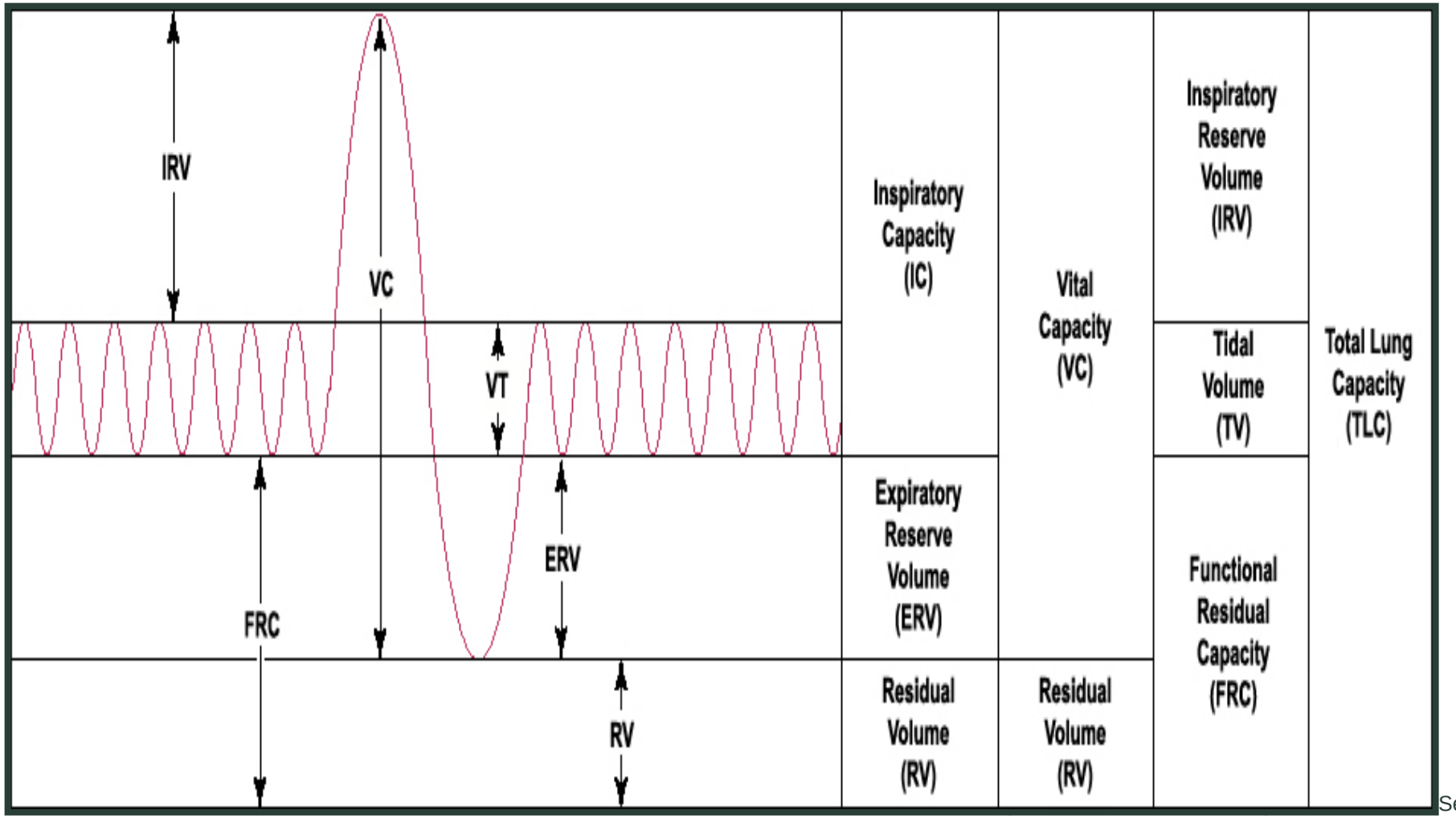
- Extrinsic Restrictive Lung Disorders

➢ bone deformity, pregnancy, obesity, ankylosing spondylitis

Pulmonary Function Testing

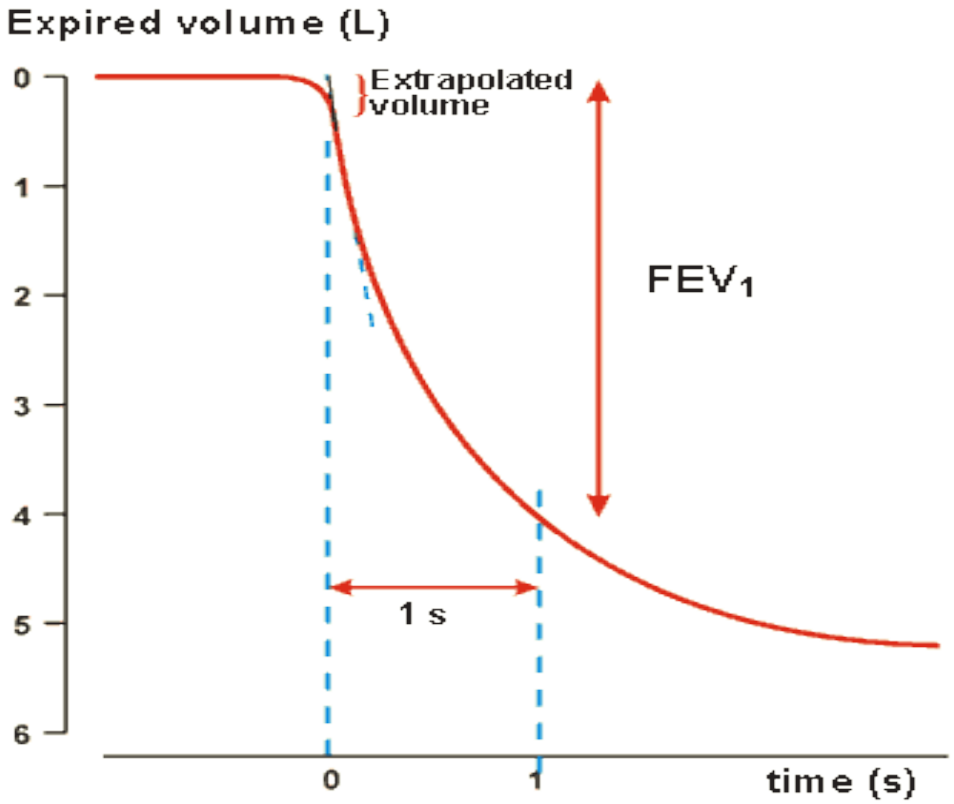
- Spirometry
- Includes FEV1 and FVC
- Flow Volume Loop
- Includes forced inspiratory and expiratory maneuvers
- Diffusing Capacity for Carbon Monoxide -DLCO

Spirometry
Lung volumes



Forced Expiratory Volume in one second -- FEV1

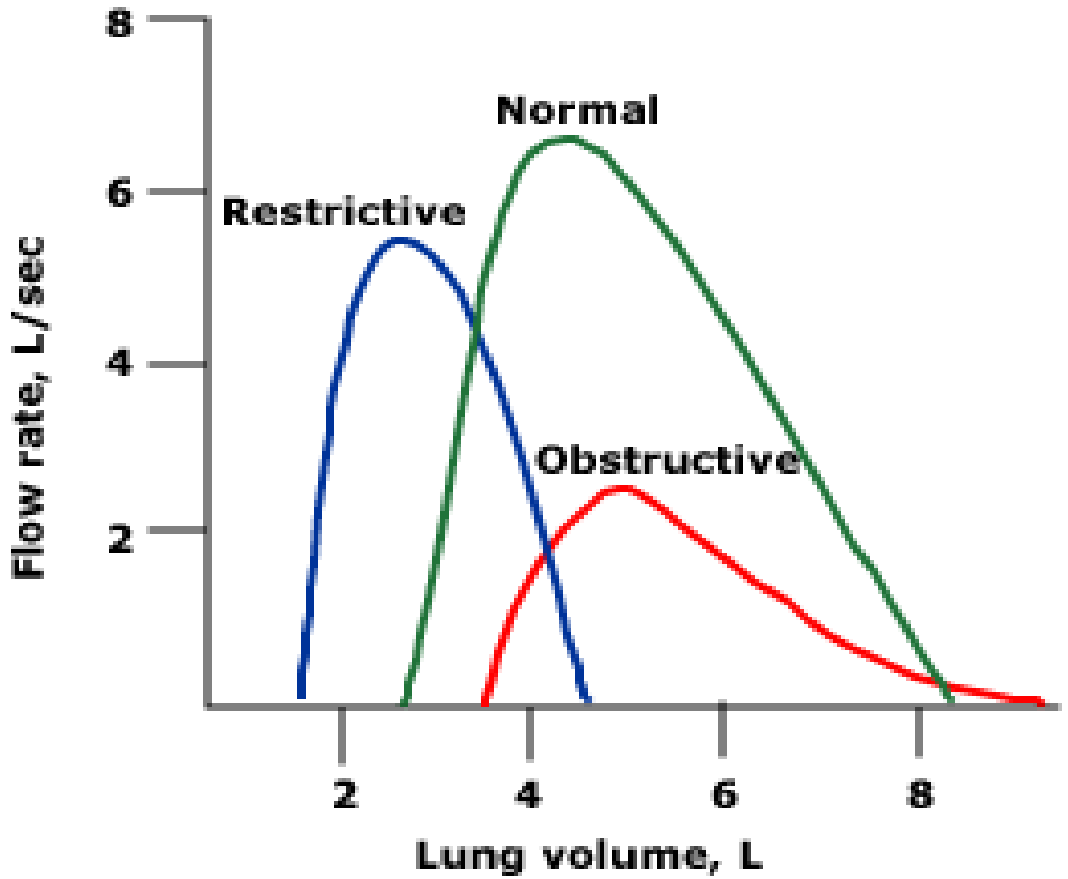
The volume of air forcibly expired from a maximum inspiratory effort in the first second



Forced vital capacity FVC

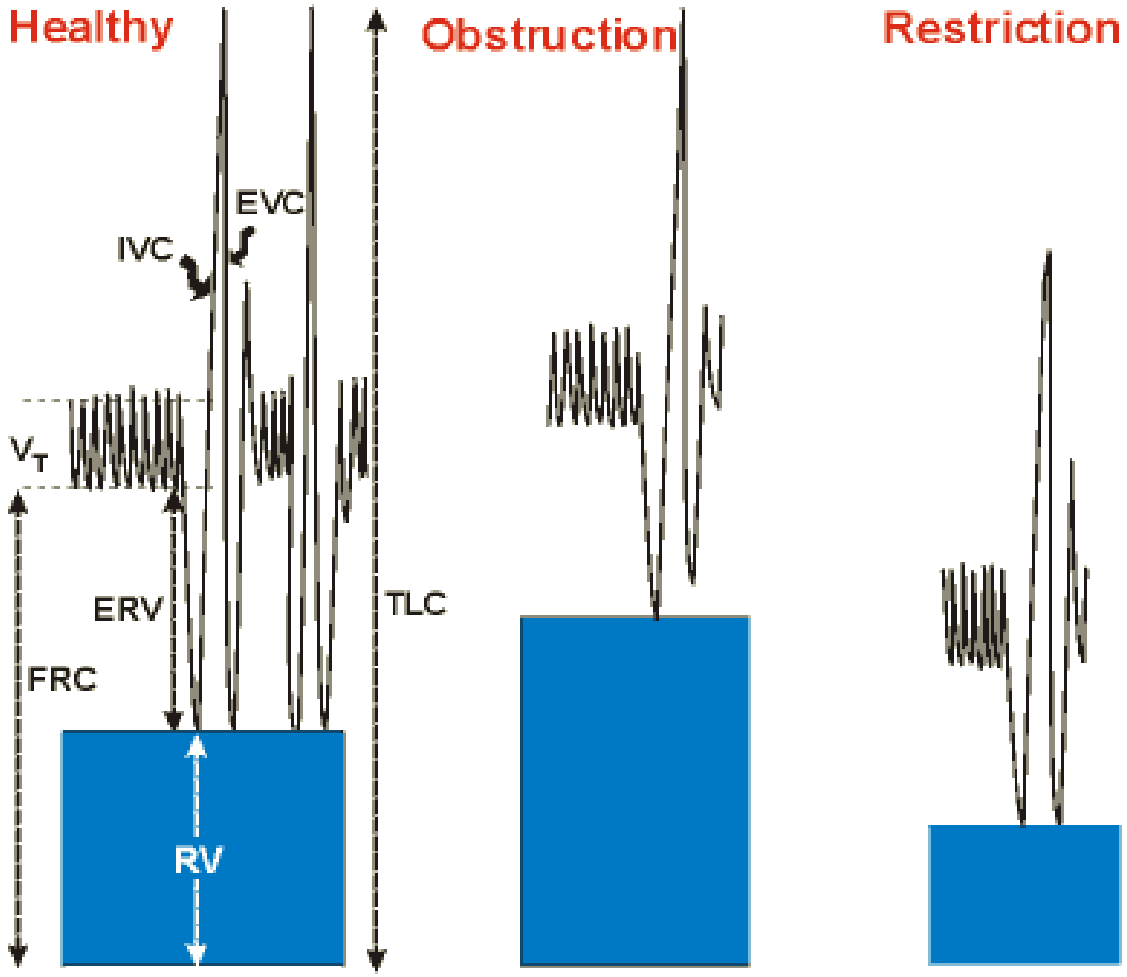
- Maximum volume in rapid, forced and maximum expiration after maximum inspiration.
- Expressed as a percentage of theoretical FVC
- **Reduced due to obstruction:**
  - Advanced obstruction of the airways, emphysematous thorax and emphysema, severe COPD FEV_1 more greatly reduced here than FVC!
- **Reduced due to restriction:**
  - Reduced lung volume in fibrosis, kyphoscoliosis, diseases of the pleura and neuromuscular system, ankylosing spondylitis

Flow Volume Curves during Maximal Forced Expiration



Uptodate.com

Comparison of spirometry



Easy interpretation of Pulmonary Function Tests

1. Look at the forced vital capacity (FVC)
2. Look at the forced expiratory volume in one second (FEV1)
3. If both FVC and FEV1 are normal the there is no need to go any further. The applicant has a normal PFT test.
4. If FVC and /or FEV are low, then the presence of disease is likely.
5. Then you should go to % predicted for FEV1/FVC.
6. If FEV1/FVC is 88%-90% or higher, then there is restrictive lung disease
7. If the % predicted for FEV1/FVC is 69% or lower, then there is obstructive lung disease.

Spirometric Classification of COPD Based on Post Bronchodilator FEV1

GLOBAL INITIATIVE FOR CHRONIC OBSTRUCTIVE LUNG DISEASE

GOLD

In patients with FEV1/FVC<70%

Stage I: **Mild**	FEV1 ≥80% Predicted
Stage II: **Moderate**	50%≤ FEV1 <80% predicted
Stage III: **Severe**	30%≤FEV1 <50% predicted
Stage IV: **Very Severe**	FEV1 <30% predicted or

Easy interpretation of Pulmonary Function Tests
Reversible Airway Obstruction

- Response to bronchodilator after baseline airflow measurements are done
- FVC or FEV1 should increase by **12%**
- FVC or FEV1 should increase at least by **200ml**

Diffusing Capacity for Carbon Monoxide - DLCO

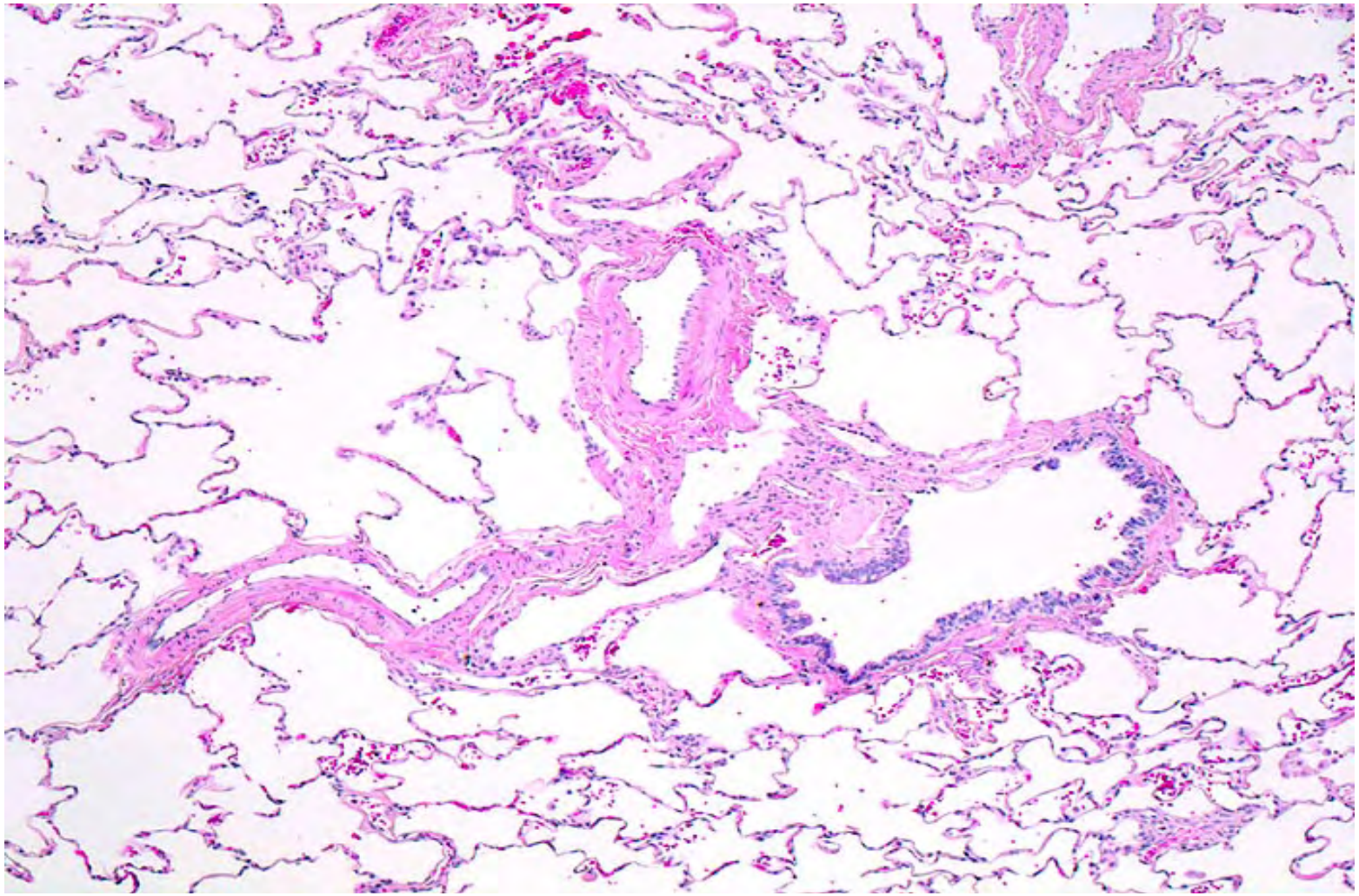
- Measures ability of lungs to transport inhaled gas from alveoli to pulmonary capillaries

- Depends on:
  - alveolar–capillary membrane
  - hemoglobin concentration
  - cardiac output

DLCO—Indications

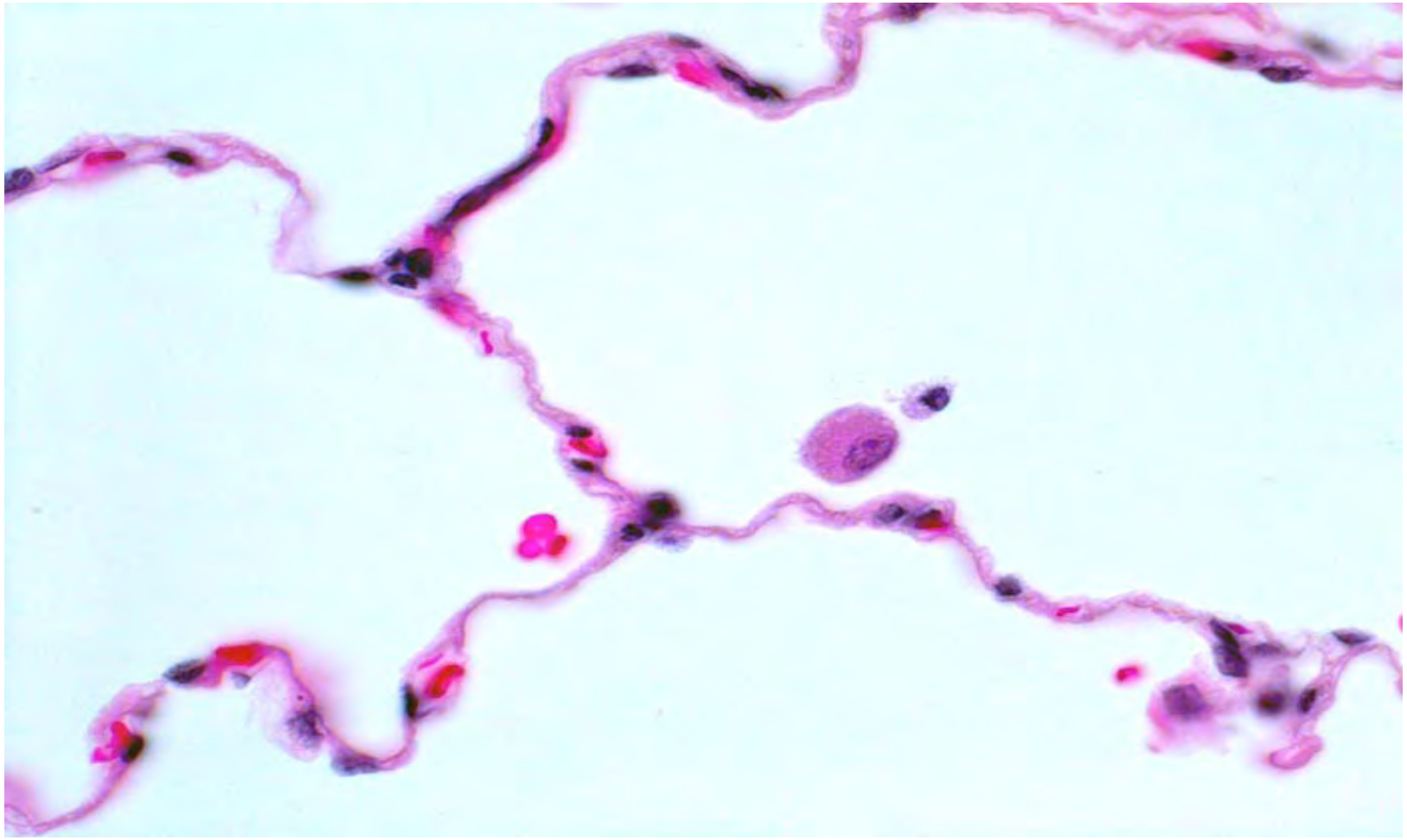
- Differentiate asthma from emphysema
- Evaluation and severity of restrictive lung disease
- Early stages of pulmonary hypertension
- Expensive!

Normal Lung Parenchyma



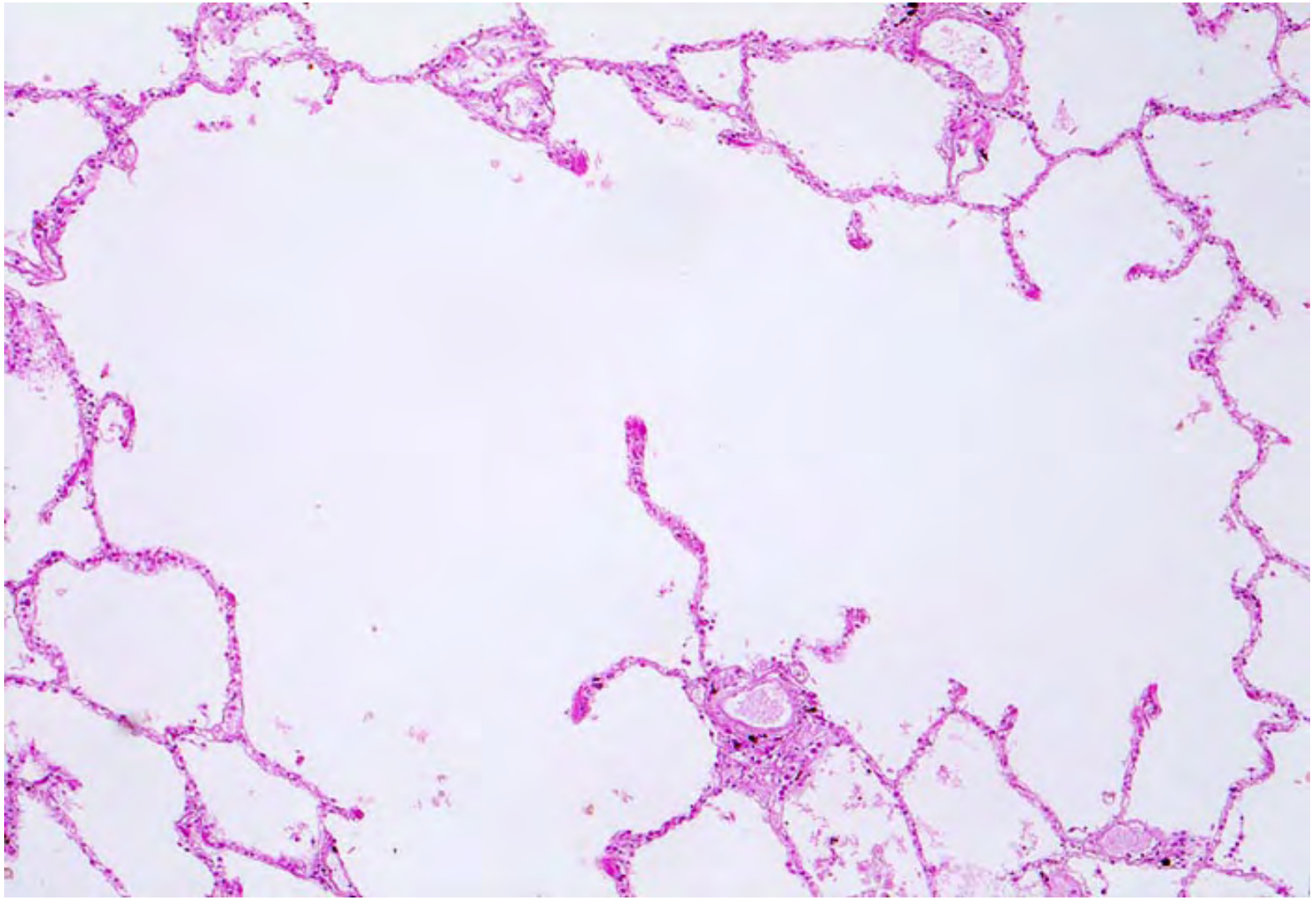
http://www.alf3.urz.unibas.ch/pathopic/e/intro.htm

Normal Alveolar Capillary Membrane



http://www.alf3.urz.unibas.ch/pathopic/e/intro.htm

Emphysematous Lung Parenchyma



http://www.alf3.urz.unibas.ch/pathopic/e/intro.htm

Diffusing Capacity

- **Decreased DLCO**

  (<80% predicted)

  - Obstructive lung disease
  - Parenchymal disease
  - Pulmonary vascular disease
  - Anemia

- **Increased DLCO**

  (>120-140% predicted)

  - Asthma (or normal)
  - Pulmonary hemorrhage
  - Polycythemia
  - Left to right shunt

Case 1

Case 1
Life $1,000,000 and CI rider

- male 45 years old, financial advisor.
- build bp and labs all normal.
- History of hay fever, allergic to cats
- asthma since childhood
- declares hospital admission due to asthma attack 18 months ago
- nil else of note.

Case 1
Life $1,000,000 and CI rider

Aps from pulmonologist

Initial visit (12 months)

- wheezing coughing 4/5 days a week, including at night
- Spirometry:

Forced Vital Capacity (FVC)	85% predicted
Forced Expiratory Vol 1 Sec (FEV1)	75% predicted
FEV1/FVC	65%

increase in FEV1 of 220 ml or 14% after bronchodilator

Case 1
Life $1,000,000 and CI rider

last AP visit (one month previous to application)

- skin testing positive for trees, ragweed, cats

Current treatment:

- low dose inhaled corticosteroids bid
- albuterol (short acting beta agonist) as needed

Currently asymptomatic, no hospital admissions or missed days at work

aerobic exercise (1 hr) 3 days a week

current office spirometry is normal

Asthma

Asthma
GINA 2016

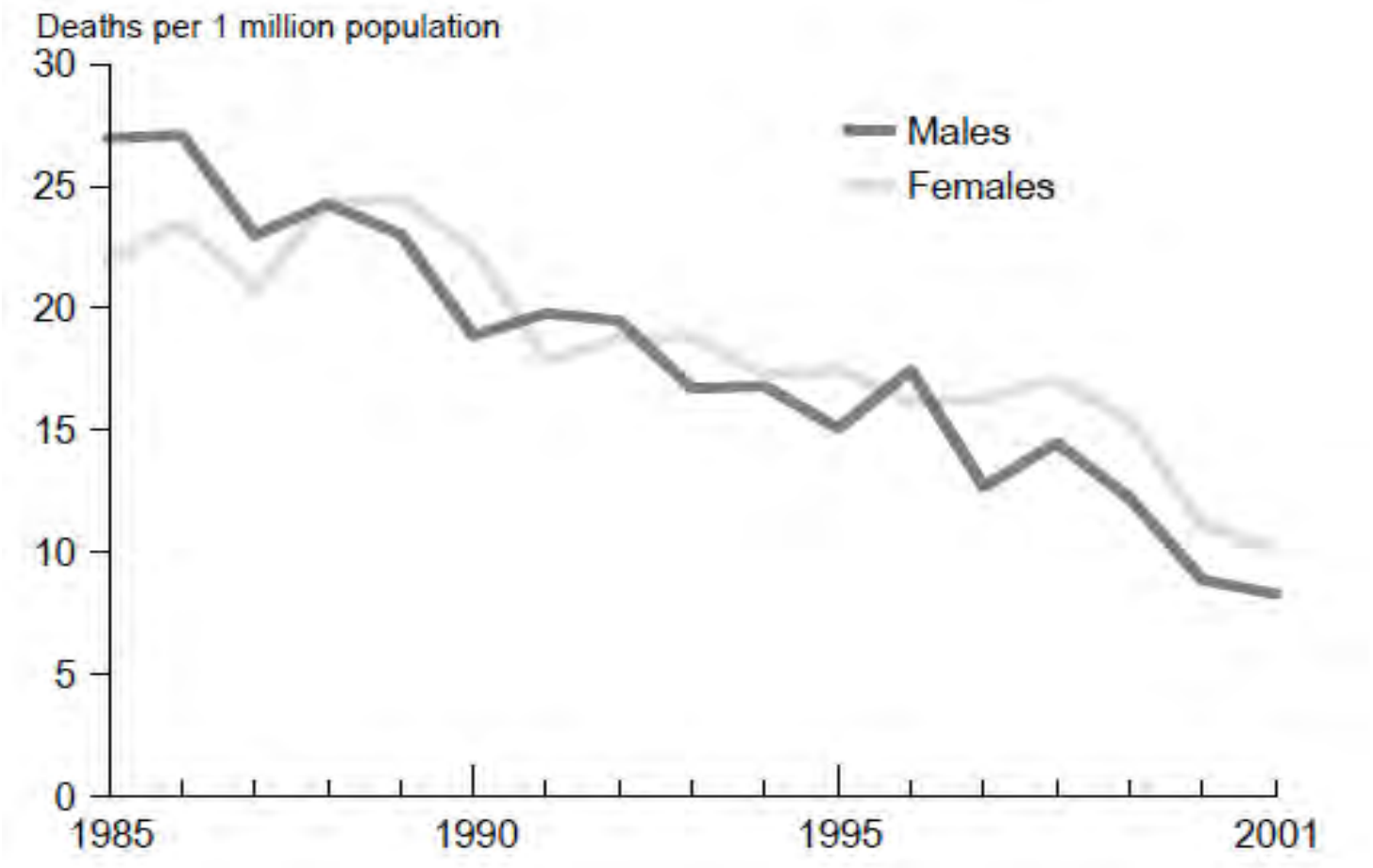
Asthma is a heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness and cough that vary over time and in intensity, together with variable expiratory airflow limitation and is completely ***reversible***.

Asthma

- onset early in life (often childhood)
  - 3 million people in Canada; 600,000 are children under the age of 12
- Symptoms vary from day to day, episodic
- wheeze cough (worse at night), shortness of breath
- allergy trigger, rhinitis, and/or eczema also present
- family history of asthma

GOLD Executive Summary
Am J Resp Crit Care Med
Vol 176. pp 532-555,2007

Age standardized asthma mortality rates 1985-2001 Canadian Data Mortality Base



Health Reports. Vo. 16. No2 March 2005

Asthma in the Elderly

- may be **under-diagnosed** in the elderly, due to poor perception, an assumption that dyspnea is normal in old age, lack of fitness, or reduced activity.
- may be **over-diagnosed** in the elderly through confusion with shortness of breath due to left ventricular failure or ischemic heart disease.

If there is a history of smoking or biomass fuel exposure, COPD or asthma-COPD overlap syndrome (ACOS) should beconsidered

Case 2

Case 2
Life 500,000

- male, 63 years old retired; previously worked at an automotive plant
- height 5’8" weight 145lbs
- Family history :
- mother d. stroke @ 76 years
- father d. prostate cancer @ 62 yrs

Declares:

- elevated cholesterol, well controlled with statins
- hypertension, well controlled blood pressure 135/80
- previous smoker, one pack a day, quit 10 months ago

Case 2
Life 500,000

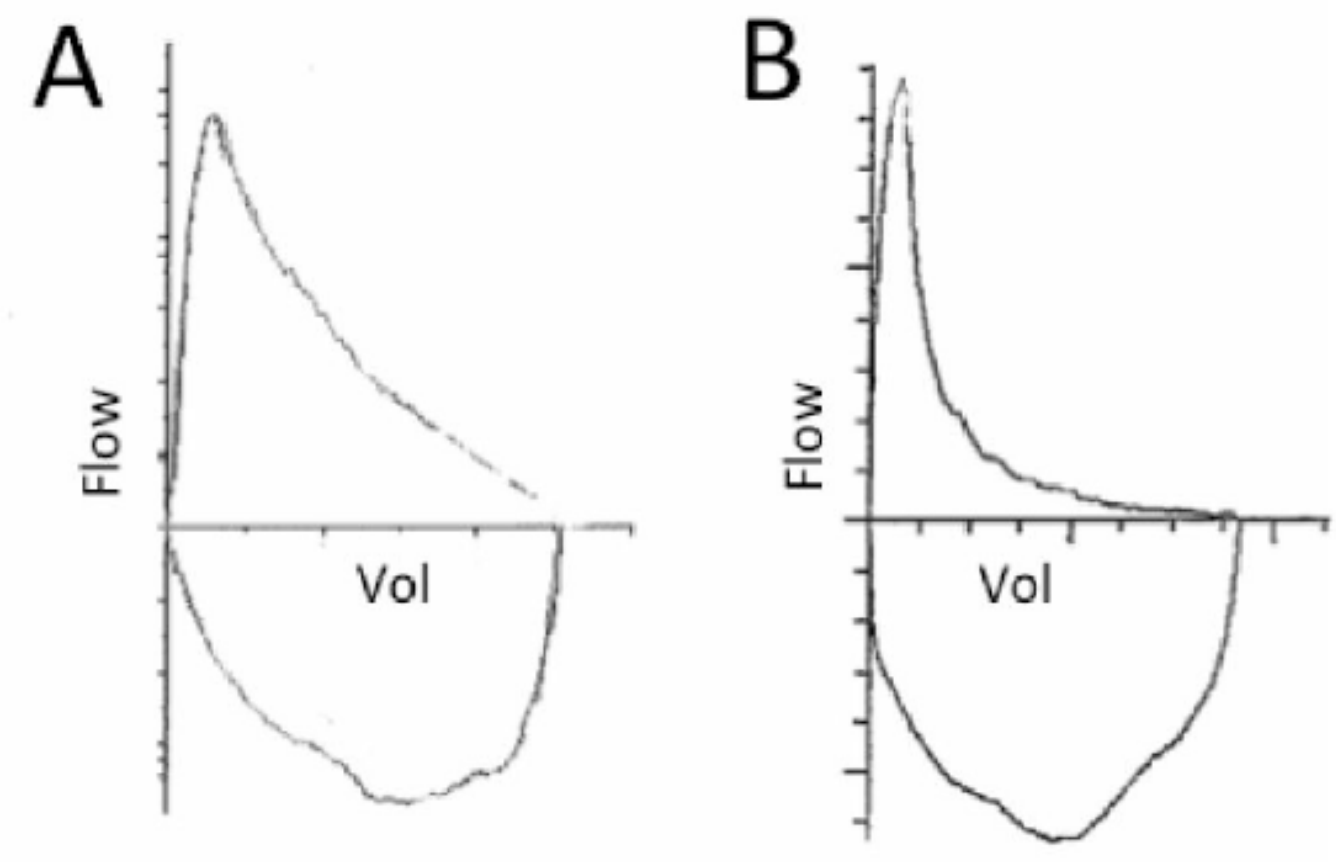
APS family physician

dyslipidemia and hypertension since 2001, well controlled compliant with treatment, possibly occupational asthma (related to paint mists)

- smoker for 25 years, 1 package per day
- hemiparalysis of diaphragm after car accident
- 4 years previous, sinusitis which complicated with pneumonia treated with antibiotics, steroids and albuterol as needed. CXR after treatment was normal

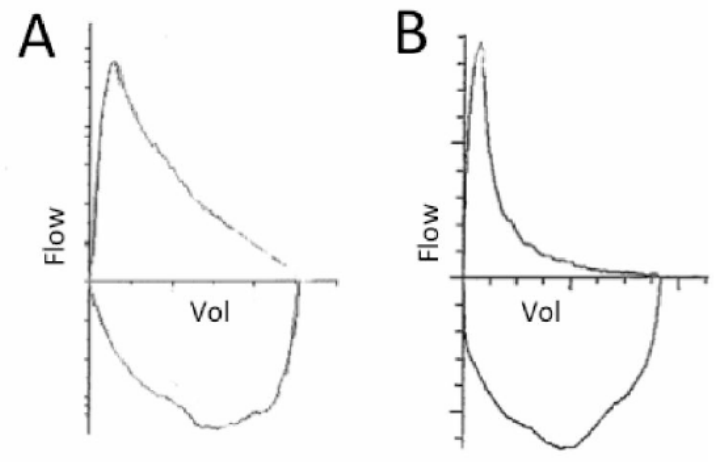
"several attempts to quit smoking failed until 10 months ago patient quit on his own."

Case 2 – Life 500,000
Flow Volume Loop – male 63



Med Clin North Am. 2012 July ; 96(4): 745–752. doi:10.1016/j.mcna.2012.04.011.

Case 2
Life 500,000



Aps family physician

- Spirometry (2 years old):

Forced Vital Capacity (FVC)	67% predicted
Forced Expiratory Vol 1 Sec (FEV1)	47% predicted
FEV1 / FVC	52%

no change in airflow after bronchodilator

Diagnosed: Asthmatic bronchitis/chronic bronchitis

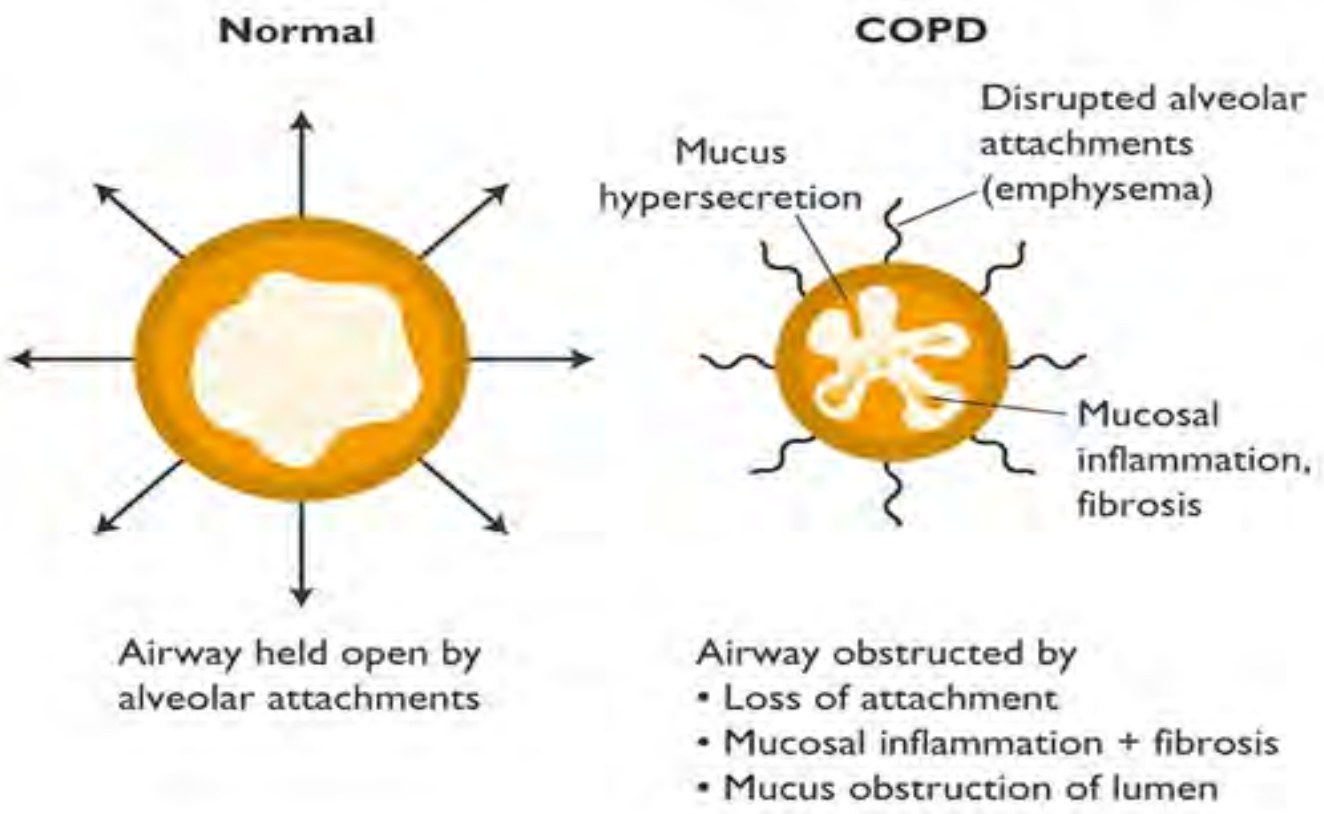
Chronic Obstructive Pulmonary Disease COPD

Chronic Obstructive Pulmonary Disease
GOLD 2018

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

Environment:	**Host:**
tobacco	genetic abnormalities
biomass fuel exposure	abnormal lung development
air pollution	accelerated aging

Mechanisms of airflow limitation
COPD



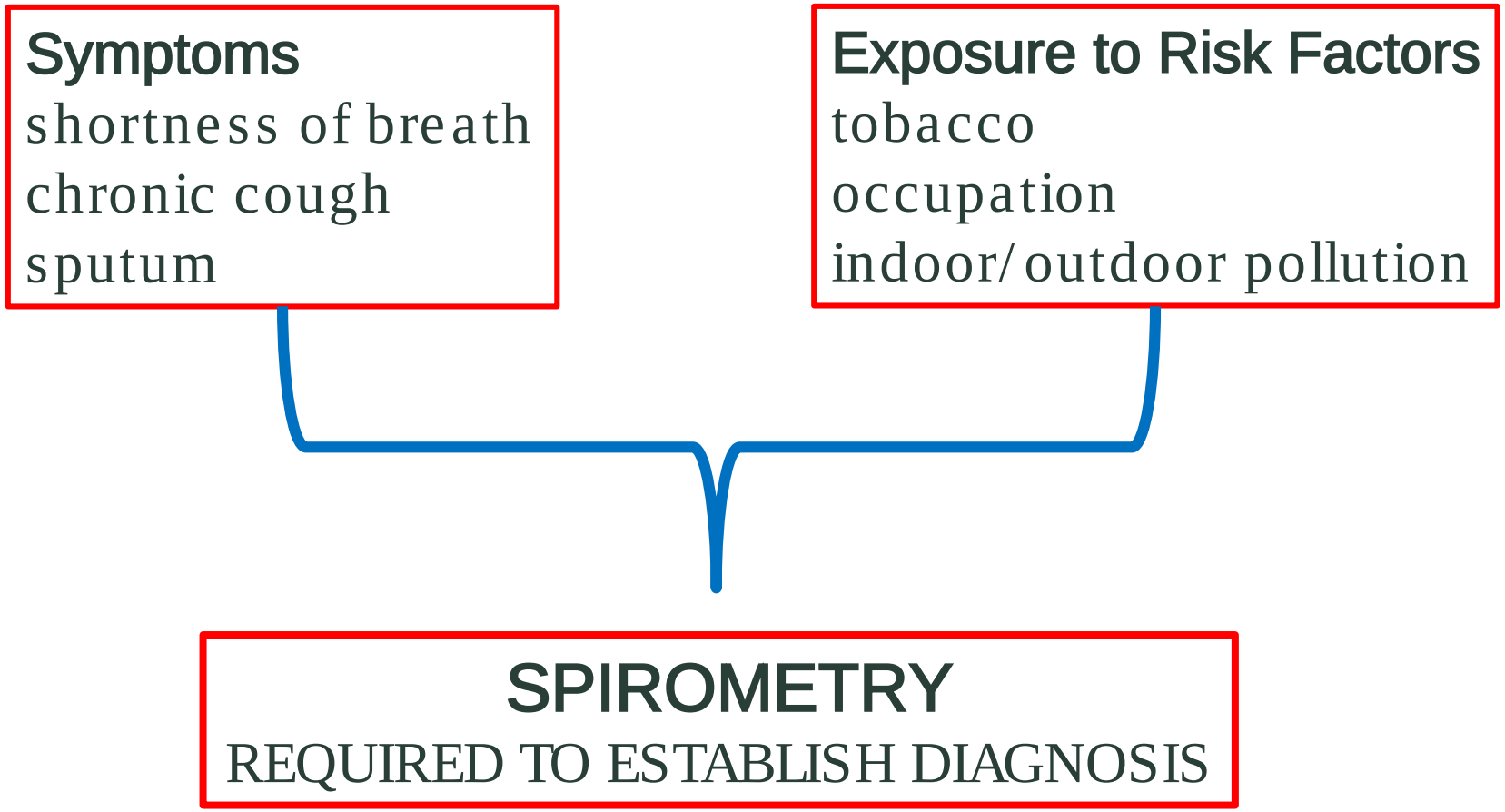
Images.MD

Chronic Obstructive Pulmonary Disease

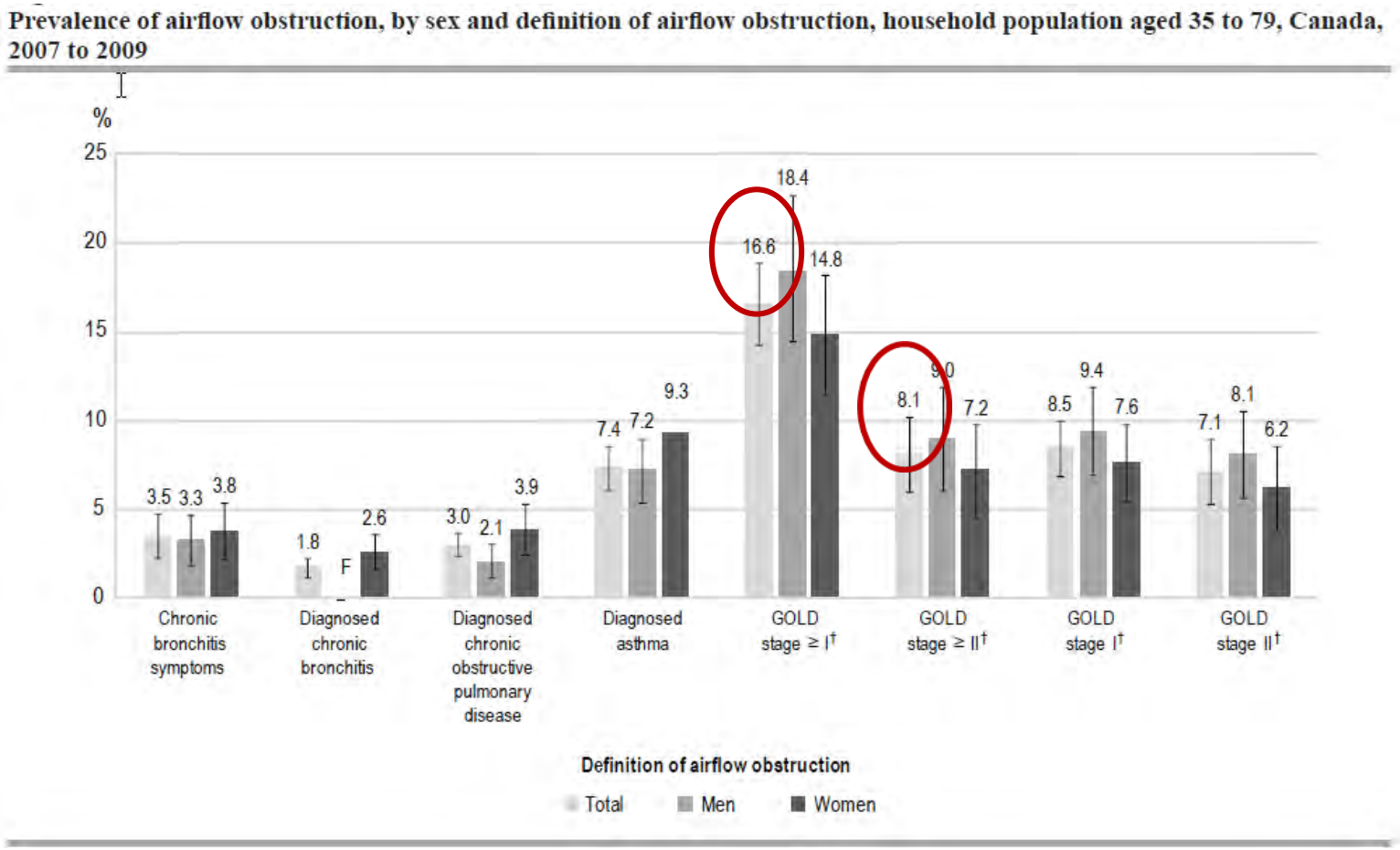
- onset in midlife
- symptoms slowly progressive
- long history of tobacco smoking
- dyspnea during exercise
- largely ***irreversible*** airflow limitation

GOLD Executive Summary Am J Resp Crit Care Med
Vol 176. pp 532-555,2007

Diagnosis COPD



Prevelance of COPD in Canada

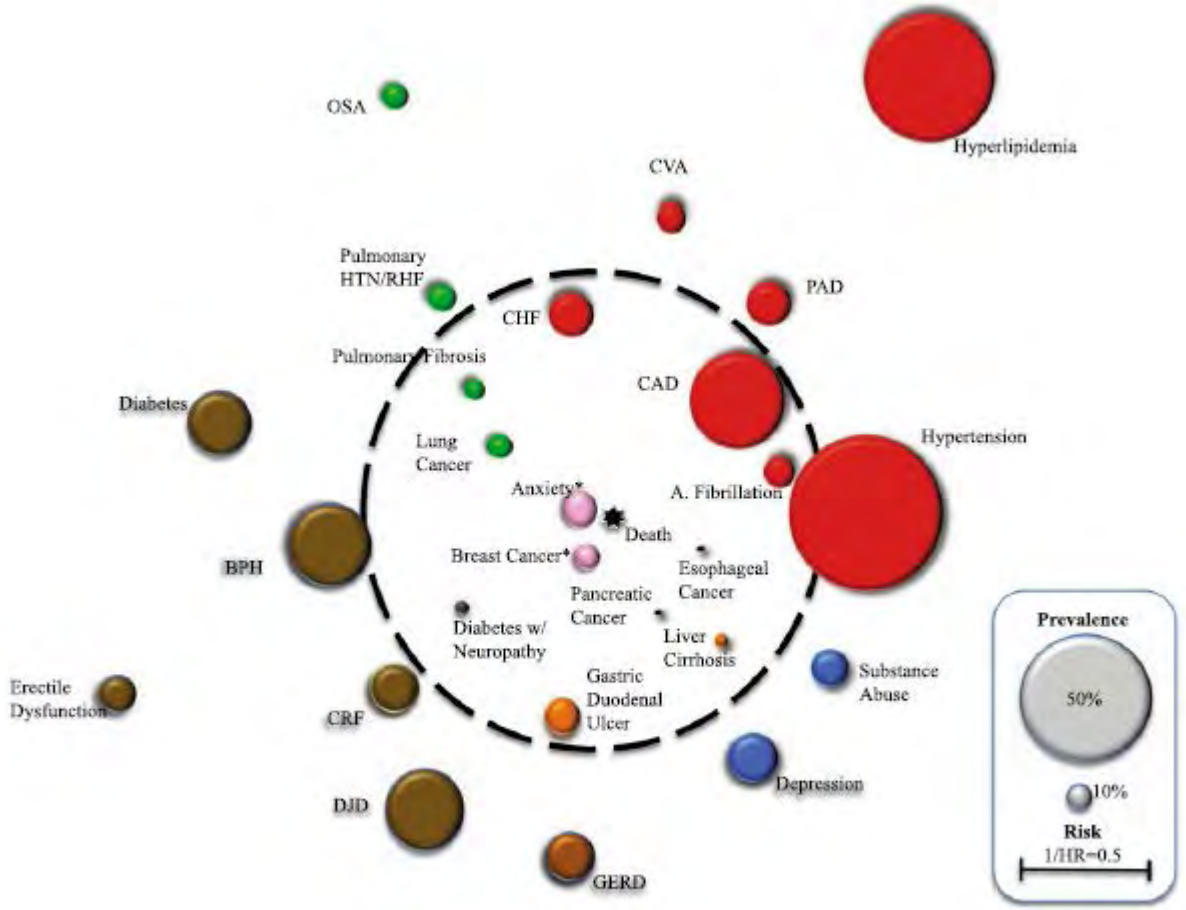


Statistics Canada, Catalogue no. 82-003-X • Health Reports, Vol. 25, no. 3, pp. 3-11, March 2014

Risk Factors
Occupational Irritants

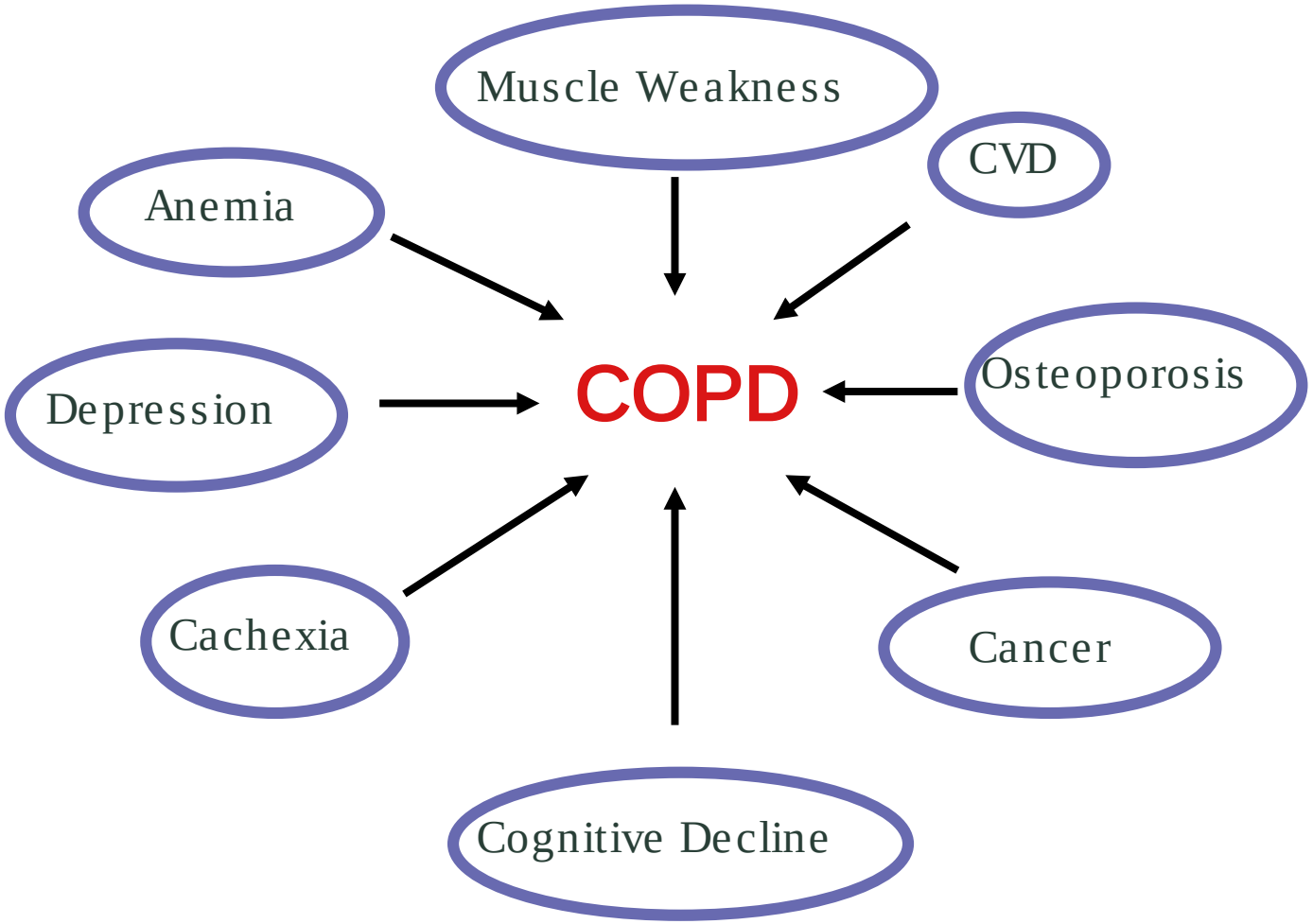
Occupation	Irritant
Agricultural worker	Endotoxin
Coal miner	Coal dust
Concrete worker	Mineral dust
Construction worker	Dust
Gold miner	Silica
Hard rock miner	Mineral dust
Rubber worker	Industrial chemicals

Comorbidities and Mortality Risk "Comorbidome"



Divo et al. Am J Respir Crit Care Med 2012;186(2):155–61.

Systemic effects of COPD



Therap Advan Resp Disease Tkac et al. 2007

Potential pathogenic mechanisms of cardiovascular disease in COPD

- Systemic and lung inflammation
- Hypoxia: both alveolar and tissue hypoxia
- Hypercapnic acidosis
- Endothelial dysfunction/vessel wall abnormalities
- Polycythemia

Skeletal dysfunction in COPD

Pathophysiologic changes
- Reduced muscle mass
- Altered bio-energetics
- Altered Capillarization
- Fibre type redistribution

Pathogenic Mechanisms
- Protein synthesis/breakdown imbalance
- Disuse atrophy
- Inflammation & oxidative stress
- Hypoxia/hypercapnoea
- Use of corticosteroids
- Poor nutritional intake

Physical manifestations
- Reduced strength
- Reduced resistance
- Increased fatigue

Obstructive Lung Disease and Low Lung Function in the US

- 68% of the population with low lung function did not have a current diagnosis of Obstructive Lung Disease
- Only significant predictors of low lung function without current diagnosis of Obstructive Lung disease were:
- Current smokers
- Inactivity
- Cardiovascular Disease

Mannino et al.
Arch Int Med 2000
160: 1683-1689

Lung Function and Mortality in the US

5542 adults,
22 year follow up
1302 deaths

Lung Function	Hazard Ratio
Severe COPD	2.7
Moderate COPD	1.6
Mild COPD	1.2
Restrictive Lung Disease	1.7
Respiratory Symptoms only	1.2
No Lung Disease	1.0

Mannino et al.
Thorax 2003
58: 388-393

Lung Function and Mortality in the US

5542 adults,
22 year follow up
1302 deaths

former smokers with moderate or severe COPD have similar mortality risk compared to current smokers

Moderate or severe COPD in *never* smokers did not have significantly increase mortality risk

Mannino et al.
Thorax 2003
58: 388-393

Case 3

Case 3
Life 5,000,000

- Male 55 years old
- height 5'7" weight 201 lbs; BMI 31.4
- labs mild dyslipidemia
- fasting glucose 6.1, HbA1c 5.9
- declares treated hypertension (bp on exam 135/85)
- current smoker, 10 cigarettes per day
- TMT 6.8 METS, stopped because reached target heart rate, reported negative for ischemia

Case 3
Life 5,000,000

APS family physician

- hypertension, well controlled
- "Borderline" glucose levels (IFG)
- overweight encouraged to exercise
- GERD
- "asthmatic bronchitis" - longstanding history of allergies/hay fever with asthma since he was a child
- smoker since the age of 20, 10 cigarettes per day

Case 3
Life 5,000,000

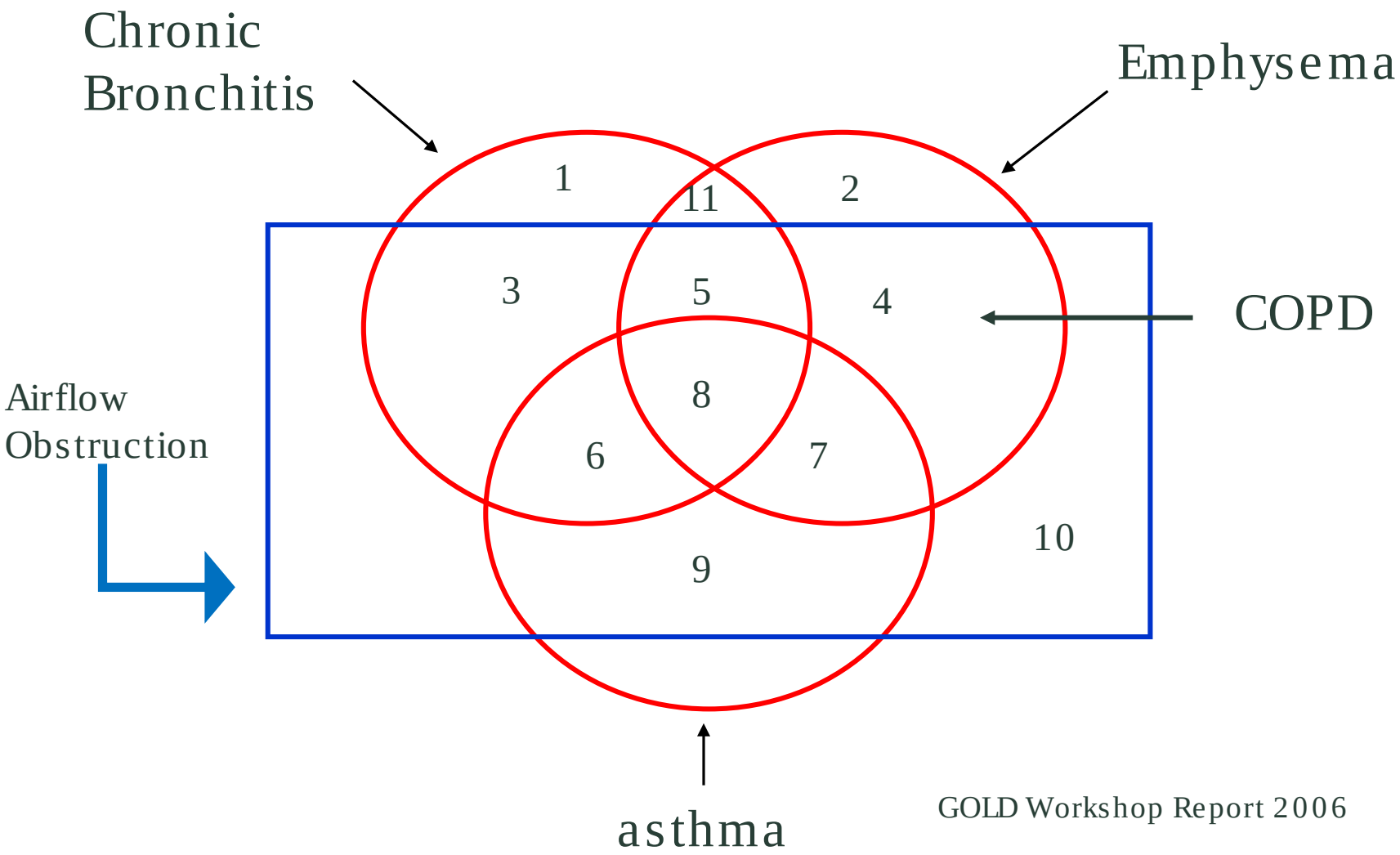
- Spirometry

Forced Vital Capacity (FVC)	65% predicted
Forced Expiratory Vol 1 Sec (FEV1)	40% predicted
FEV1 / FVC	61%

partial reversibility in airflow after bronchodilator

Diagnosed: Asthmatic bronchitis/chronic bronchitis

Overlap of Chronic Bronchitis, emphysema and asthma



GOLD Workshop Report 2006

Asthma COPD Overlap Syndrome

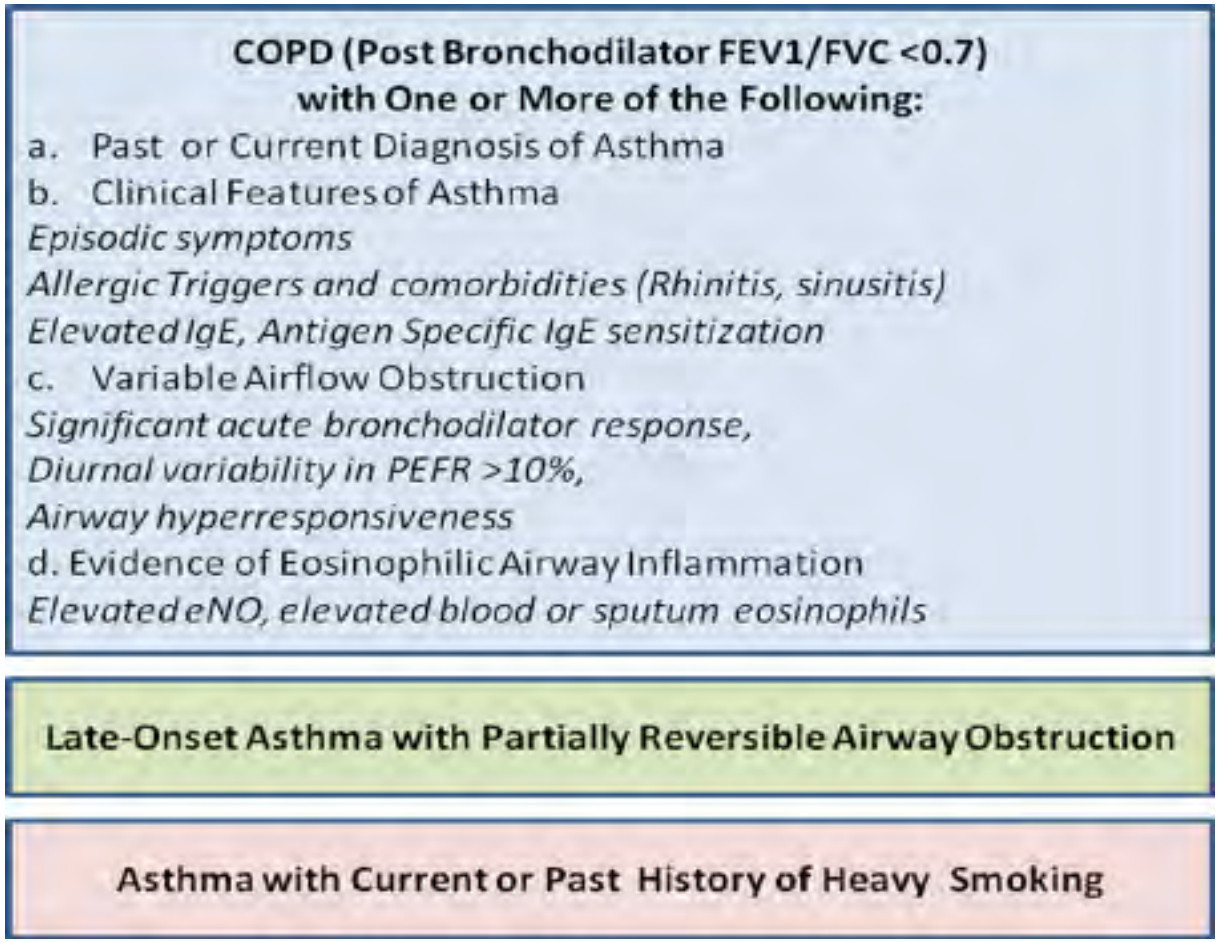
Asthma COPD Overlap Syndrome (ACOS)
'A description for clinical use'

Asthma-COPD overlap syndrome (ACOS) is characterized by persistent airflow limitation with several features usually associated with asthma and several features usually associated with COPD. ACOS is therefore identified by the features that it shares with both asthma and COPD

A specific definition cannot be developed until more evidence is available about its clinical phenotypes and underlying mechanisms

Joint Committee Statement GOLD and GINA 2014/2015

Identifying the applicant with ACOS



Curr Allergy Asthma Rep (2015) 15:7

Diagnosis of ACOS

Favors Asthma	Favors COPD
Onset before age 20 years	Onset after age 40 years
Variation in symptoms over minutes, hours or days Symptoms worse during the night or early morning Symptoms triggered by exercise, emotions including laughter, dust or exposure to allergens	Persistence of symptoms despite treatment Good and bad days but always daily symptoms and exertional dyspnea Chronic cough and sputum preceded onset of dyspnea, unrelated to triggers
Record of variable airflow limitation (spirometry, peak flow)	Record of persistent airflow limitation (post-bronchodilator FEV1/FVC < 0.7)
Lung function normal between symptoms Previous doctor diagnosis of asthma Family history of asthma, and other allergic conditio	Lung function abnormal between symptoms Previous doctor diagnosis of COPD, chronic bronchitis or emphysema Heavy exposure to a risk factor: tobacco smoke, biomass fuels
No worsening of symptoms over time. Symptoms vary either seasonally, or from year to year May improve spontaneously or have an immediate response to BD or to ICS over weeks	Symptoms slowly worsening over time (progressive course over years) Rapid-acting bronchodilator treatment provides only limited relief.
Normal	Severe hyperinflation

If three or more boxes in either asthma or COPD are checked, then that is the most likely diagnosis

If there are similar numbers of boxes checked in each column then the diagnosis of ACOSshould be considered

GOLD/ GINA 2014

BODE Index

- **B**ody mass index
- degree of airflow **O**bstruction
- **D**yspnea
- **E**xercise capacity

B
O
D
E

COPD Prognostic Index
CPI score

Prognostic factor	Addition to risk score				Risk score
Standardized QoL Score	<−1	−1 to <0	0 to <1	≥1	
CRQ score	<68	68 to <86	86 to <104	≥104	
SGRQ score	>64	<47 to 64	<30 to 47	≥30	
Score	**18**	**13**	**7**	**0**	
FEV_1% pred	<30	30 to 49	50 to 59	≥60	
Score	**24**	**15**	**7**	**0**	
Age, y	<55	55 to 64	65 to 74	≥75	
Score	**0**	**7**	**14**	**20**	
Sex	Male	**0**	Female	**1**	
BMI <20	No	**0**	Yes	**11**	
History of ED visits/exacerbation	No	**0**	Yes	**20**	
History of CVD	No	**0**	Yes	**7**	
				Total risk score	

Briggs et al Arch Intern Med 2008
168(1):71-79

Estimated Risk of Death, Hospitalization and estimated Exacerbations with CPI

Index Score	3 yr mort. risk	3 yr hosp. risk	Expected exacerb 3yr. No.
10	0.01	0.03	2
20	0.02	0.04	2
30	0.03	0.06	3
40	0.04	0.09	3
50	0.06	0.14	4
60	0.10	0.22	5
70	0.14	0.32	6
80	0.21	0.45	7
90	0.31	0.61	9

Briggs et al
Arch Intern Med 2008
168(1):71-79

Lung function and aging

- decrease in static elastic recoil- elastic fibre rupture and recoil as a consequence there is dilation of alveolar ducts and enlarged airspaces “senile emphysema
- decrease in the compliance of the chest wall. Calcification of costal cartilage and rib vertebral articulations and narrowing of intervertebral disc spaces
- decrease in the strength of the respiratory muscles influenced by it increase in functional residual capacity and by nutritional status (correlation between low body weight and diagragm muscle mass

Roger M Oskvig
CHEST 1999;115;158-164

Lung function and aging

- 70 year old man expends 70% of total elastic work of breathing on the chest wall.
- control of breathing
- diminished response to hypoxia and hypercapnia- lower tidal volume
- perception of dyspnea is intact
- Pulmonary circulation similar to what occurs in heart and circulatory system

JP Jansens et al.
Eur Resp J, 1999

Lung function and aging

- FEV1 decreases progressively with age
- nonsmoking men 30 mL/y
- nonsmoking women 23 ml/y
- FVC in nonsmokers estimated to decrease15-30ml/y

} even greater decrease after 65y

Vital Capacity ↓

residual volume ↑

} TLC unchanged

Aalami et al.
Arch Surg.Vol 138
pg 1068-1076

e-cigarettes

Lifting the e-cigarette smokescreen

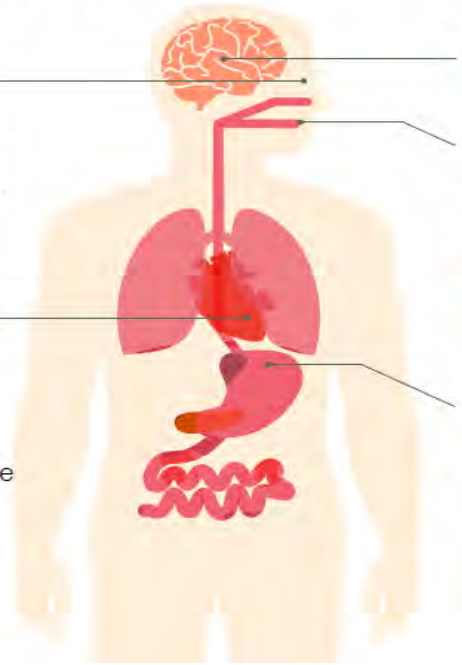
AMERICAN LUNG ASSOCIATION.

The Impact of E-Cigarettes on the Lung

Adverse effects of vaping

Eyes
- Irritation
- Blurry vision
- Wounds and burns in case of e-cigarette explosion

Heart and circulation
- Increased heart rate
- Increased blood pressure
- Chest pain



Brain
- Addiction

Mouth and airways
- Irritation
- Cough
- Increased airway resistance

Stomach
- Vomiting
- Nausea
- Pain

Key points!

Asthma

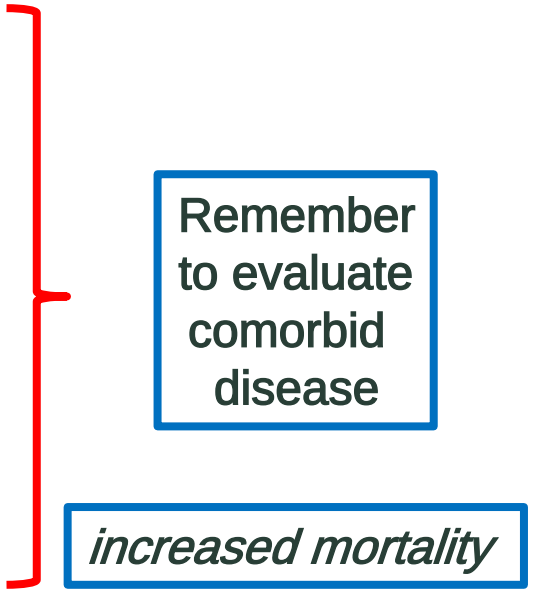
younger applicants, with a history of allergies and reversible airway obstruction

COPD

older applicants, with a long history of smoking and irreversible airway obstruction

ACOS

middle aged applicants, with/without atopy, allergy, smoking



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