Brigham and Women's Hospital
Founding Member, Mass General Brigham

PULMONARY OVERVIEW

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Jefferson Medical College
Medicine Residency at Deaconess Hospital
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Assistant Professor of Medicine at HMS
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DISCLOSURES

Co-editor of two sections on Chronic Cough in UpToDate.

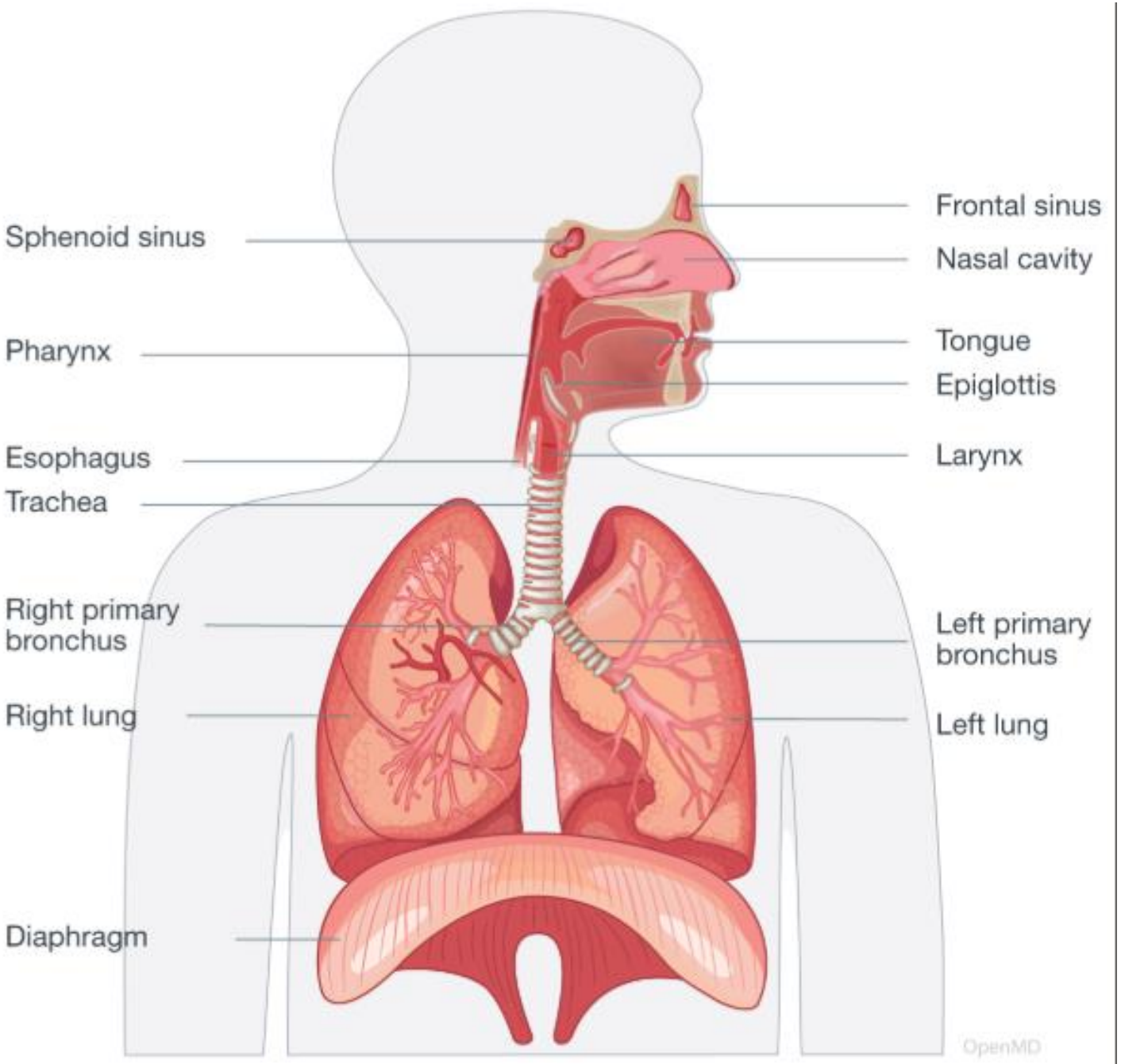
I have no relevant financial relationships with ineligible companies.

OBJECTIVES

- Respiratory anatomy
- Respiratory function
- Respiratory defense
- Respiratory studies
- What can go wrong with respiratory tract?
- Treatments for respiratory problems
- What’s new in treatment for respiratory problems?

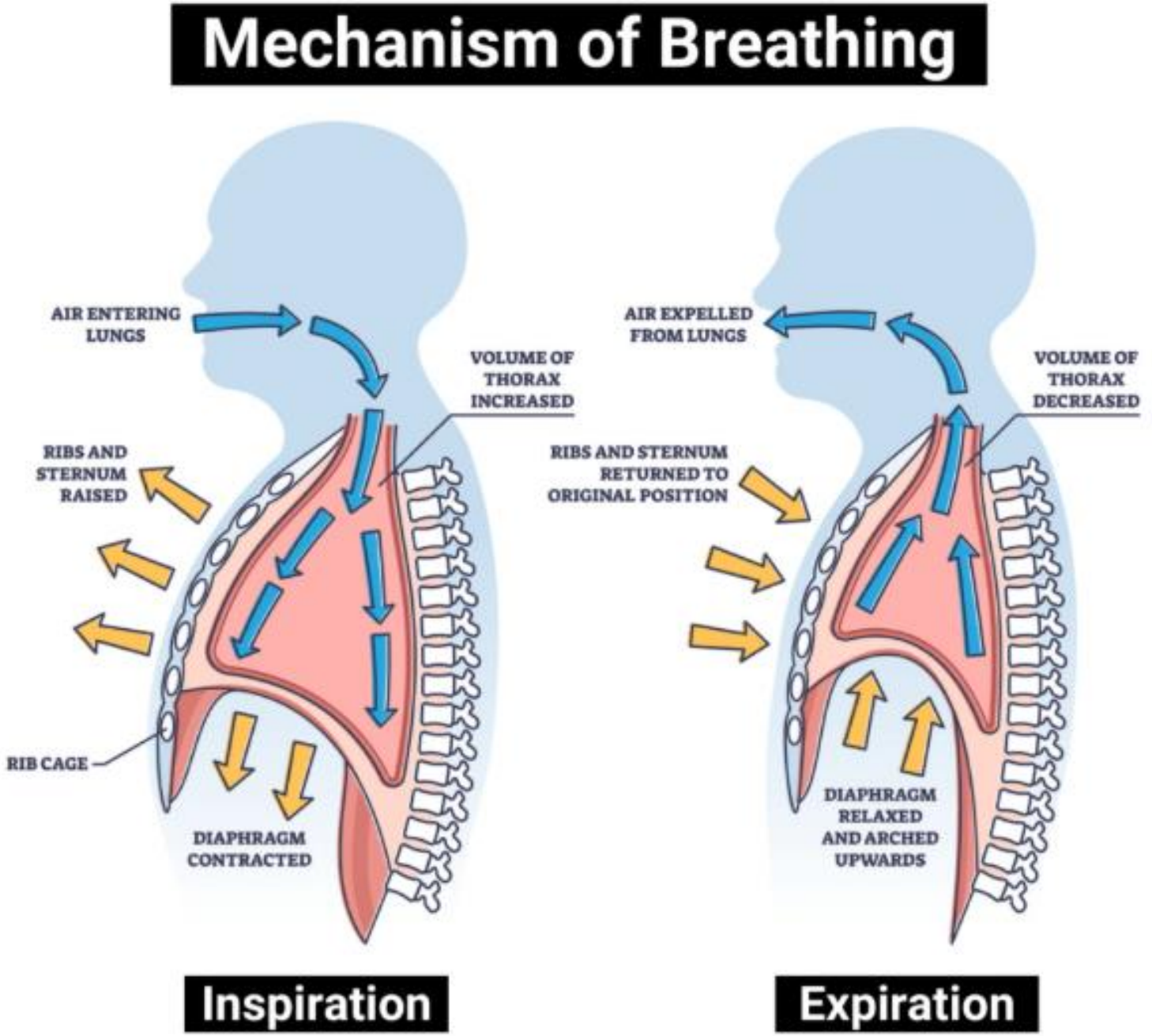
Respiratory Anatomy

- Brain, peripheral nervous system
- Sinuses
- Oro/nasopharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles
- Alveoli
- Interstitium
- Pulmonary and bronchial arteries and veins, capillaries
- Pleura
- Chest wall
- Diaphragm
- Nearby structures, including heart, esophagus, thyroid, thymus, lymph nodes



Respiratory Function

- O2 in, CO2 out



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Respiratory Defense

- Nose/mouth
- Epiglottis/Larynx (redirect foreign material)
- Cough (expel inhaled material and endogenous secretions)
- Mucociliary escalator (remove smaller inhaled material and endogenous secretions)
- Cellular immunity (white blood cells, macrophages)
- Humoral immunity (antibodies)
- Brain (hold your breath, escape inhaled toxins, wear a mask)

Respiratory Studies

- History (review, don't assume, explain why you are asking)
- Physical exam (observation, inspection, auscultation, percussion, palpation)
- Sputum (culture, eosinophils, cytology, Pneumocystis)
- Blood (CBC with differential, chemistries, urinalysis, inflammatory markers, autoimmune, immunoglobulins)
- CXR (old films)
- CT scan (old films, protocols, vessel suppression, pitfalls - insp/exp)
- PFT's (adequate test? obstruction/restriction, bronchodilator, upper airway)
- CPET (cardiac, pulmonary, deconditioning)
- Ultrasound (normal, effusion, heart failure, pneumothorax, pneumonia)
- Bronchoscopy (flex/rigid) (inspection, wash, lavage, biopsy - endobronchial, transbronchial (conventional, cryobiopsy), node; EBUS, navigational, robotic)
- PET scan (neoplasm, sarcoid, other inflammatory)
- Thoracoscopic pleural biopsy
- Surgical lung biopsy (focal lesion, three lobes for Interstitial Lung Disease)
- Other: Video Swallow Study (modified barium swallow; larynx), Barium Swallow (esophagus), Cardiac testing, Electromyogram

75 year old man

75 year old man with Combined Pulmonary Fibrosis and Emphysema (CPFE)

75 year old man
with Combined
Pulmonary Fibrosis
and Emphysema
(CPFE),
ANCA vasculitis,

75 year old man
with Combined
Pulmonary Fibrosis
and Emphysema
(CPFE),
ANCA vasculitis,
Lung cancer,

75 year old man
with Combined
Pulmonary Fibrosis
and Emphysema
(CPFE),
ANCA vasculitis,
Lung cancer,
Still smoking

64 F with hemoptysis

64 F with hemoptysis and HHT (Hereditary Hemorrhagic Telangiectasia)

Respiratory Studies

- History (keep asking, don't assume, go back and ask again, explain why you're asking)
- Physical exam (inspection, auscultation, percussion, palpation)
- **Sputum** (culture, eosinophils, cytology, Pneumocystis)
- Blood (CBC with differential, chemistries, urinalysis, inflammatory markers, autoimmune, immunoglobulins)
- CXR (old films)
- CT scan (old films, protocols, vessel suppression, pitfalls - insp/exp)
- PFT's (adequate test? obstruction/restriction, bronchodilator, upper airway)
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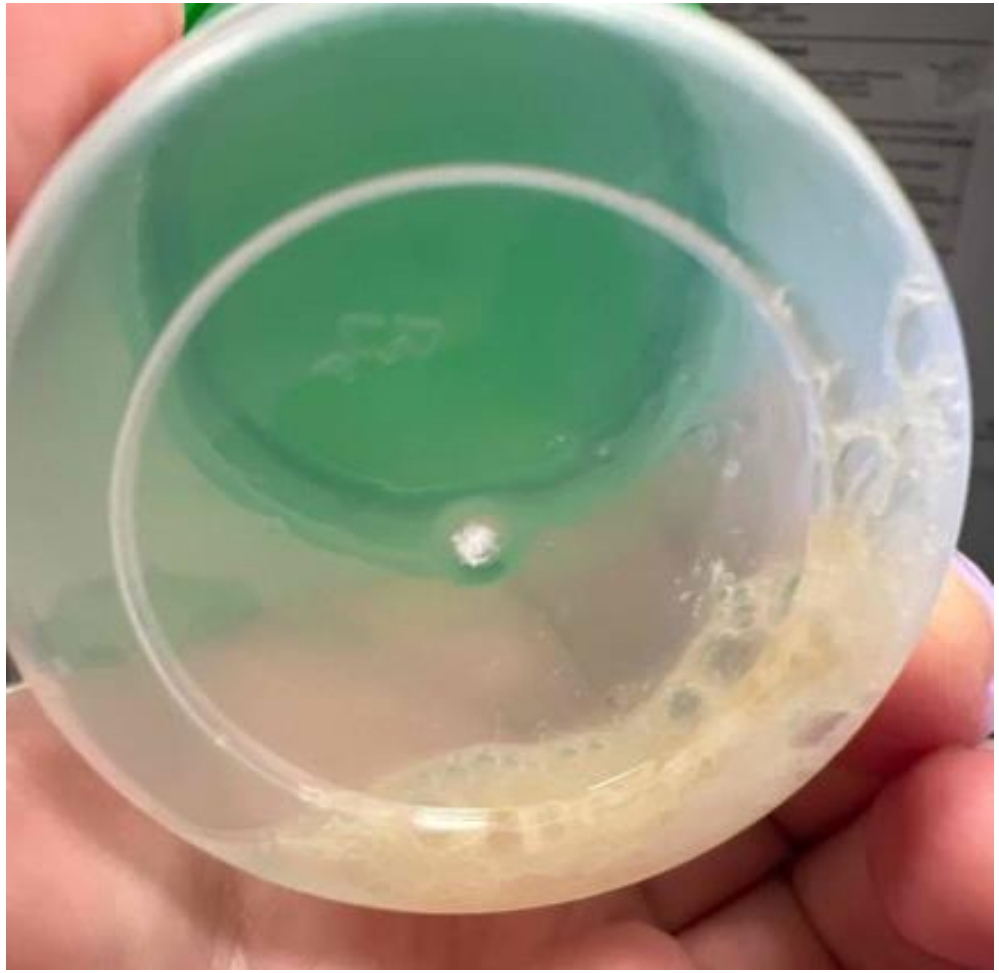
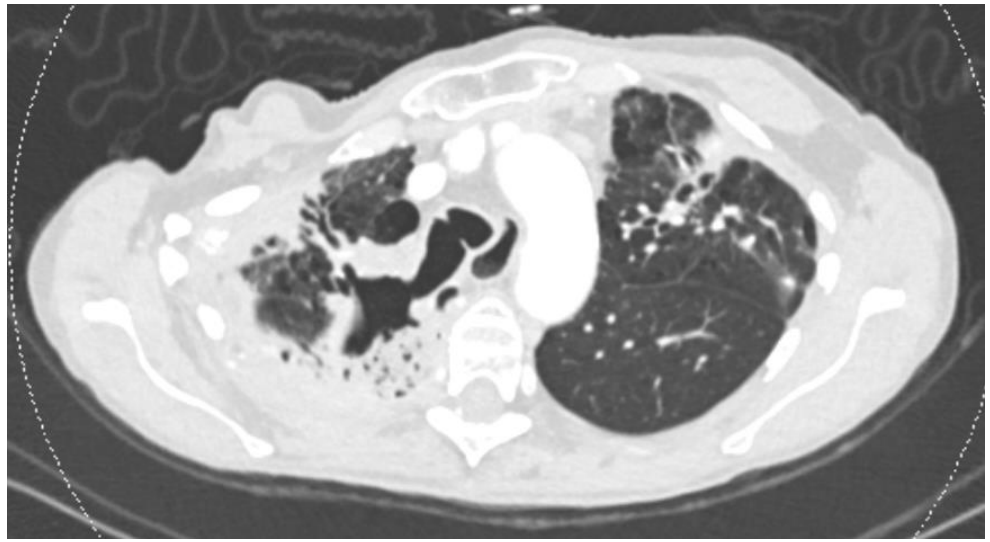
- Surgical lung biopsy
- Other: Video Swallow Study (modified barium swallow), Barium Swallow, Cardiac testing, Electromyogram

Sputum from a 77 M with Chronic Obstructive Pulmonary Disease



64 F with chronic cavitary fungal and mycobacterial infection



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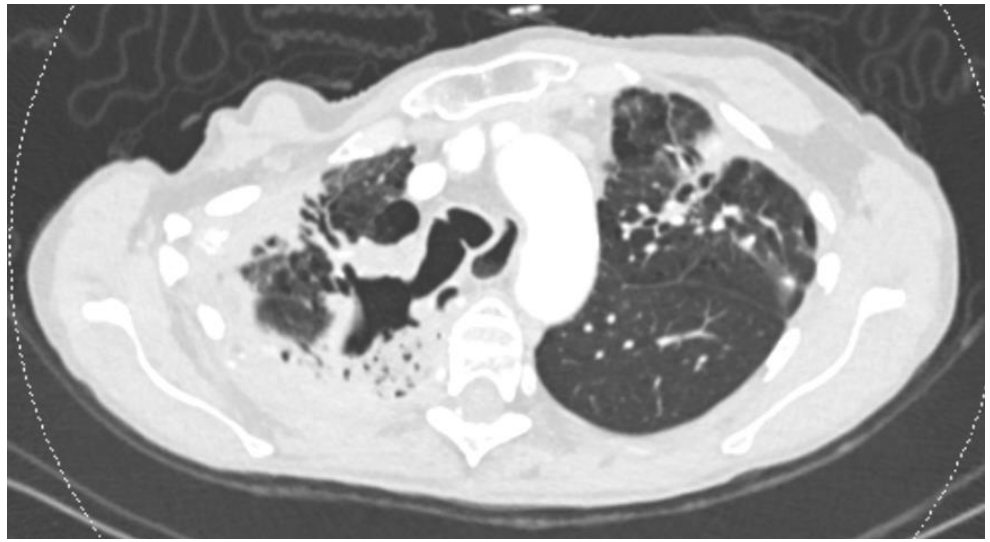

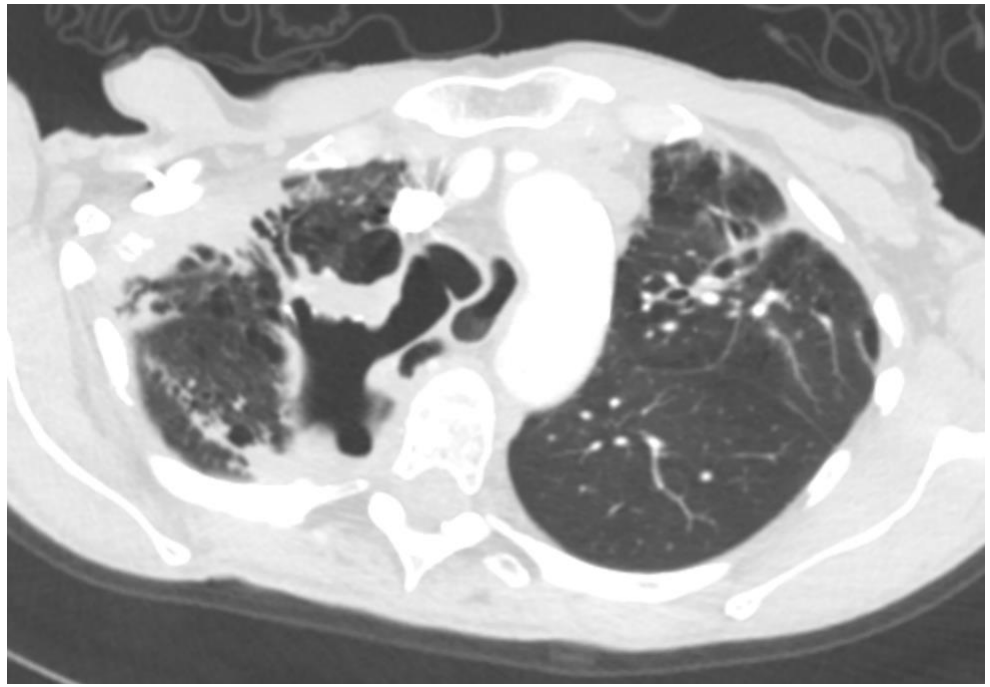

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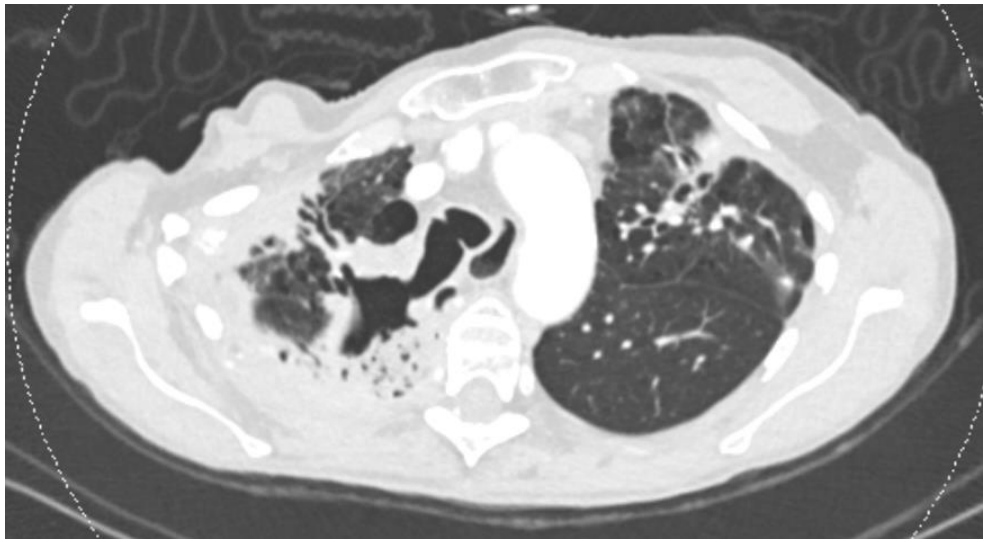

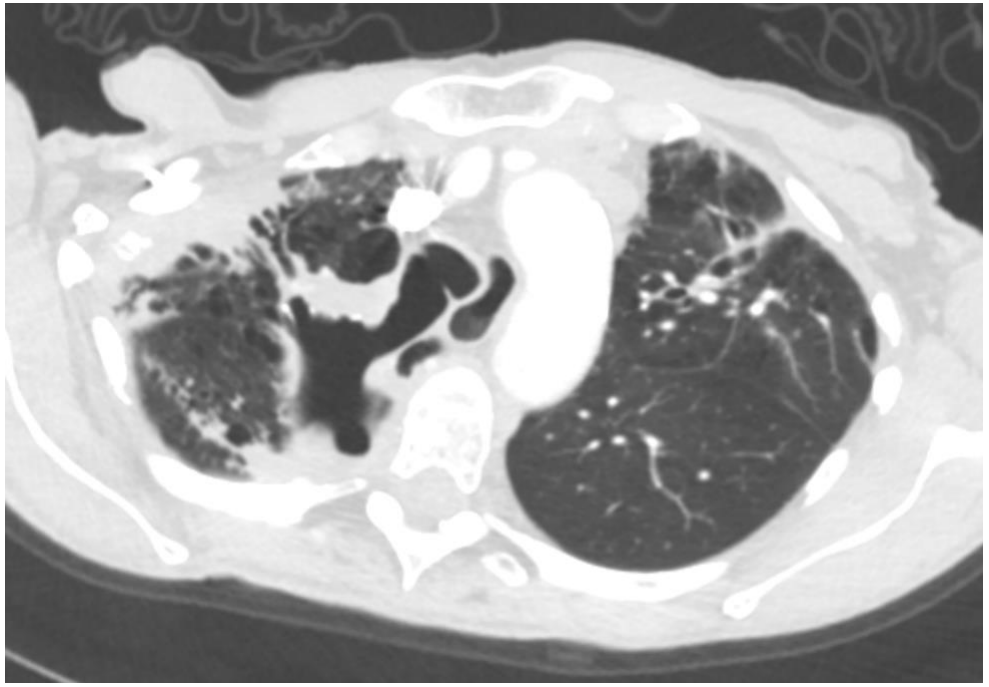

Respiratory Studies

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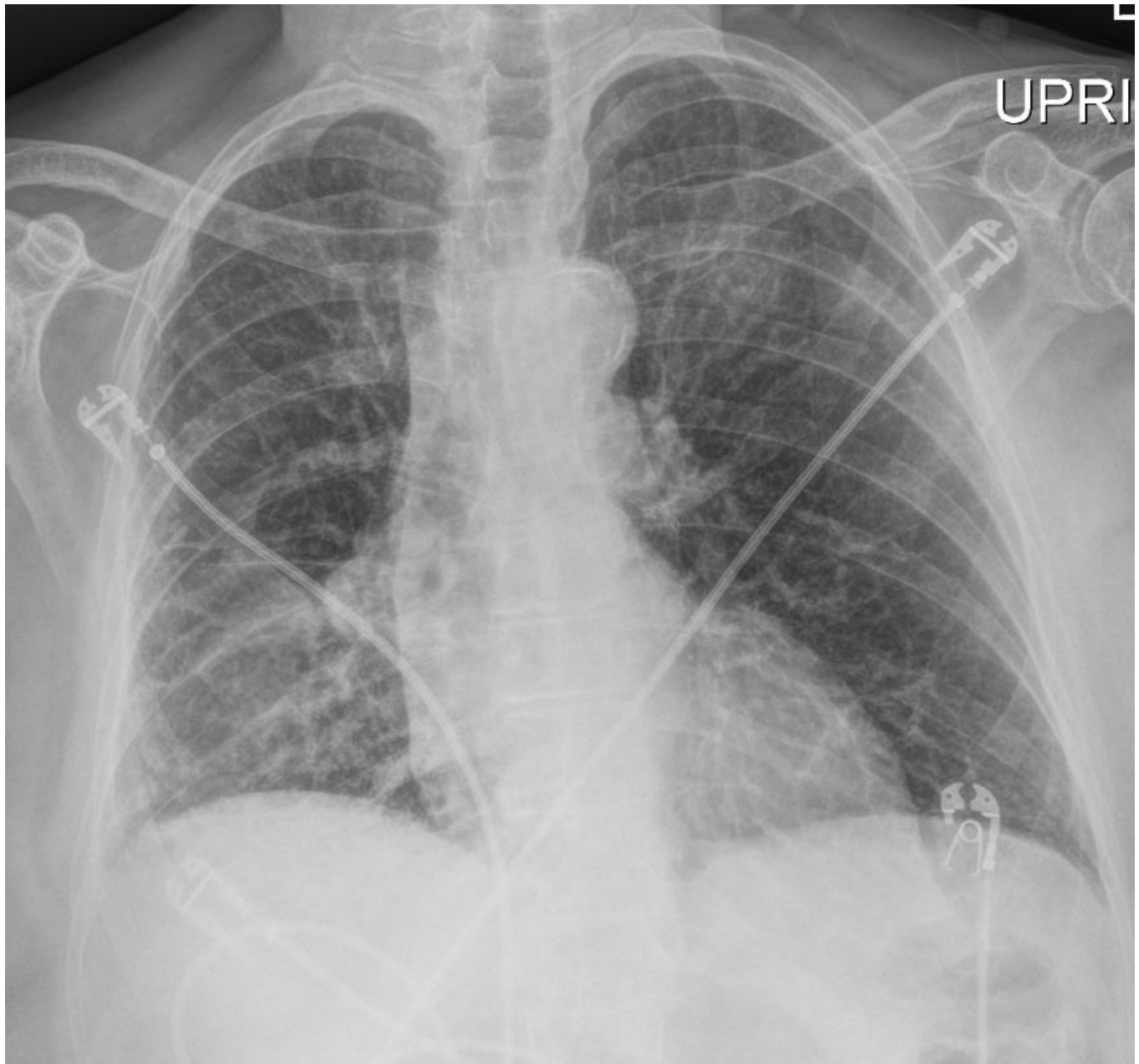
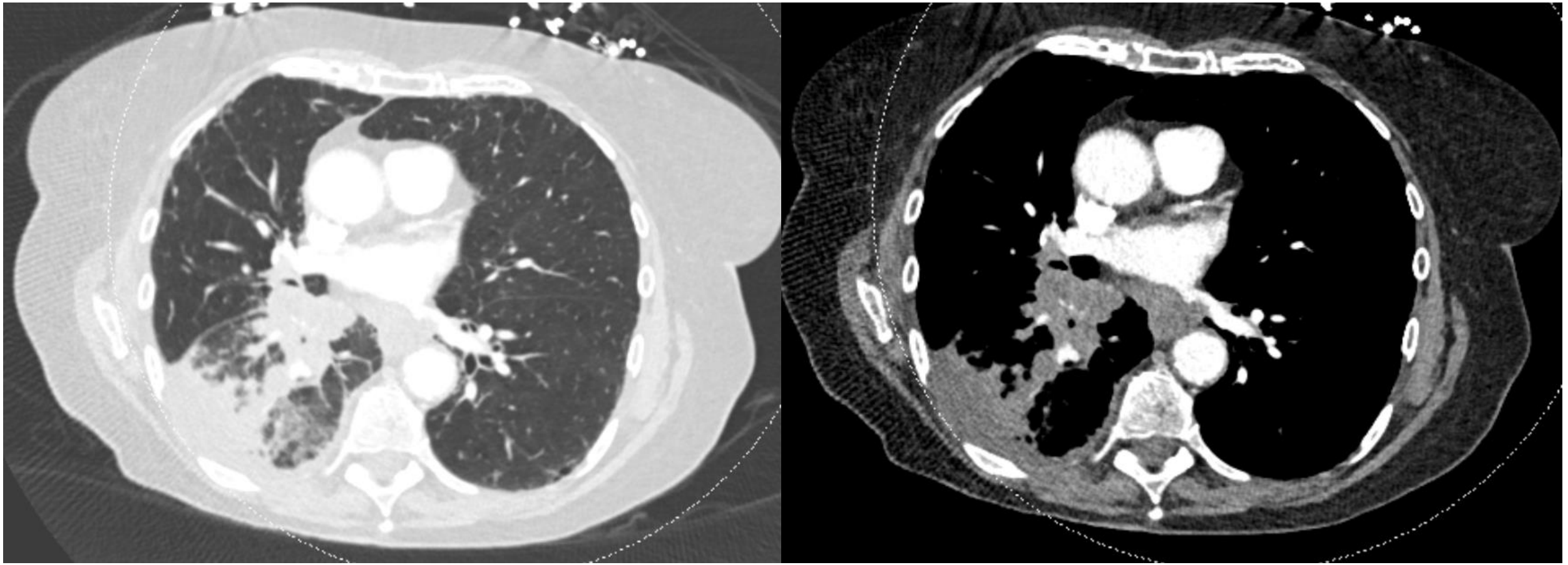
- Physical exam (inspection, auscultation, percussion, palpation)
- Sputum (culture, eosinophils, cytology, Pneumocystis)
- Blood (CBC with differential, chemistries, urinalysis, inflammatory markers, autoimmune, immunoglobulins)
- **Chest x-ray** (old films)
- **CT scan** (old films, protocols, vessel suppression, pitfalls - insp/exp, artificial intelligence)
- PFT's (adequate test? obstruction/restriction, bronchodilator, upper airway)
- CPET (cardiac, pulmonary, deconditioning)
- Ultrasound
- Bronchoscopy (flex/rigid) (inspection, wash, lavage, biopsy - endobronchial, transbronchial (conventional, cryobiopsy), node; EBUS, navigational, robotic)
- PET scan (neoplasm, sarcoid, other inflammatory)
- Thoracoscopic pleural biopsy
- Surgical lung biopsy
- Other: Video Swallow Study (modified barium swallow), Barium Swallow, Cardiac testing, Electromyogram

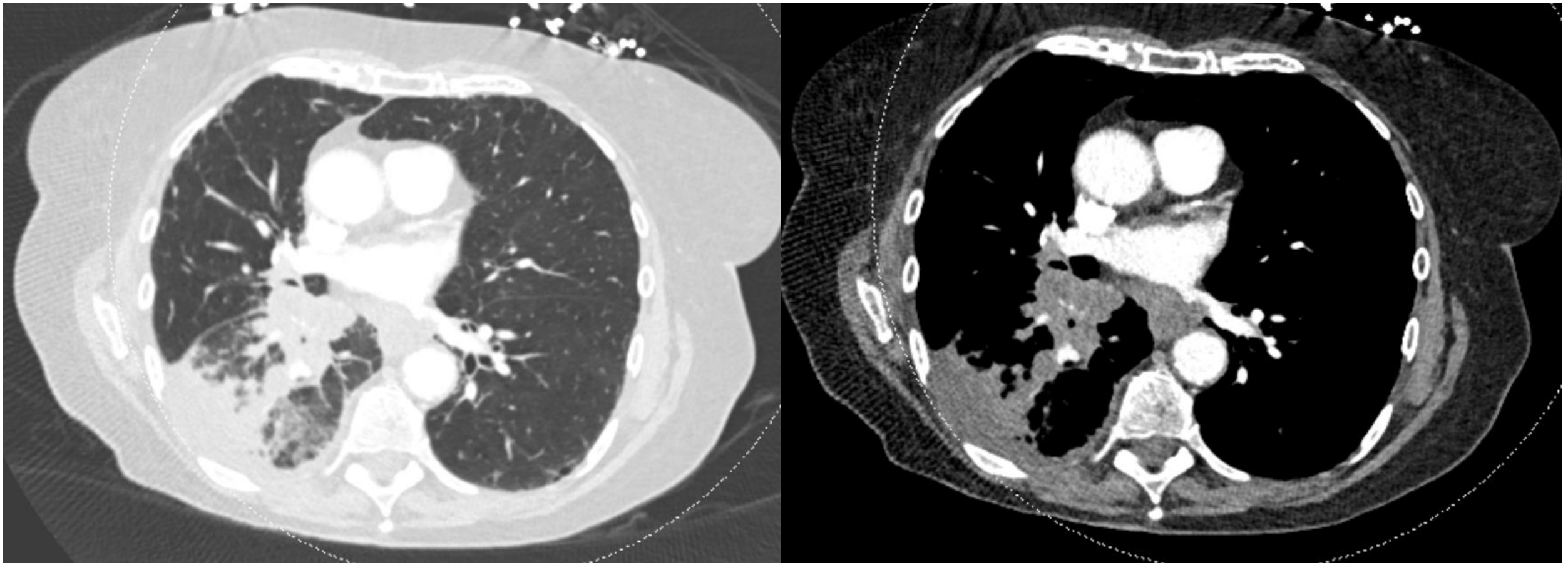
80 F former smoker with mild Interstitial Lung Disease, new malaise and dyspnea



80 F former smoker with mild Interstitial Lung Disease, new malaise and dyspnea



80 F former smoker with mild Interstitial Lung Disease, new malaise and dyspnea, found to have Small Cell Lung Cancer



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- Blood (CBC with differential, chemistries, urinalysis, inflammatory markers, autoimmune, immunoglobulins)
- CXR (old films)
- CT scan (old films, protocols, vessel suppression, pitfalls - insp/exp)
- **Pulmonary Function Testing** (adequate test? obstruction/restriction, bronchodilator, upper airway)
- CPET (cardiac, pulmonary, deconditioning)
- Ultrasound
- Bronchoscopy (flex/rigid) (inspection, wash, lavage, biopsy - endobronchial, transbronchial (conventional, cryobiopsy), node; EBUS, navigational, robotic)
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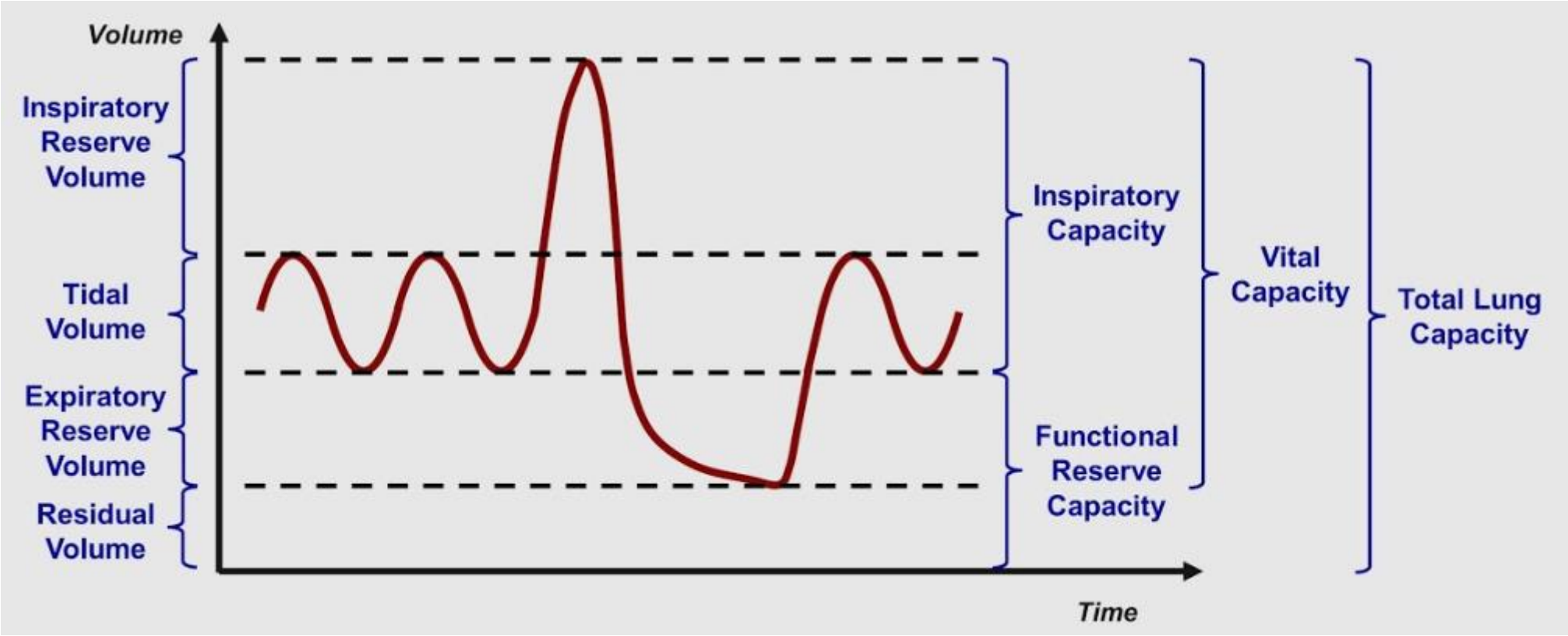

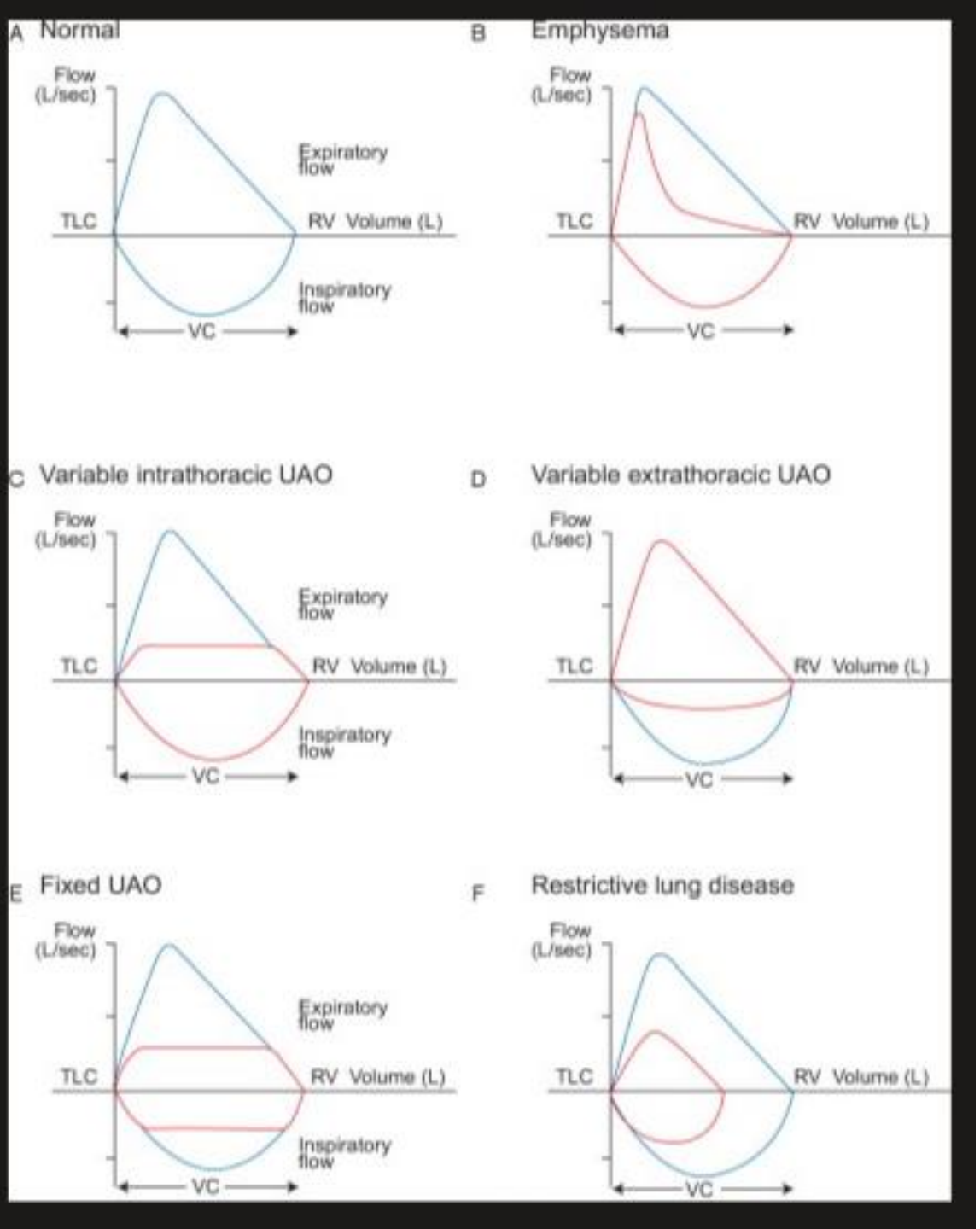

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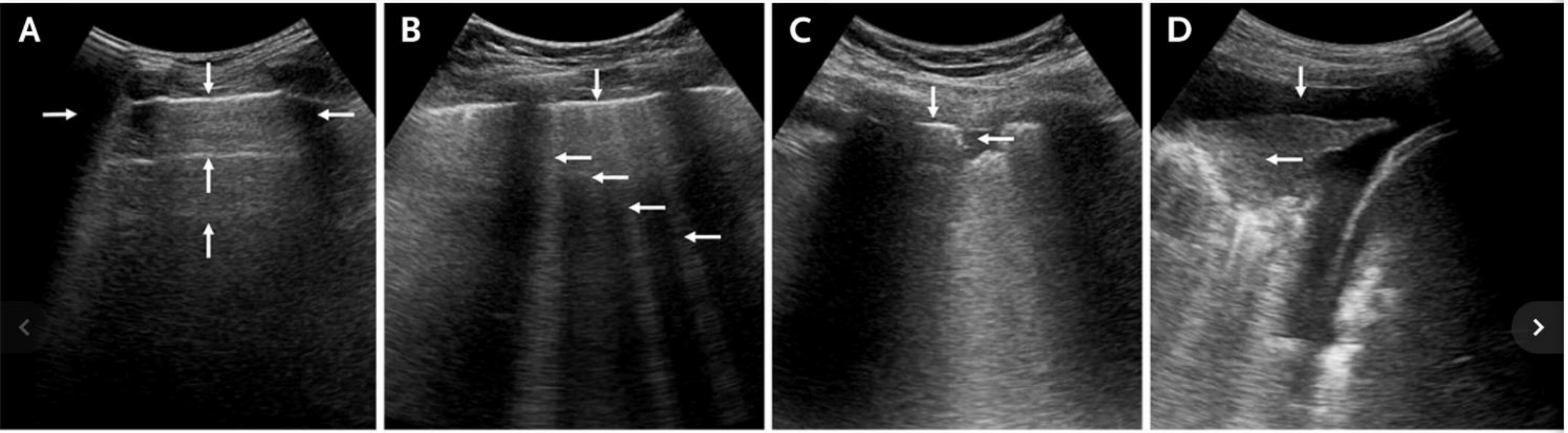

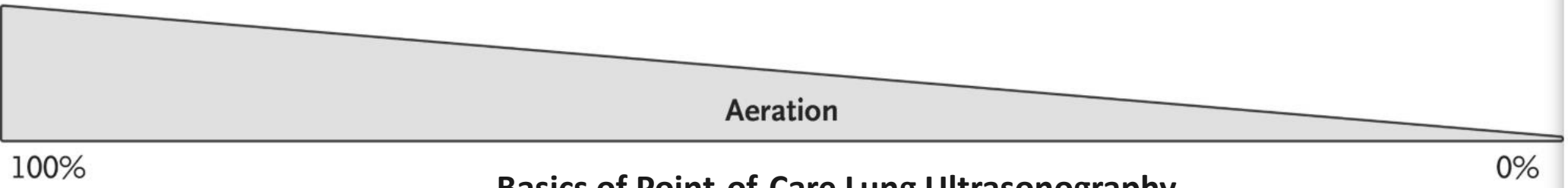

Ultrasound Images of the Lung According to the Level of Aeration.

A fully aerated lung (Panel A) has a smooth and hyperechoic pleural line (down arrow) and horizontal artifacts called A lines (up arrows). Acoustic shadowing from the ribs can be seen (left- and right-facing arrows). A lung with edema (Panel B) has multiple vertical artifacts called B lines (left-facing arrows) and a normal pleural line (down arrow). A lung with consolidations (Panel C) has hypoechoic structures, which are formed by collapsed and airless alveoli (left-facing arrow) that are surrounded by aerated alveoli; the consolidations move together with lung sliding, which is movement of the pleural line (down arrow) in accordance with respiration. A lung with complete loss of aeration (Panel D) has lobular consolidation (left-facing arrow) and pleural effusion (down arrow).

Basics of Point-of-Care Lung Ultrasonography

Natalia Buda, M.D., Ph.D., et al

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DOI: 10.1056/NEJMvcm2108203
VOL. 389 NO. 21.

Respiratory Studies

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Bronchoscopy

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76 F with metastatic small cell lung cancer

R
A

Respiratory Studies

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- Surgical lung biopsy (thoracotomy, Video Assisted Thoracic Surgery)
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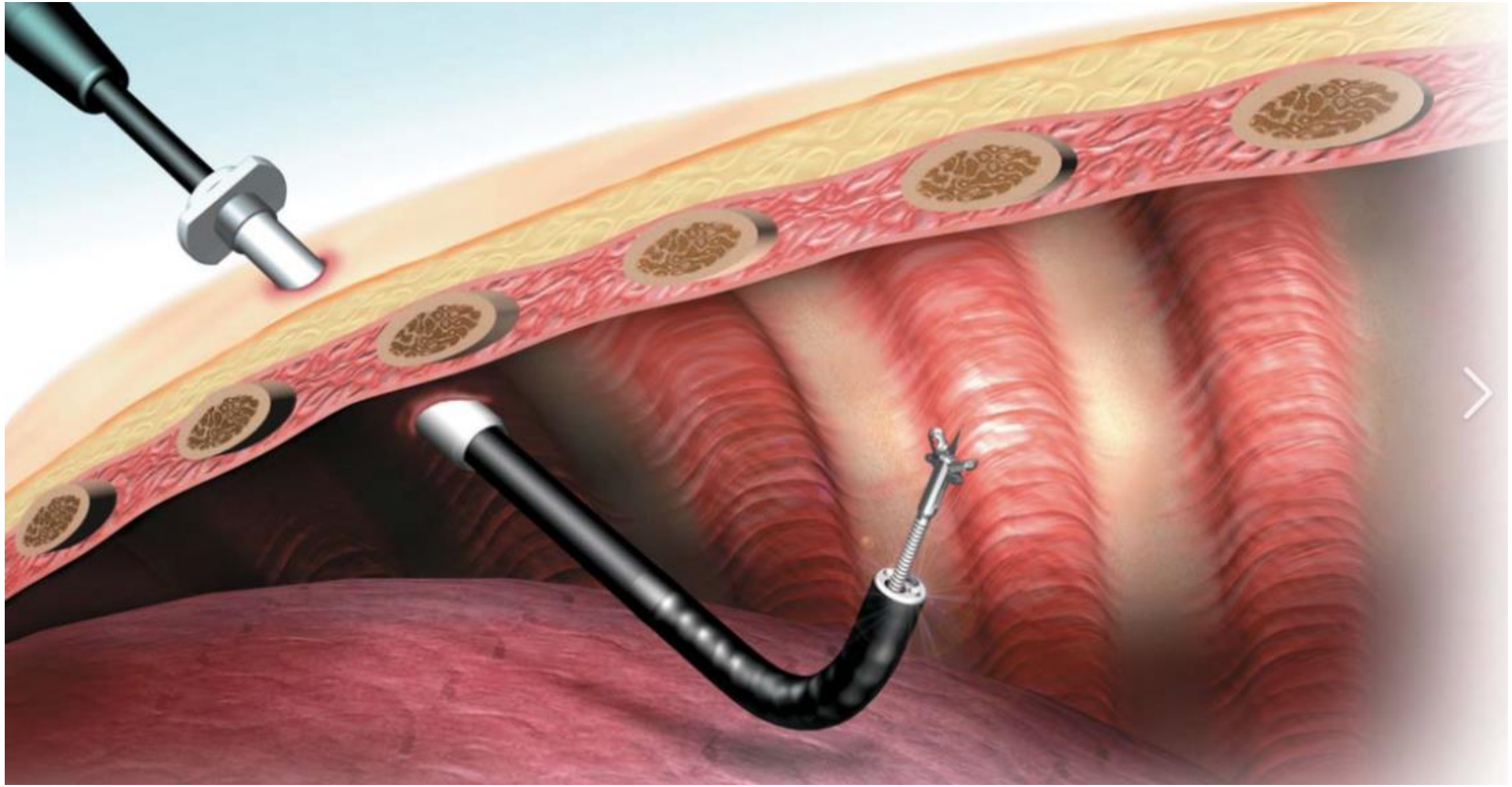
Thoracoscopy



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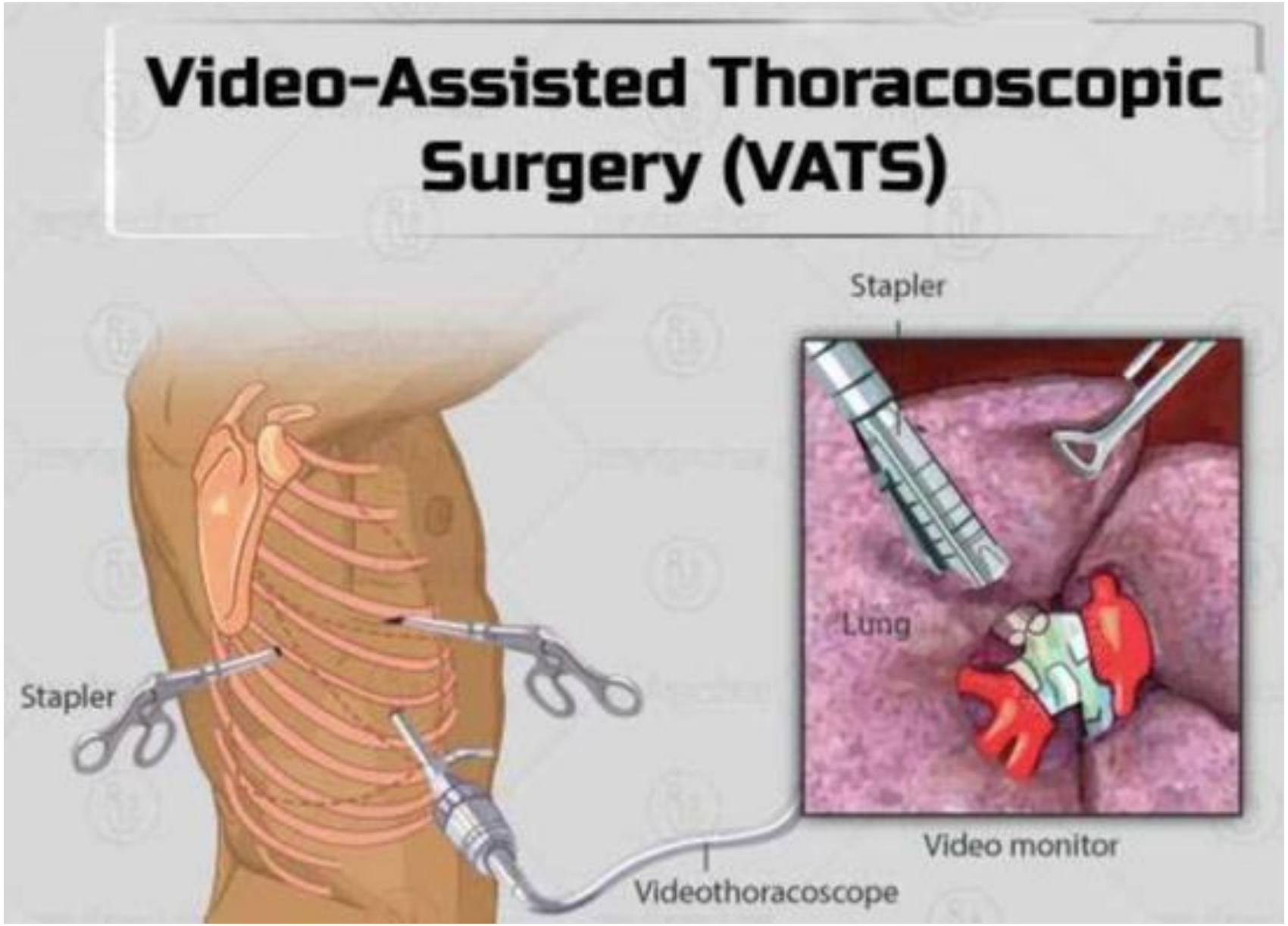
Video-Assisted Thoracoscopic Surgery (VATS)
Stapler
Lung
Stapler
Video monitor
Videothoracoscope

Thoracotomy VATS

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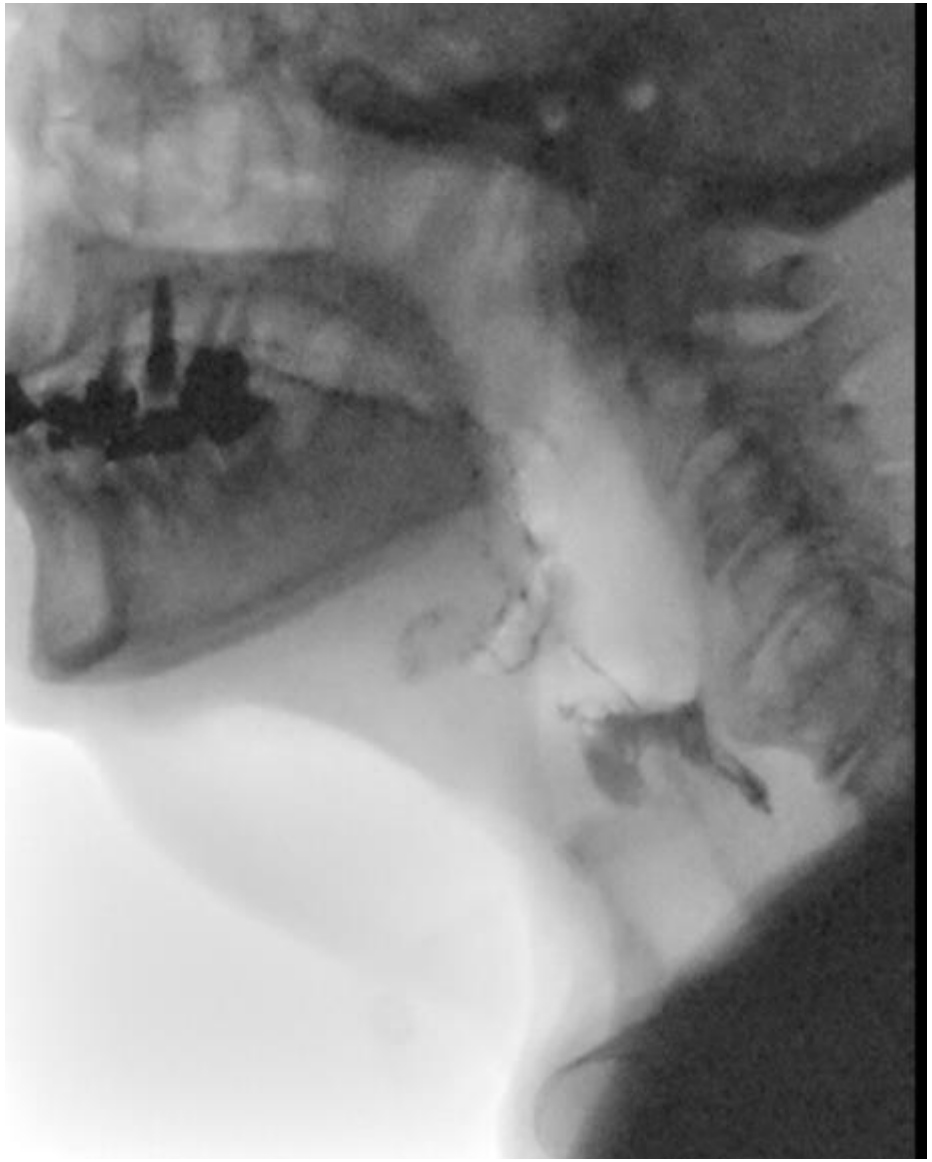
82 M with cough. He often chokes when eating or drinking.



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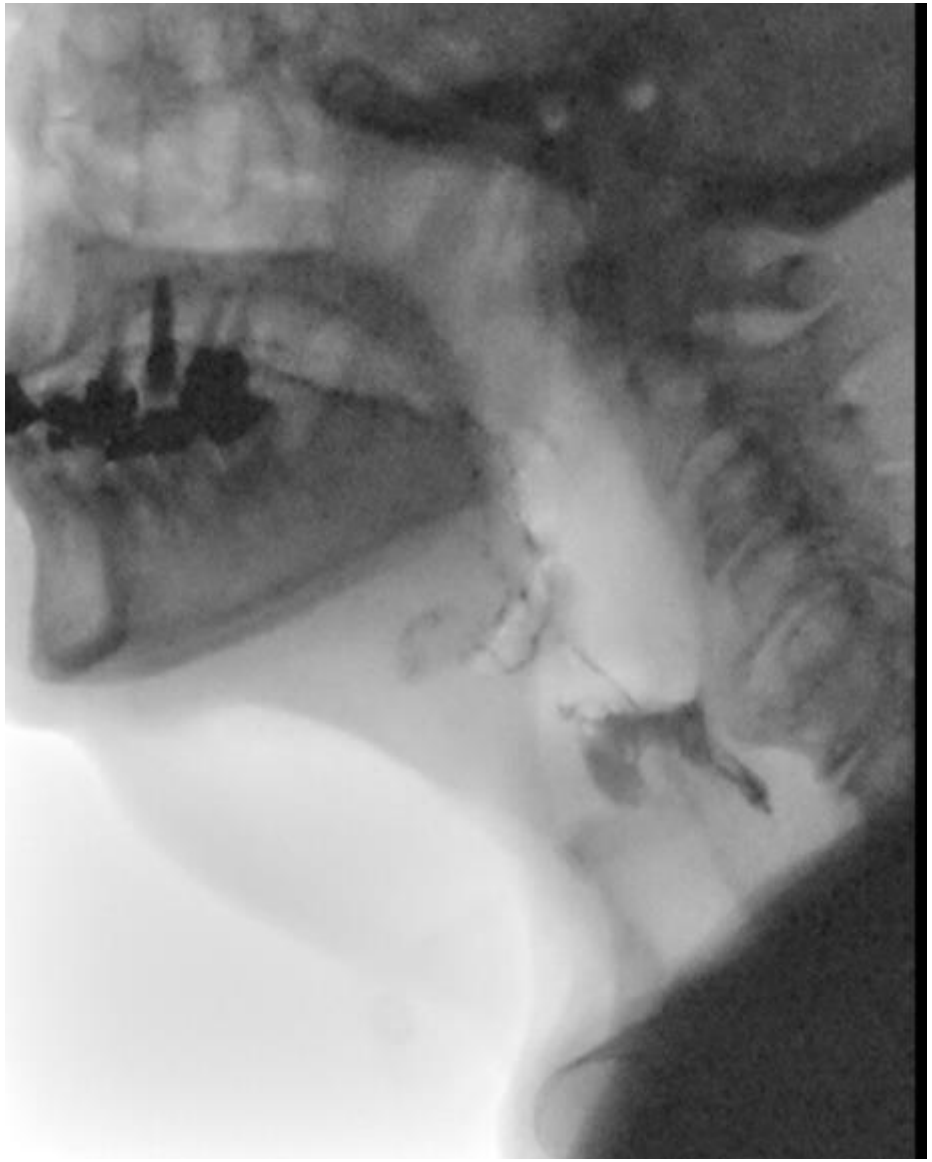

Zenker’s diverticulum (posterior) emptying into trachea (anterior)

What can go wrong with the respiratory tract?

- Exogenous
  - Inhaled (infectious agents, particulates, aspiration, thermal)
  - Trauma (rib fracture, pulmonary contusion)
  - Medications (amiodarone, nitrofurantoin, chemotherapy, targeted therapy)
- Endogenous (hematogenous, extension)
  - Infection (septic emboli)
  - Neoplasm (primary lung, metastatic)
  - Inflammation/Fibrosis (ILD)
  - Blood vessels (clot, pulmonary hypertension, vasculitis)
  - Small and large airways (asthma, bronchiolitis, sarcoid)

Treatments for respiratory problems

- Antimicrobial (oral, intravenous, inhaled)
- Inhaled (beta agonist, muscarinic, corticosteroid)
- Immune suppression
- Intravenous Immune Globulin
- Biologic
- Antifibrotic
- Chemotherapy, targeted therapy
- Vascular drugs (oral, intravenous, inhaled)
- Bronchoscopic treatments (resection, cryotherapy, valves, other)
- Percutaneous ablation of tumors (cryo, radiofrequency)
- Radiation (Stereotactic Body Radiation Therapy)
- Resection (Video Assisted Thoracic Surgery)

What's new in treatment for respiratory problems?

- COPD (ensifentrine by nebulizer – phosphodiesterase inhibitor, biologics)
- Asthma (biologics)
- Bronchiectasis (brensocatib by tablet – DPP1 inhibitor – dipeptidyl peptidase)
- Interstitial lung disease (immunosuppression, oral antifibrotics)
- Pulmonary hypertension (many drugs)
- Lung cancer (new agents)
- Interventional pulmonary (EBUS, navigational bronchoscopy, other)
- Interventional radiology (ablation)

MOC REFLECTIVE STATEMENT

- The lungs are in direct contact with the outside world.
- Lung problems may be caused by exogenous or endogenous factors.
- This is an exciting time in pulmonary medicine, as there is deeper understanding of pulmonary disease and a growing array of treatments.

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- Brensocatib in Bronchiectasis - A New Sheriff in Town? Bell, SC, N Engl J Med 2025 Apr 24;392(16):1647-1648. doi: 10.1056/NEJMe2502618


Forests are the lungs of our land, purifying the air and giving fresh strength to our people.
— Franklin D. Roosevelt