Pathophysiology of COPD

Real-Time Live Broadcast

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This Presentation is Approved for 1 CRCE Credit Hour

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Learning Objectives

- Define COPD.
- Describe chronic bronchitis & emphysema.
- Identify risk factors & etiology.
- Identify strategies for prevention.
- Outline appropriate treatment options.

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COPD

Chronic Obstructive Pulmonary Disease (COPD) is a **heterogeneous** lung condition characterized by **chronic** respiratory symptoms (dyspnea, cough, sputum production and/or exacerbations) due to **abnormalities of the airways** (bronchitis, bronchiolitis) **and/or alveoli** (emphysema) that cause persistent, often **progressive**, airflow obstruction.

(Original) Source: Celli, et al. Am J Respir Crit Care Med 2022

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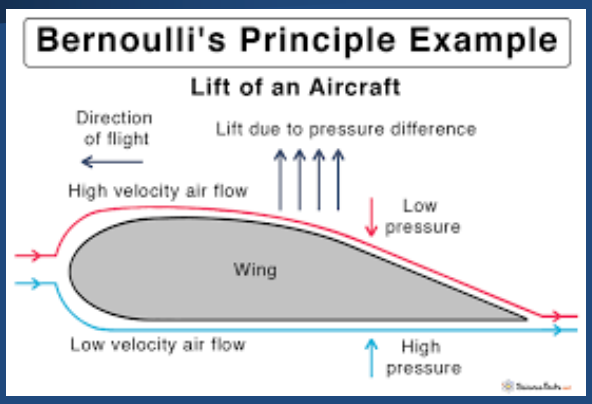
Bernoulli Principle



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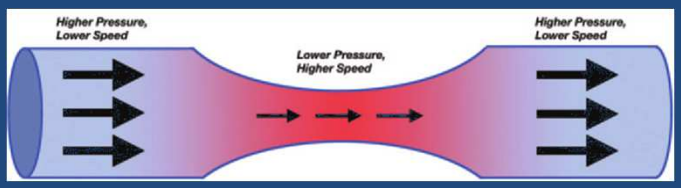
Bernoulli Principle



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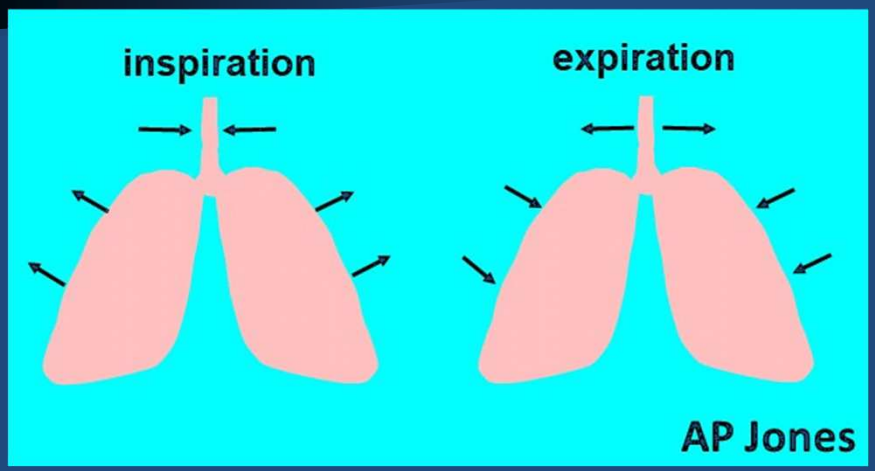
Chronic Bronchitis



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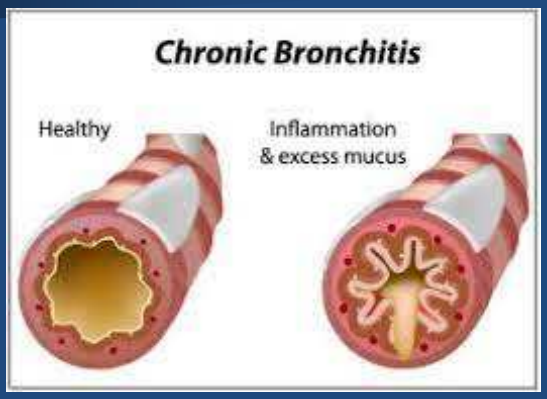
Chronic Bronchitis



https://www.ncbi.nlm.nih.gov/books/NBK482437/

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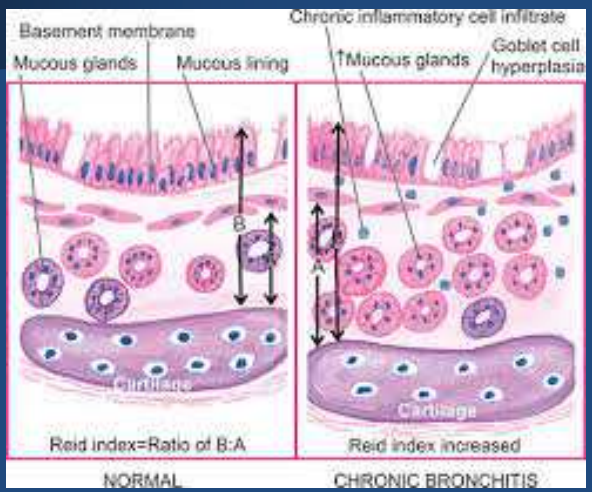

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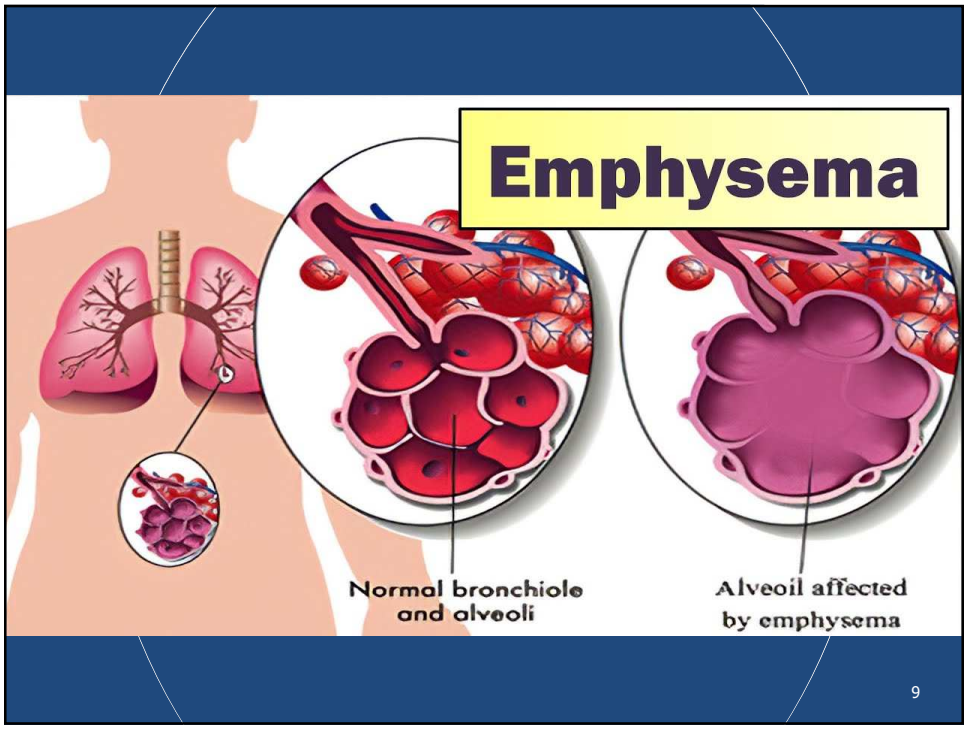

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Smoking

↓

Neutrophils

↓

Elastase

↑

Alpha1 Anti-Trypsin

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Asthma vs Emphysema

PRIMARY CELL TYPES

Asthma

- CD4 T-cells
- Eosinophils
- Plasma cells
- Mast cells

COPD

- Macrophages
- Neutrophils
- CD8 T- cells

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Asthma vs Emphysema

KEY MEDIATORS

Asthma

- IL-4
- IL-5
- IL-13

COPD

- IL-8
- TNF-alpha

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Asthma vs Emphysema

PRIMARY INFLAMMATION SITE

Asthma	COPD
➢ Proximal airways	➢ Distal airways ➢ Lung parenchyma

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Risk Factors

Smoking

Pollution

Genetics

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Etiotypes For COPD

GOLD Definition

- COPD C- Cigarette Smoking (Vaping & Cannabis)

~Including Passive and In Utero

- COPD P- Pollution Exposure

~ Wildfire Smoke, Occupational Hazards, Air Pollution

- COPD G- Genetically determined

~ Alpha 1 Trypsin Deficiency (other genetic variants)

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Etiotypes For COPD

GOLD Definition Cont.

- COPD D- Abnormal Lung Development

~ Early Life Events, Premature and Low Birth Weight

- COPD I- Infections

~ Childhood Infections, Tuberculosis associated COPD, HIV associated COPD

- COPD A- Asthma

~Develops from childhood asthma

- COPD U- Unknown causes

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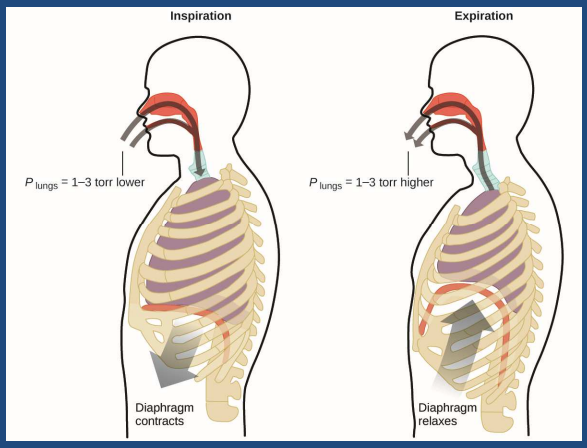
Boyle's Law

P1V1 = P2V2.



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Diagnosis of COPD

- **Evaluate Symptoms**

- **History of Risk Factors**
- **Persistent dyspnea that worsens with exercise**
- **Recurrent Wheeze**
- **Chronic Cough**
- **Recurrent respiratory infections**

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Pink Puffer VS Blue Bloater

- Thin, pink skin
- Pursed Lip Breathing
- Dyspnea
- Minimal Cough
- Accessory Muscle Use
- Hyperinflation
- Barrel Chest
- Decreased Breath Sounds
- Tachypnea

- Obese
- Cyanotic
- Chronic, Productive Cough
- Digital Clubbing
- Crackles and Wheezes
- Purulent Sputum
- Peripheral Edema
- Prolonged Exhalation

**Pneumothorax (due to blebs)

** Polycythemia

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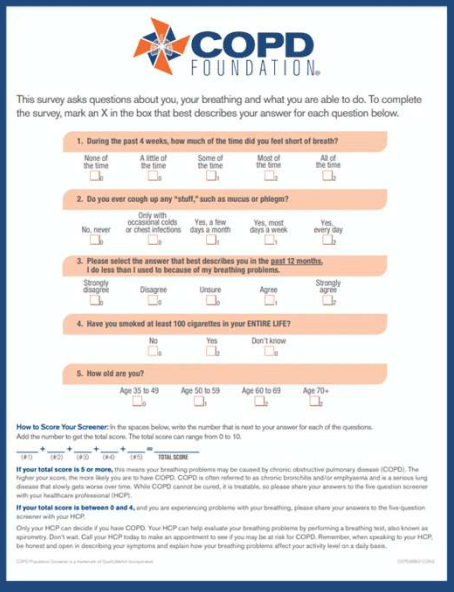
Scoring



COPD FOUNDATION

This survey asks questions about you, your breathing and what you are able to do. To complete the survey, mark an X in the box that best describes your answer for each question below.

1. During the past 4 weeks, how much of the time did you feel short of breath?
None of the time (0) | A little of the time (1) | Some of the time (2) | Most of the time (3) | All of the time (4)

2. Do you ever cough up any "stuff," such as mucus or phlegm?
No, never (0) | Only with occasional colds or chest infections (1) | Yes, a few days a month (2) | Yes, most days a week (3) | Yes, every day (4)

3. Please select the answer that best describes you in the past 12 months.
I do less than I used to because of my breathing problems.
Strongly disagree (0) | Disagree (1) | Unsure (2) | Agree (3) | Strongly agree (4)

4. Have you smoked at least 100 cigarettes in your ENTIRE LIFE?
No (0) | Yes (2) | Don't know (0)

5. How old are you?
Age 35 to 49 (0) | Age 50 to 59 (1) | Age 60 to 69 (2) | Age 70+ (3)

How to Score Your Screener: In the spaces below, write the number that is next to your answer for each of the questions. Add the number to get the total score. The total score can range from 0 to 10.

(#1) + (#2) + (#3) + (#4) + (#5) = TOTAL SCORE

If your total score is 5 or more, this means your breathing problems may be caused by chronic obstructive pulmonary disease (COPD). The higher your score, the more likely you are to have COPD. COPD is often referred to as chronic bronchitis and/or emphysema and is a serious lung disease that slowly gets worse over time. While COPD cannot be cured, it is treatable, so please share your answers to the five question screener with your healthcare professional (HCP).

If your total score is between 0 and 4, and you are experiencing problems with your breathing, please share your answers to the five-question screener with your HCP.

Only your HCP can decide if you have COPD. Your HCP can help evaluate your breathing problems by performing a breathing test, also known as spirometry. Don't wait. Call your HCP today to make an appointment to see if you may be at risk for COPD. Remember, when speaking to your HCP, be honest and open in describing your symptoms and explain how your breathing problems affect your activity level on a daily basis.

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Questionnaires

- CAT
- MRC

Modified MRC Dyspnea Scale Figure 2.8

PLEASE TICK IN THE BOX THAT APPLIES TO YOU | ONE BOX ONLY | Grades 0 - 4

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

Reference: ATS (1982) Am Rev Respir Dis. Nov;126(5):952-6.

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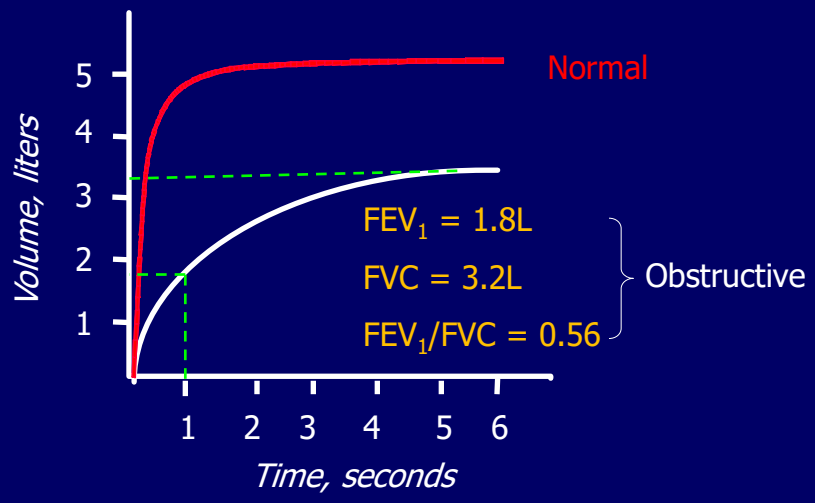
CRJ2

Spirometry: Obstructive Disease



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Slide 22

CRJ2 Sue i have inserted a bracket and shifted the obstructive label. The FVC in this slide is about 3.4 by eyeball - shoudl be moved down to 3.2 or the numbers should be changed

Christine Jenkins, 4/14/2008

Spirometric Diagnosis

- Post-bronchodilator FEV_1/FVC measured 15 minutes after 400µg salbutamol or equivalent
- Obstructive Disease confirmed by post–bronchodilator FEV_1/FVC < 0.7

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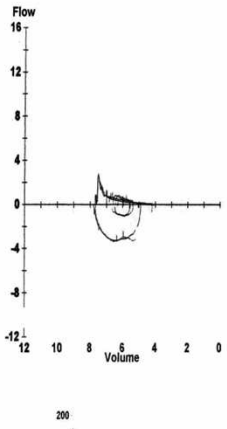
PFT Report

		Ref	Pre	% Ref	Post	% Ref	%Chg
Spirometry							
FVC	Liters	4.09	2.81	69	3.50	86	24
FEV1	Liters	3.30	1.00	30	1.08	33	8
FEV1/FVC	%	80	35		31		
FEF25-75%	L/sec	3.39	0.40	12	0.41	12	3
PEF	L/sec	8.21	2.62	32	2.74	33	5
Lung Volumes							
TLC	Liters	6.21	7.70	124			
VC	Liters	4.09	3.27	80			
FRC PL	Liters	3.17	5.42	171			
Vtg	Liters		7.01				
ERV	Liters		0.99				
RV	Liters	2.20	4.43	201			
RV/TLC	%	37	58				
Diffusing Capacity							
DLCO	mL/min/mmHg	25.2	12.9	51			
DL Adj	mL/min/mmHg	25.2	12.9	51			
DLCO/VA	1/min/mmHg	3.82	2.72	71			
DL/VA Adj	1/min/mmHg		2.72				
Resistance							
Raw	cmH2O/L/sec	1.46	4.87	333			
Gaw	L/sec/cmH2O	0.761	0.205	27			
sGaw	1/cmH2O sec	0.216	0.029	13			



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Gold Grades

Severity of Airflow Obstruction

- GOLD 1: MILD

~FEV1 ≥ 80% predicted

- GOLD 2: MODERATE

~ 50% ≤ FEV1 < 80% predicted

- GOLD 3: SEVERE

~30%≤ FEV1 < 50% Predicted

- GOLD 4: VERY SEVERE

~Very Severe FEV1 < 30% predicted

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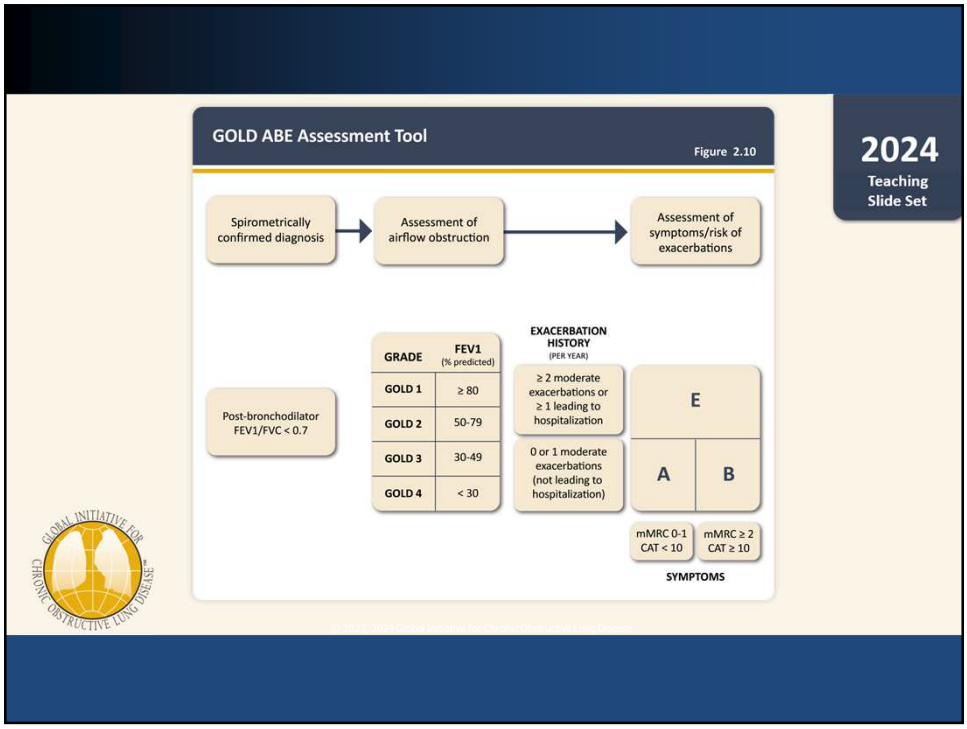

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PRISm

- COPD?

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PRISm

- Preserved Ratio Impaired Spirometry

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Diseases Associated With Airflow Obstruction

- COPD
- Asthma
- Bronchiectasis
- Cystic Fibrosis
- Post-tuberculosis
- Lung cancer (greater risk in COPD)
- Obliterative Bronchiolitis

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Chest Imaging

- **X-Ray**
- **Low Dose Chest CT**

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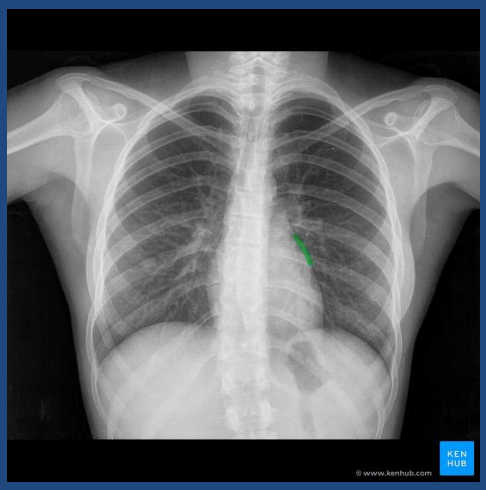
Normal Chest X-Ray



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Flattened Diaphragm

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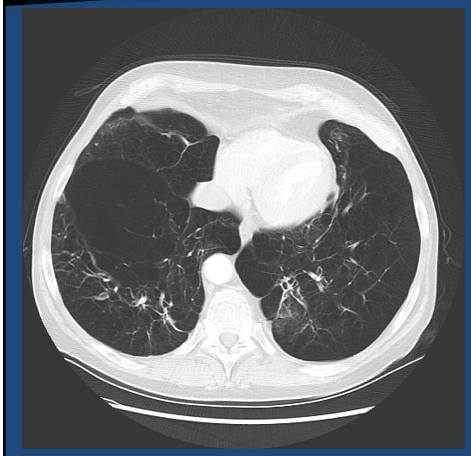
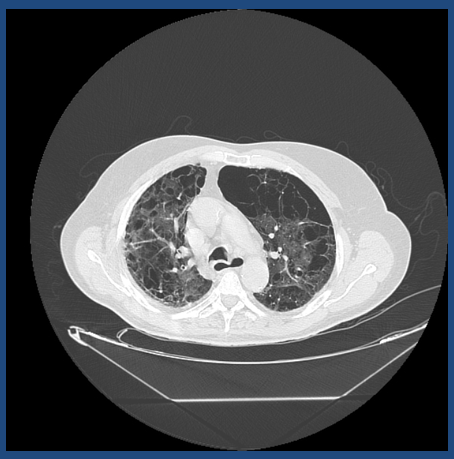
Chest CT

Blebs





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Barrel Chest

"Blue Bloater"

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Pink Puffer

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Complications of COPD

- **Pneumonia**
- **Respiratory Failure**
- **Cor Pulmonale**
- **Polycythemia**
- **Pneumothorax**

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Prevention Strategies
for Exacerbations

- Avoid Triggers for exacerbations
- Create a COPD "Action Plan"

~Green Zone, Yellow Zone, Red Zone

- Healthy Lifestyle

~ Staying active, eating healthy, managing stress

- Vaccines (Pneumococcal, RSV, Pertussis, etc.)

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Treatment

- Patient and Family Education
- Smoking Cessation (if applicable)
- Pharmacological therapy
- Supplemental oxygen
- Valve Therapy
- Pulmonary Rehab

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2024 Teaching Slide Set

Goals for Treatment of Stable COPD

Figure 3.1

- Relieve Symptoms
- Improve Exercise Tolerance
- Improve Health Status

→ **REDUCE SYMPTOMS**

AND

- Prevent Disease Progression
- Prevent and Treat Exacerbations
- Reduce Mortality

→ **REDUCE RISK**

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2024 Teaching Slide Set

Management of COPD

Figure 3.2

Diagnosis
- Symptoms
- Risk factors
- Spirometry (repeat if borderline)

Initial Assessment
- FEV1 – ***GOLD 1 - 4***
- Symptoms (CAT or mMRC) } **GOLD ABE**
- Exacerbation history
- Smoking status
- α1- antitrypsin
- Comorbidities

Initial Management
- Smoking cessation
- Vaccination
- Active lifestyle and exercise
- Initial pharmacotherapy
- Self management education
  - risk factor management
  - inhaler technique
  - breathlessness
  - written action plan
- Manage comorbidities

Adjust
- Pharmacotherapy
- Non-pharmacological therapy

Review
- Symptoms (CAT or mMRC)
- Exacerbations
- Smoking status
- Exposure to other risk factors
- Inhaler technique & adherence
- Physical activity and exercise
- Need for pulmonary rehabilitation
- Self management skills
  - breathlessness
  - written action plan
- Need for oxygen, NIV, lung volume reduction, palliative approaches
- Vaccination
- Management of comorbidities
- Spirometry (at least annually)

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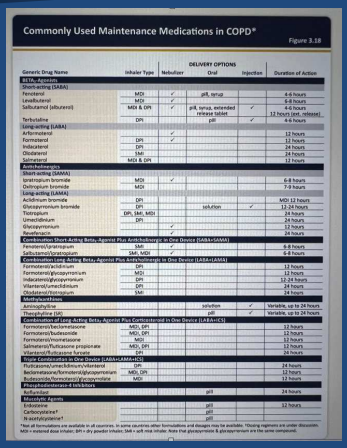
Pharmacology



Commonly Used Maintenance Medications in COPD*

Figure 3.18

Generic Drug Name	Inhaler Type	DELIVERY OPTIONS Nebulizer	Oral	Injection	Duration of Action
BETA$_2$-Agonists					
Short-acting (SABA)					
Fenoterol	MDI	✓	pill, syrup		4-6 hours
Levalbuterol	MDI	✓			5-8 hours
Salbutamol (albuterol)	MDI & DPI	✓	pill, syrup, extended release tablet	✓	4-6 hours 12 hours (ext. release)
Terbutaline	DPI		pill	✓	4-6 hours
Long-acting (LABA)					
Arformoterol		✓			12 hours
Formoterol	DPI	✓			12 hours
Indacaterol	DPI				24 hours
Olodaterol	SMI				24 hours
Salmeterol	MDI & DPI				12 hours
Anticholinergics					
Short-acting (SAMA)					
Ipratropium bromide	MDI	✓			6-8 hours
Oxitropium bromide	MDI				7-9 hours
Long-acting (LAMA)					
Aclidinium bromide	DPI				MDI-12 hours
Glycopyrronium bromide	DPI				12 hours
Tiotropium	DPI, SMI, MDI		solution	✓	24 hours
Umeclidinium	DPI				24 hours
Glycopyrronium		✓			12 hours
Revefenacin					24 hours
Combination Short-Acting Beta$_2$-Agonist Plus Anticholinergic in One Device (SABA+SAMA)					
Fenoterol/Ipratropium	SMI	✓			6-8 hours
Salbutamol/Ipratropium	SMI, MDI	✓			6-8 hours
Combination Long-Acting Beta$_2$-Agonist Plus Anticholinergic in One Device (LABA+LAMA)					
Formoterol/aclidinium	DPI				12 hours
Formoterol/glycopyrronium	MDI				12 hours
Indacaterol/glycopyrronium	DPI				12-24 hours
Vilanterol/umeclidinium	DPI				24 hours
Olodaterol/tiotropium	SMI				24 hours
Methylxanthines					
Aminophylline			solution	✓	Variable, up to 24 hours
Theophylline (SR)			pill	✓	Variable, up to 24 hours
Combination of Long-Acting Beta$_2$-Agonist Plus Corticosteroid in One Device (LABA+ICS)					
Formoterol/beclometasone	MDI, DPI				12 hours
Formoterol/budesonide	MDI, DPI				12 hours
Salmeterol/fluticasone	DPI				12 hours
Formoterol/mometasone propionate	MDI, DPI				12 hours
Vilanterol/fluticasone furoate	DPI				24 hours
Triple Combination in One Device (LABA+LAMA+ICS)					
Fluticasone/umeclidinium/Vilanterol	DPI				24 hours
Beclometasone/formoterol/glycopyrronium	MDI, DPI				12 hours
Budesonide/formoterol/glycopyrrolate	MDI				12 hours
Phosphodiesterase-4 Inhibitors					
Roflumilast			pill		24 hours
Mucolytic Agents					
Erdosteine			pill		12 hours
Carbocysteine†			pill		
N-acetylcysteine†			pill		

*Not all formulations are available in all countries. In some countries other formulations and dosages may be available. †Dosing regimens are under discussion. MDI = metered dose inhaler; DPI = dry powder inhaler; SMI = soft mist inhaler. Note that glycopyrrolate & glycopyrronium are the same compound.

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Pharmacology

- Availability to the drug
- Cost of the drug to the patient
  - Accessiblemeds.org
  - Amazon pharmacy
  - GoodRx
  - Costplusdrugs.com
  - Manufacture's website
- Patients' ability to administer the drug

~Dexterity, strength and cognition

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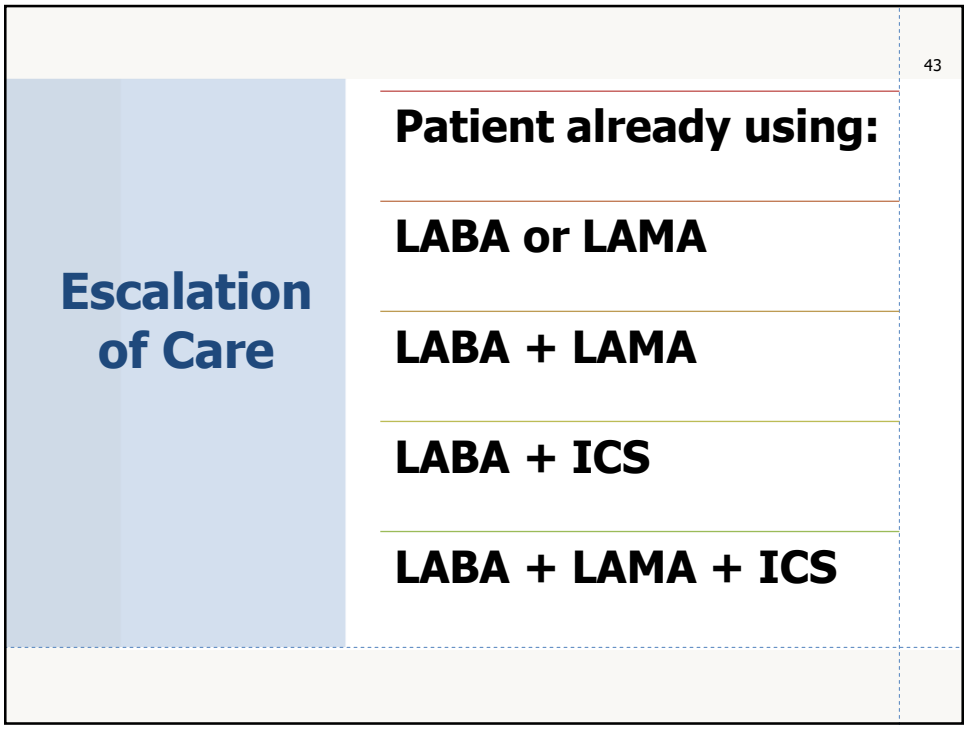
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Escalation of Care
Patient already using:
LABA or LAMA
LABA + LAMA
LABA + ICS
LABA + LAMA + ICS

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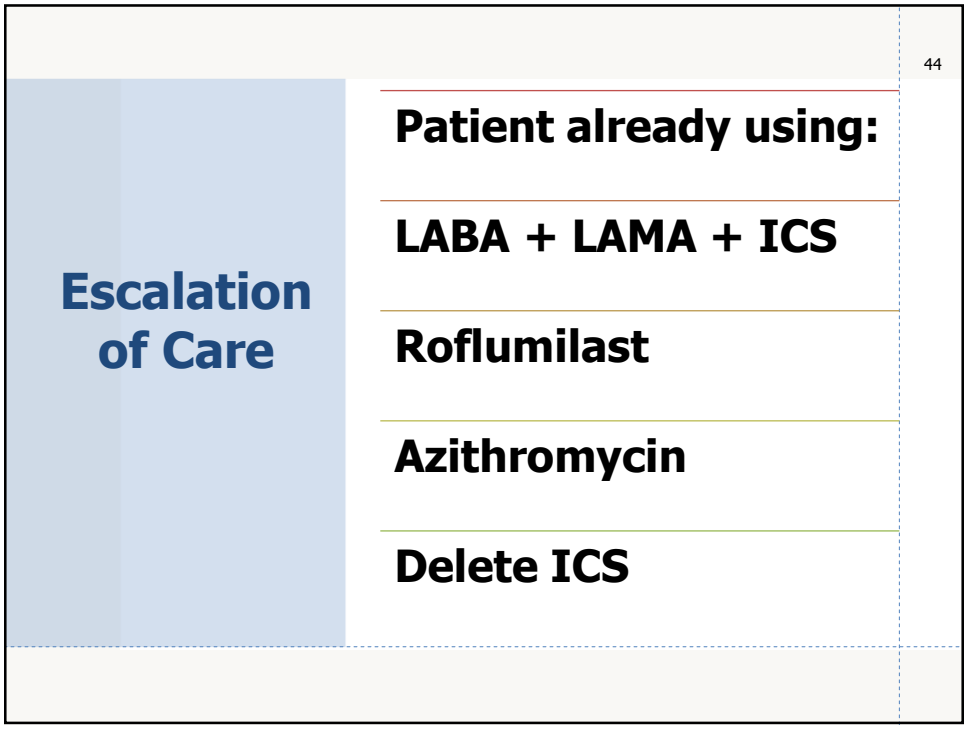
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Escalation of Care
Patient already using:
LABA + LAMA + ICS
Roflumilast
Azithromycin
Delete ICS

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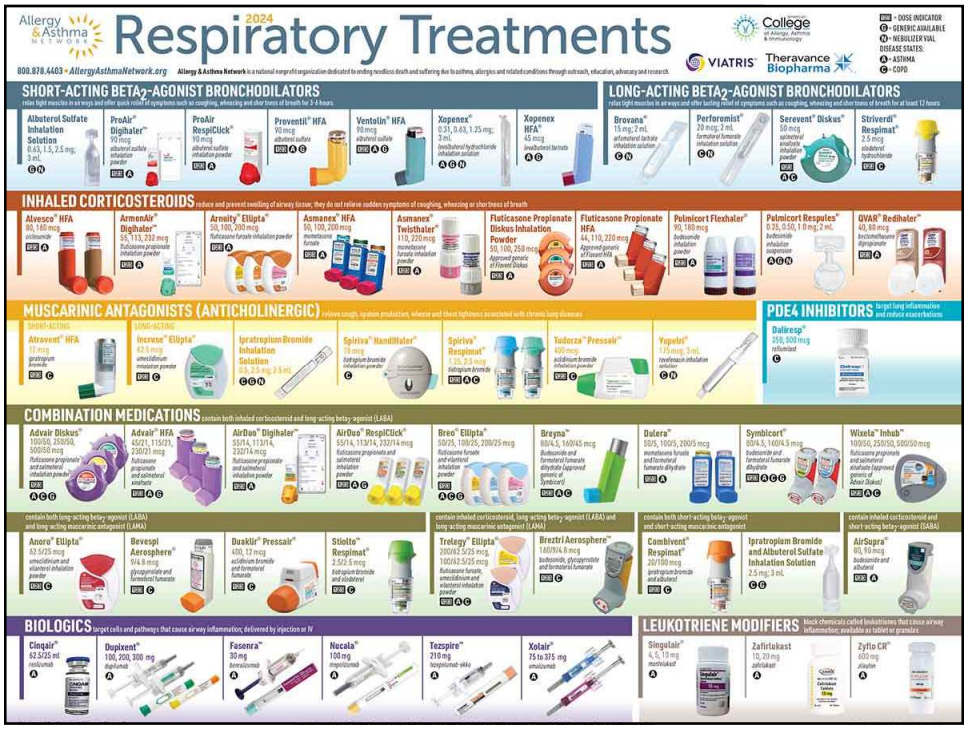

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Zephyr® Valve

Zephyr Valve, image courtesy of Pulmonx Corp.

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Lung Surgery

- **Bullectomy**
- **LVRS**
- **Lung Transplant**

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Exacerbation

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Exacerbation

ABG

- PH 7.19
- PaCO2 75 mmHg
- PaO2 52 mmHg
- HCO3- 30 mEq/L

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NIV

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V60 Modes

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- CPAP
- BIPAP
- AVAPS
- PCV

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Intubation

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Extubation

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Pulmonary Rehab

- Breathing exercises
- Education
- Phycological Counseling
- Exercise Training
- Nutrition counseling

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Smoking

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1-800-QUIT-NOW

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Homecare

Home oxygen	Home ventilation
• Group I • Group II	• R/O OSA with CPAP

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Home Oxygen

Group I

- pO2 ≤ 55
- Sat ≤ 88

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Home Oxygen

Group II

- pO2 ≤ 56-59
- Sat = 89

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Home Ventilation

R/O OSA with CPAP

- pCO2 ≥ 52
- Sat ≤ 88

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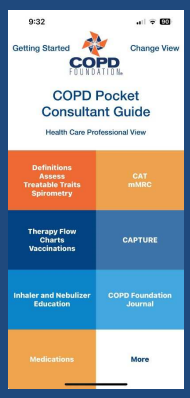
Resources
COPD Foundation App



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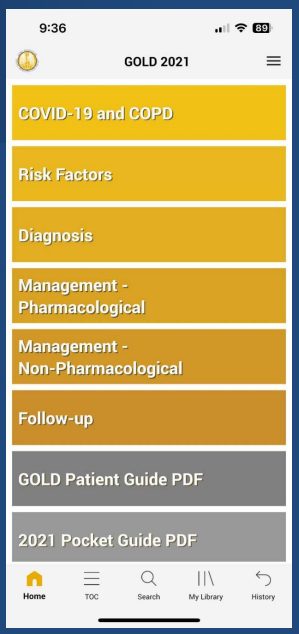
Resources
COPD
GOLD App



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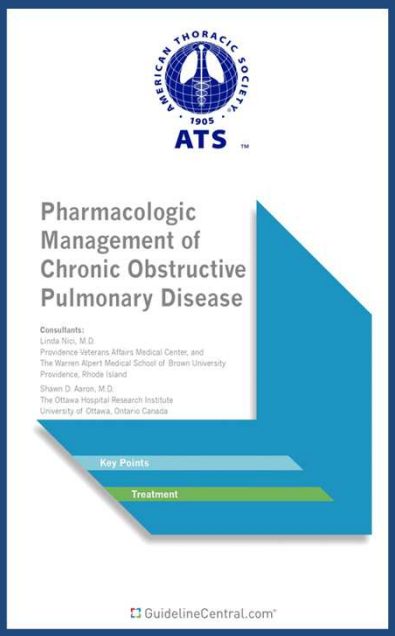
Resources ATS Guidelines Booklet



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Suggested Courses

- Average Volume-Assured Pressure Support Treatment in COPD
- COPD Management: Educating Patients on More Than Medication
- Understanding COPD GOLD Guidelines & 2024 Updates

Alyssa Dittner, BSRT, RRT, PDE, TTS

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Suggested Courses

- The Latest GOLD COPD Guidelines (With Cases to Ponder)
- A Refresher on Pulmonary Functions Testing Concepts & Interpretation

Tim W. Gilmore, PhD, RRT, RRT-NPS, RRT-ACCS, CPFT, AE-C

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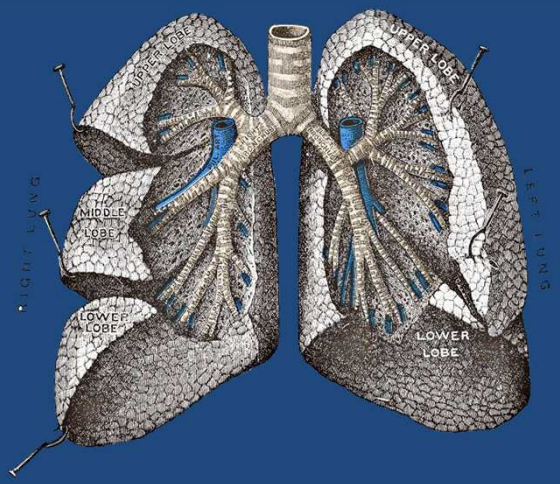
Summary & Review



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References

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