# COVID-19 Chest Imaging for Medical Students & Residents

Monday April 6th @3pm EST
Tues April 7th @6pm EST

Live Polling at:
www.pollev.com/smartland010

- Columbia P&S Class of 2009
- UCSF Radiology Residency
- UCSF Neuroradiology Fellowship

- Current:
  - Vision Radiology--Emergency Radiologist
  - Elite Medical Prep LLC--Founder and President

**Marcel Brus-Ramer, MD/PhD**

Board Certified Radiologist

Co-founder and President of Elite Medical Prep

# Goals

- Familiarize oneself with COVID-19 appearance on imaging
- Review some basic chest imaging anatomy & descriptors
- Familiarize oneself with other likely causes of dyspnea and/or fever
- Consider imaging options
- SIMPLE TAKEAWAYS

# COVID

- Sx's: fever, non-productive cough, malaise
- Imaging appearance:
  - Initially: ground glass opacities (ggo's), peripheral, bilateral, multiple lobes.
  - Progression: crescentic consolidation, diffuse patchy involvement, ggo's +
  - Very rarely: effusions,airway thickening,  septal thickening
- Imaging choice:
  - X-ray: insensitive but available--good for monitoring progression
  - CT: very very sensitive for dz.
    - Non-con CT
    - CTA & w/IV con also good


# NON-COVID

- Influenza: similar sx's but different appearance
  - Attacks airways→ small solid nodules in clusters
- Bacterial Pneumonia: segmental or lobar
  - Focal consolidations in a segmental or lobar pattern
- Pulm Edema: pleural effusions, interlobular septal thickening, dependent, cardiomegaly
- PE's: filling defects, look for RV heart strain

# COVID Imaging Timeline

**0-2 days**: Acute Phase. ~50% have normal chest CT. ~¼ to ⅓ unilateral ground glass opacities.

**3-5 day (**from sx's): Intermediate Phase.

**6-12 days:** Late Phase. progression of ground glass → increasing consolidation more common. Possible mild fibrosis w/ irregular visceral pleura and reticulation.

~50% have some GI symptoms: *Loss of appetite and diarrhea are the 2 most common*. Another hallmark SOB while doing routine activities.

# COVID Imaging Timeline

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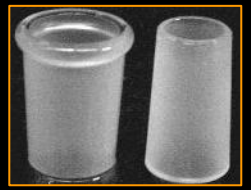

**GGO**: area of increased attenuation in lung on CT w/ preserved bronchial and vascular markings

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~50% have some GI symptoms: *Loss of appetite and diarrhea are the 2 most common*. Another hallmark SOB while doing routine activities.


# Feb 27 2020

- Up to ~50% COVID-19 patients w/ normal CT scans 0–2 days after onset of flu-like sx's
- COVID-19 RT-PCR sens may be as low as 60-70%--> COVID-19 pneumonia may have findings chest CT but initially negative RT-PCR.
- Early course of COVID-19: peripheral ground-glass opacities & bilateral (~50%–75%).
- Disease progression: 'crazy paving' & consolidation become dominant CT findings, peak at 9–13 days. Then, slow clearing at ~1 month and beyond.

Radiology

**Essentials for Radiologists on COVID-19: An Update—*Radiology* Scientific Expert Panel**

Jeffrey P. Kanne, Brent P. Little, Jonathan H. Chung, Brett M. Elicker, Loren H. Ketai

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- Disease progression: 'crazy paving' & consolidation become dominant CT findings, peak at 9–13 days. Then, slow clearing at ~1 month and beyond.

**Crazy paving**: ggo w/ superimposed interlobular septal thickening and intralobular septal thickening. Non-specific finding


Radiology

Original Research
Thoracic Imaging

Free Access

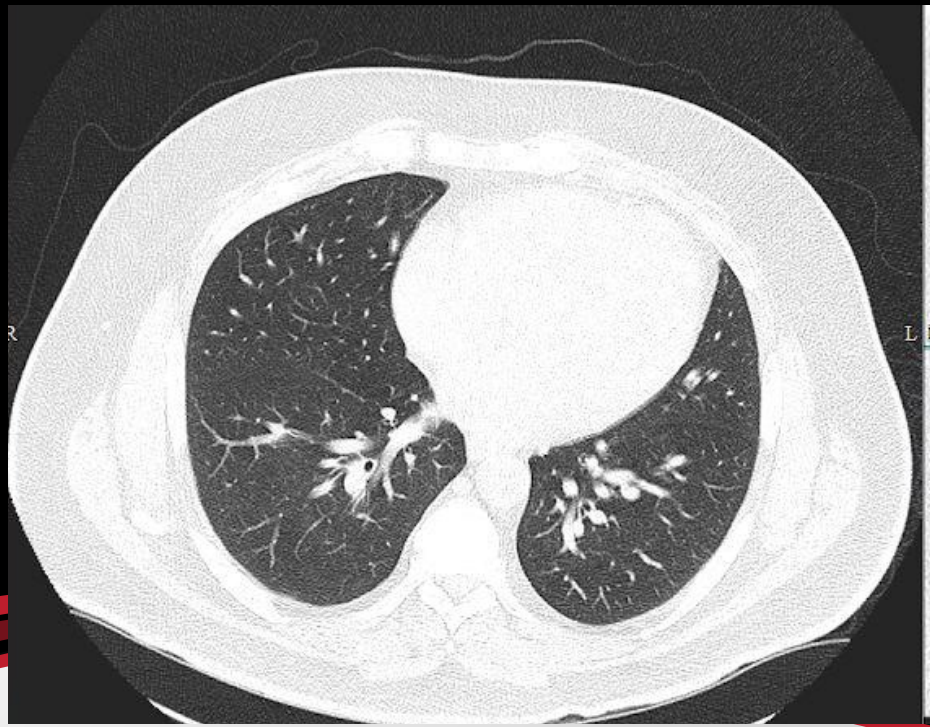
Chest CT Features of COVID-19 in Rome, Italy

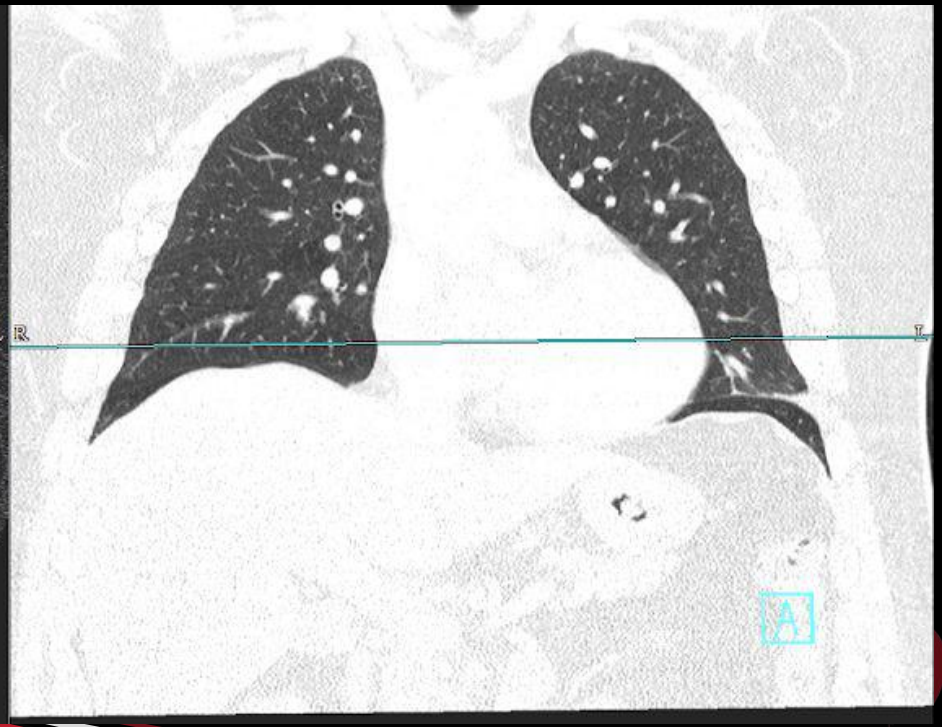
Damiano Caruso, Marta Zerunian, Michela Polici, Francesco Pucciarelli, Tiziano Polidori, Carlotta Rucci, Gisella Guido, Benedetta Bracci, Chiara de Dominicis, Prof. Andrea Laghi

# Apr 3 2020

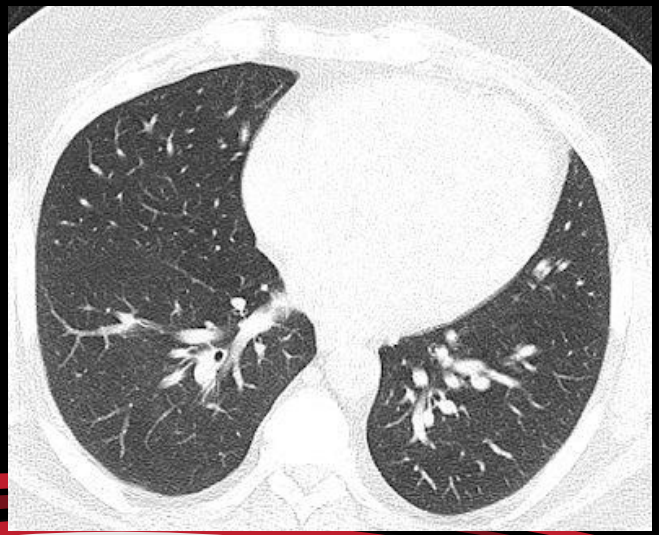
- CT for COVID-19: sensitivity=97%, specificity=56% & accuracy=72%,
  - RT-PCR as reference standard.
- Chest CT, ground-glass opacities (GGO) 100% w/ RT-PCR confirmed COVID-19.
  - 93% w/multilobe & posterior lung involvement
  - 91% bilateral pna.
- On CT, 89% w/ confirmed COVID-19 pna had subsegmental vascular enlargement (>3 mm diameter) in areas of lung opacity.
  - unclear etiology.

# Normal Chest CT



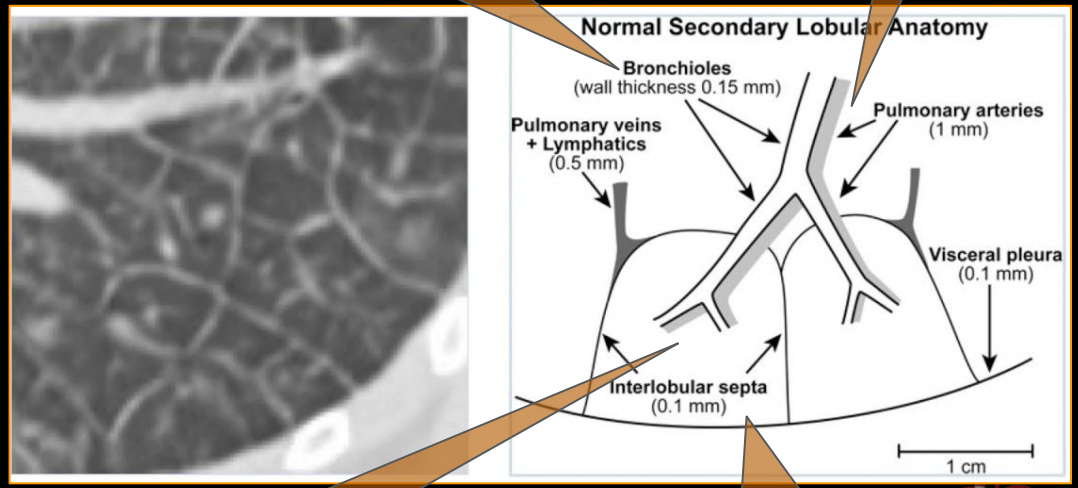


# Normal Chest CT



**Influenza**: affects bronchial epithelial cells

**PEs**: affect pulmonary arteries



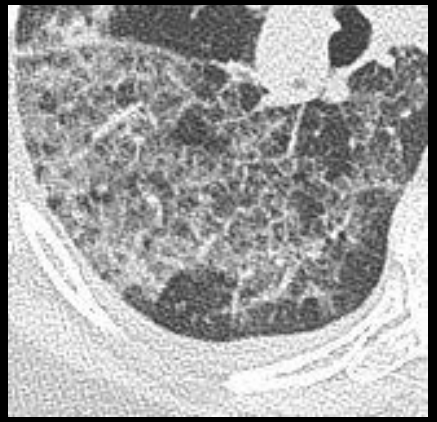

**COVID**: affects Type 2 pneumocytes in the alveoli

**Pulm Edema**: affects pulm veins in the interlobular septa

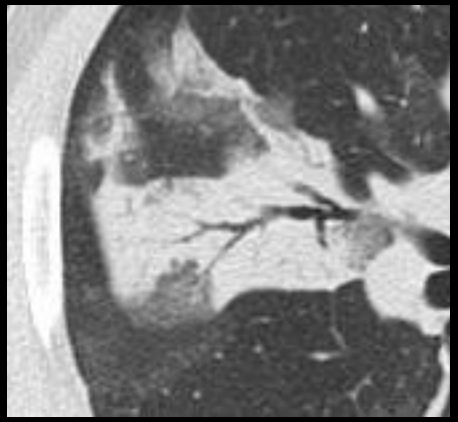
# Gallery of Pathologic Findings

Groundglass opacity

Consolidation



Crazy paving



Organizing Pneumonia

**Organizing Pneumonia**: idiopathic interstitial pneumonia characterized by lung inflammation and scarring that obstructs the small airways & alveoli

# COVID-19

Live Polling at:

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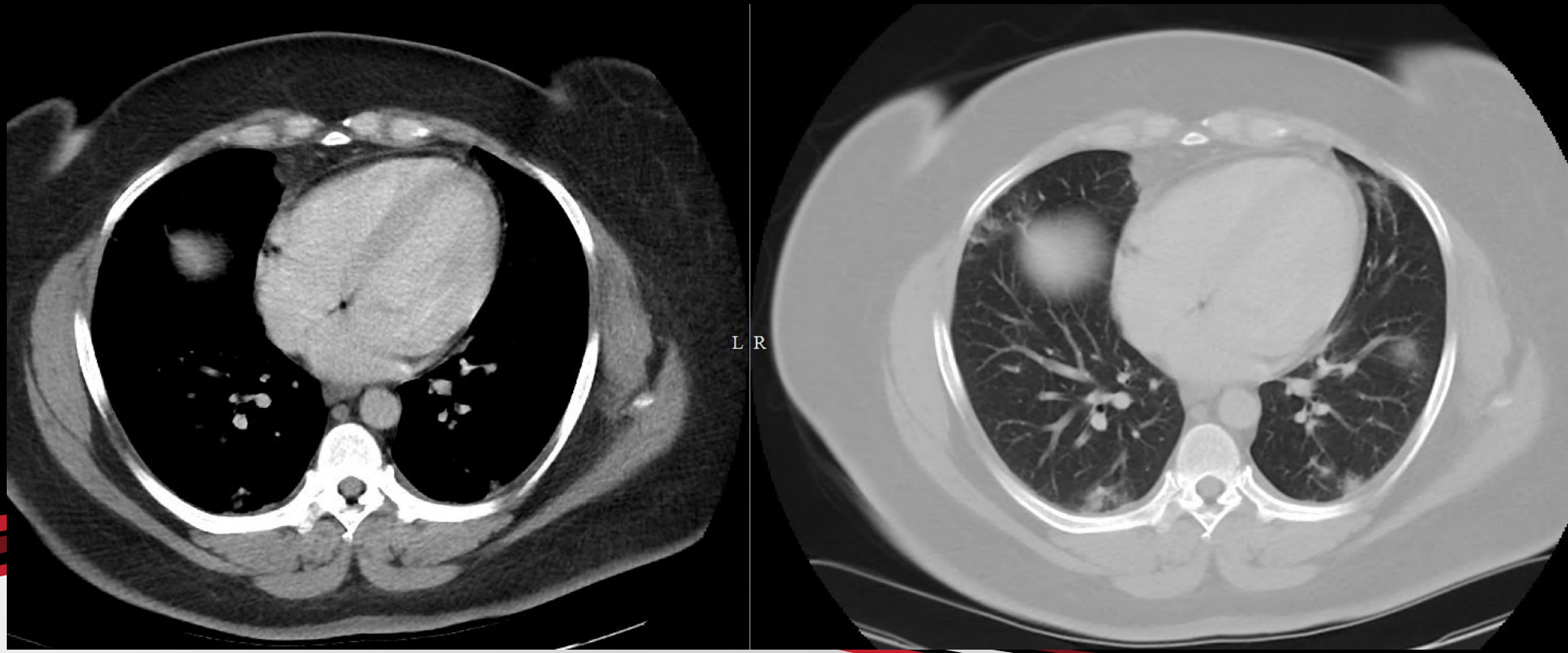
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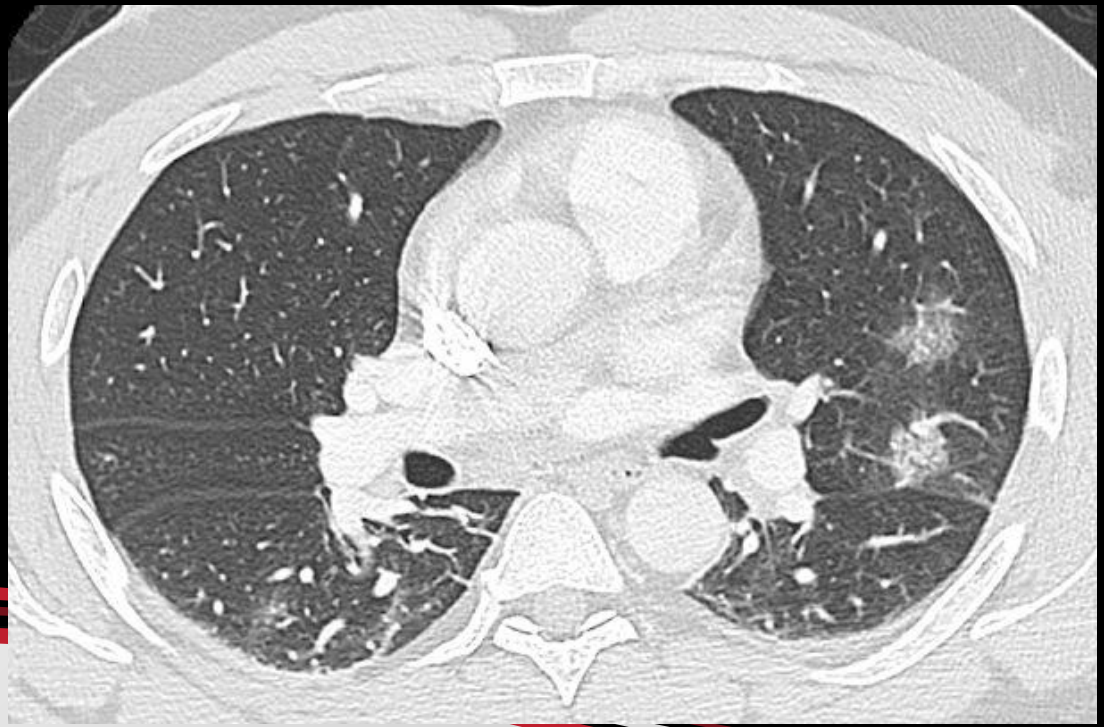
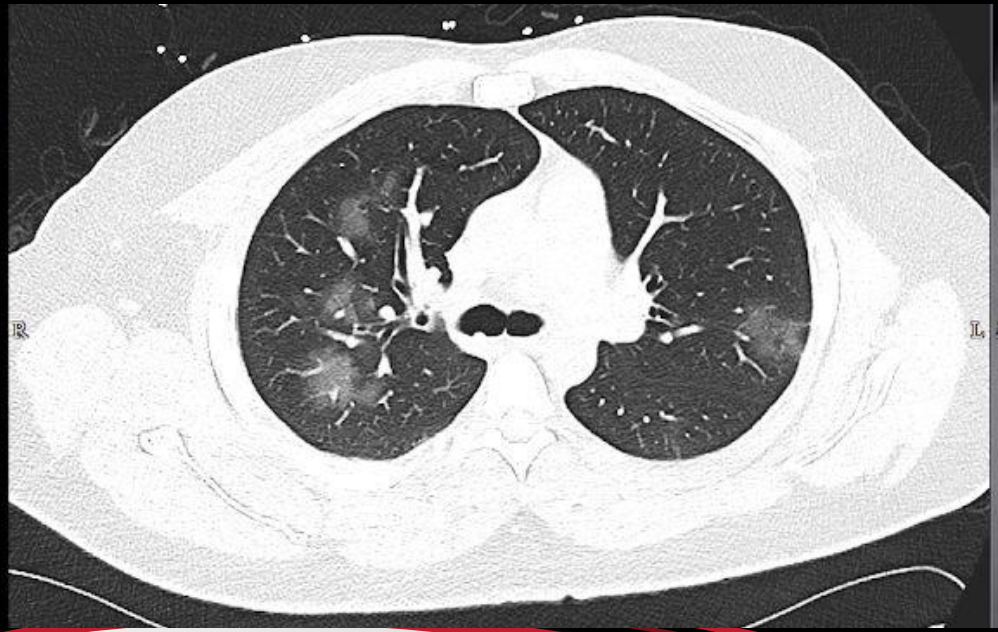
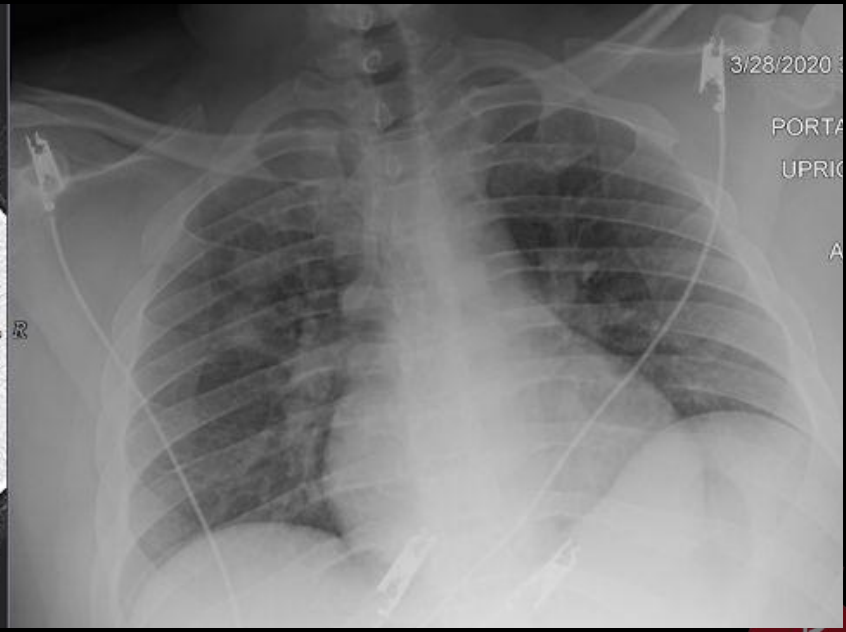
# COVID Radiology Webinar

# 47yo M, hypoxic w/ o2 sats in the 60s.  fever

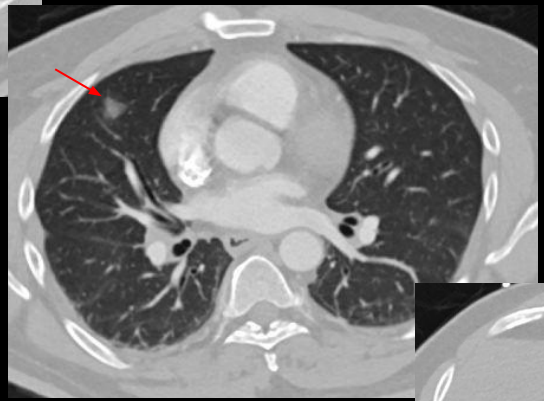


# 37yo M



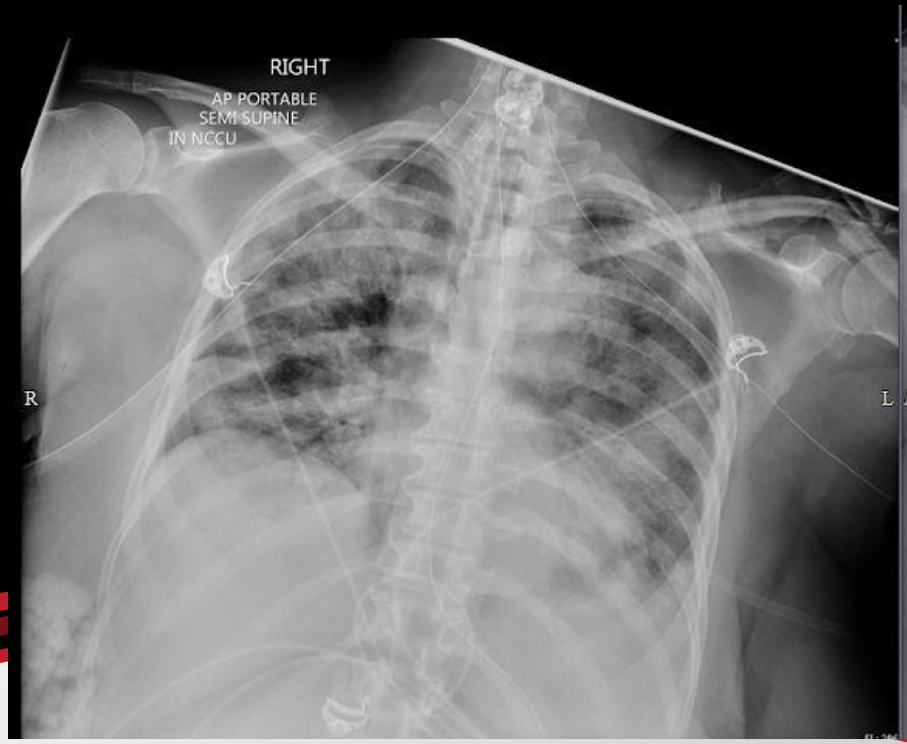



# 57yo F



# COVID Radiology Webinar

# 69yo F w/ sob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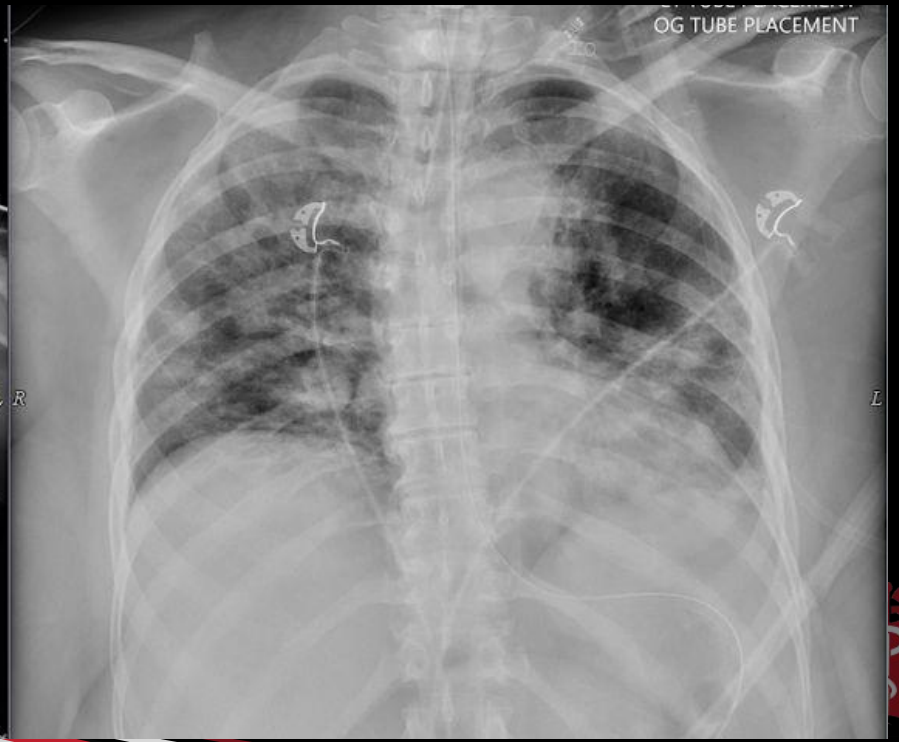
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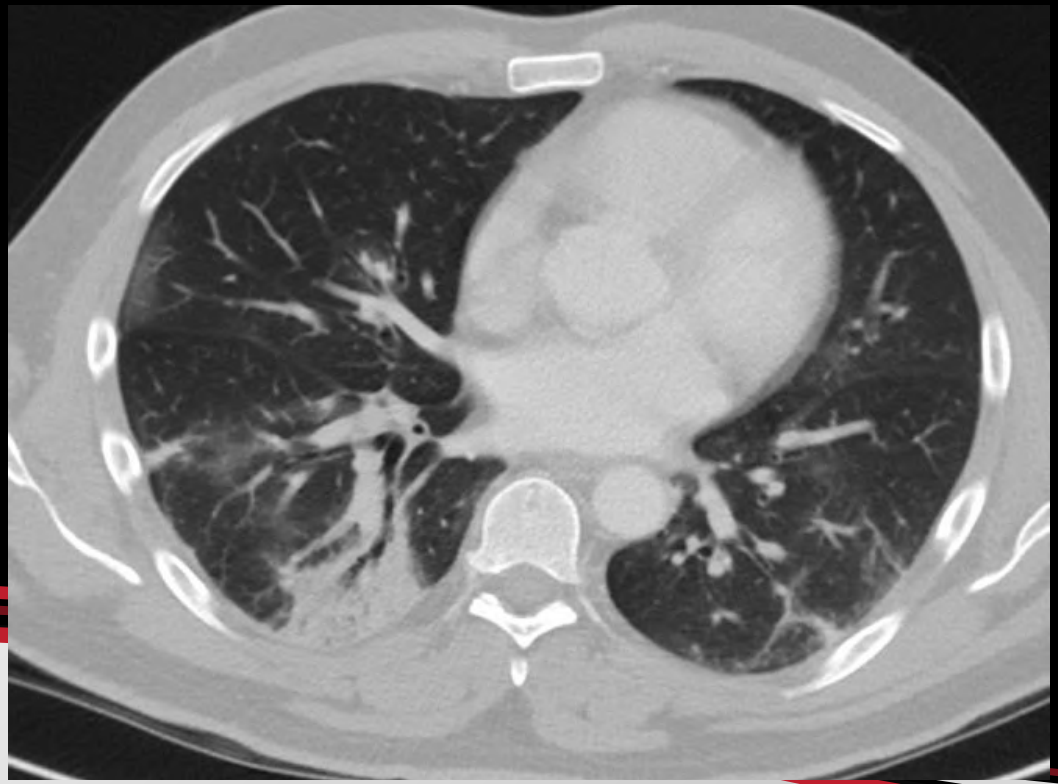
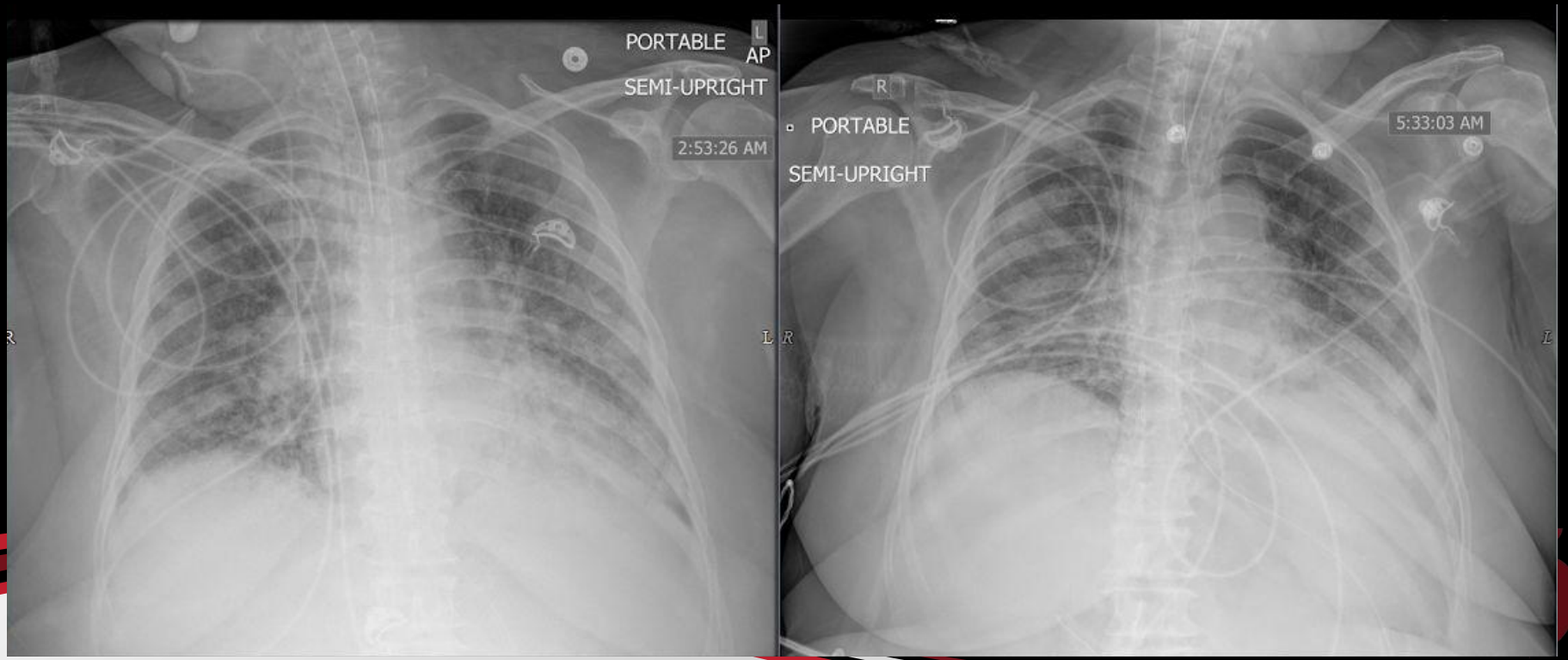
# 48 yo M



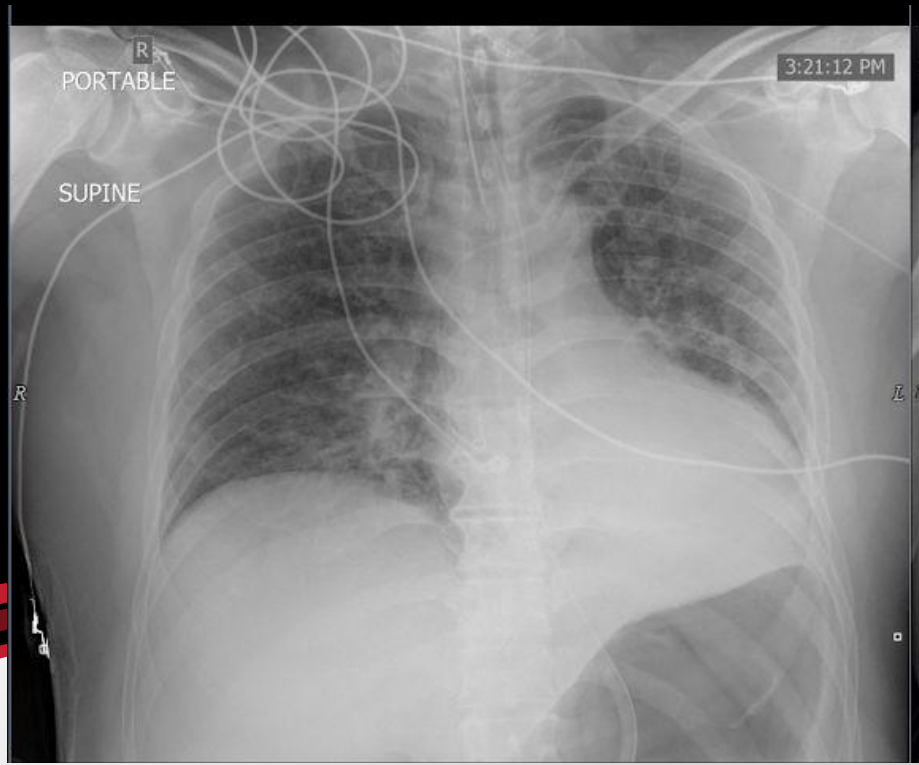
# COVID Radiology Webinar

# 81 yo NH resident. Worsening O2 sats

# CXR can be used to assess dz progression



# But… CXR appearance does NOT equal clinical status



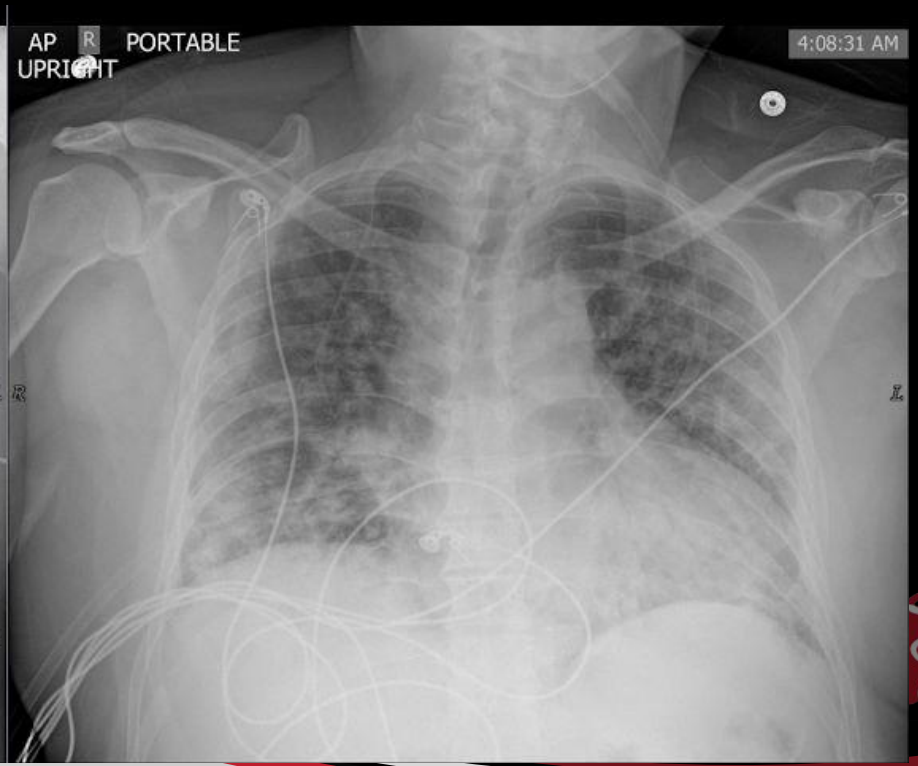



Table 3: CT feature in patients with RT-PCR confirmed COVID-19 infection

| CT Features Analysis | Patients (N=58) | % (95% CI) |
|---|---|---|
| Ground Glass Opacity (GGO) | 58 | 100% |
| Multilobe involvement (≥ 2 lobes) | 54 | 93% (86-99) |
| Bilateral distribution | 53 | 91% (83-98) |
| Posterior Involvement | 54 | 93% (86-99) |
| GGO location (peripheral) | 52 | 89% (81-97) |
| Subsegmental vessel enlargement (> 3 mm) | 52 (3.9±0.6 mm) | 89% (81-97) |
| Consolidation | 42 | 72% (60-83) |
| Subsegmental | 32 | 55% (42-67) |
| Segmental | 10 | 17% (7-26) |
| Lymphadenopathy | 34 | 58% (45-70) |
| Bronchiectasis | 24 | 41% (28-53) |
| Air Bronchogram | 21 | 36% (26-45) |
| Pulmonary nodules surrounded by GGO | 10 | 17% (7-26) |
| Interlobular Septal thickening | 8 | 13% (4-21) |
| Halo sign | 7 | 12% (3-20) |
| Pericardial Effusion | 3 | 5% (0-10) |
| Pleural effusion | 2 | 3% (0-7) |
| Bronchial wall thickening | 1 | 1% (0-3) |
| Cavitation | 0 | 0% |

CI confidence intervals

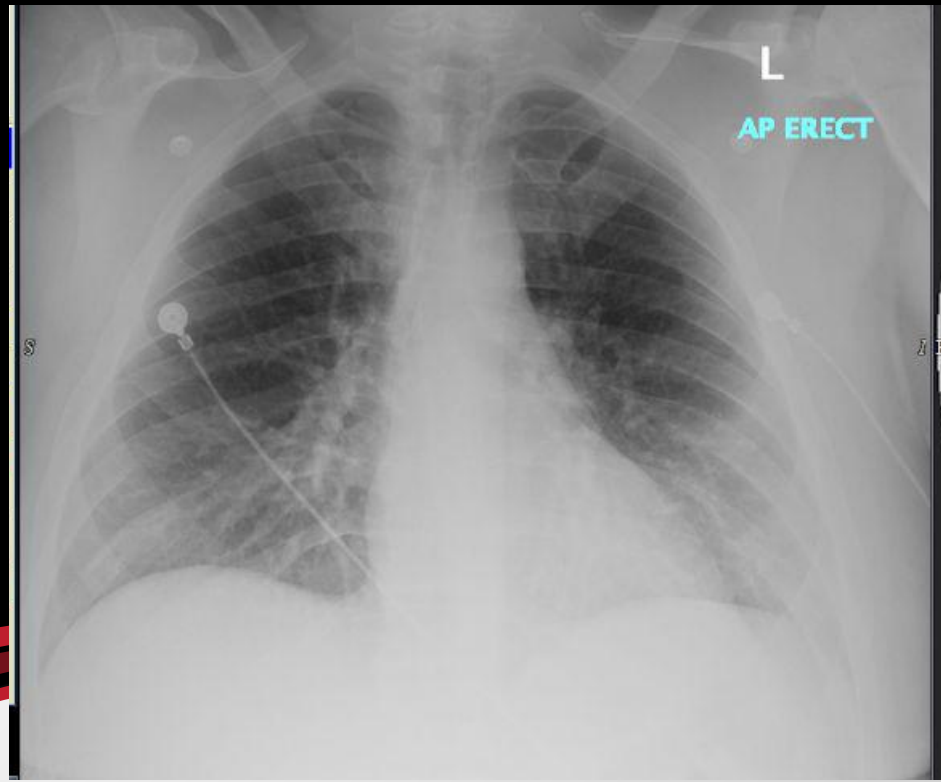
## Positive Features

- GGO
- Multiple lobes
- Bilateral
- Peripheral

## Negative Features

- Septal thickening
- Pleural effusion
- Bronchial wall thickening

# non-COVID-19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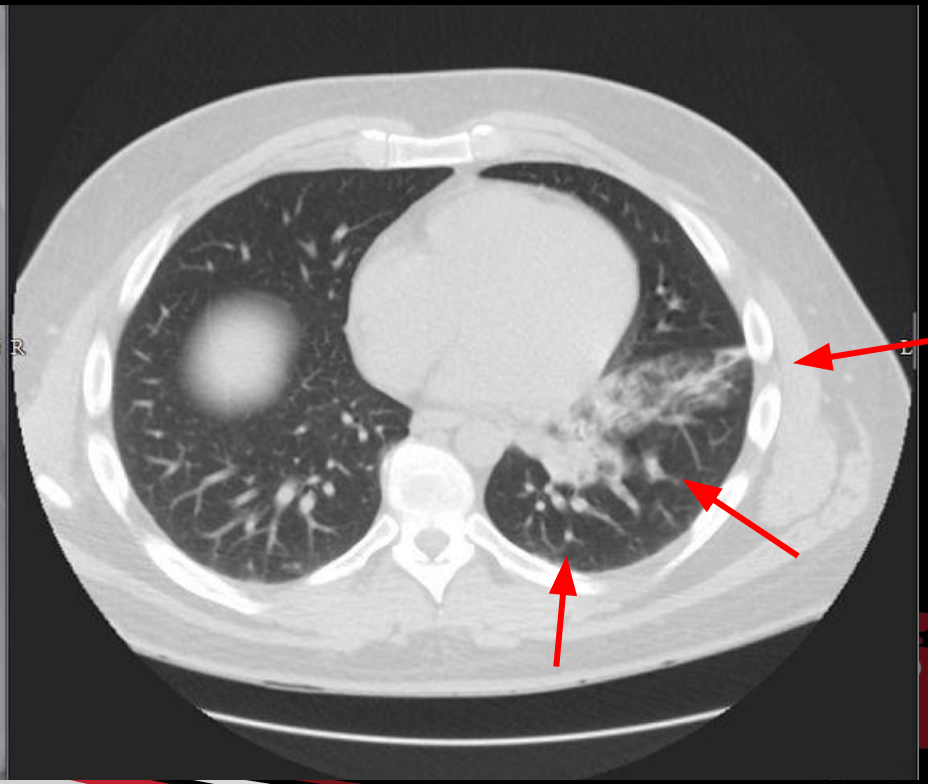
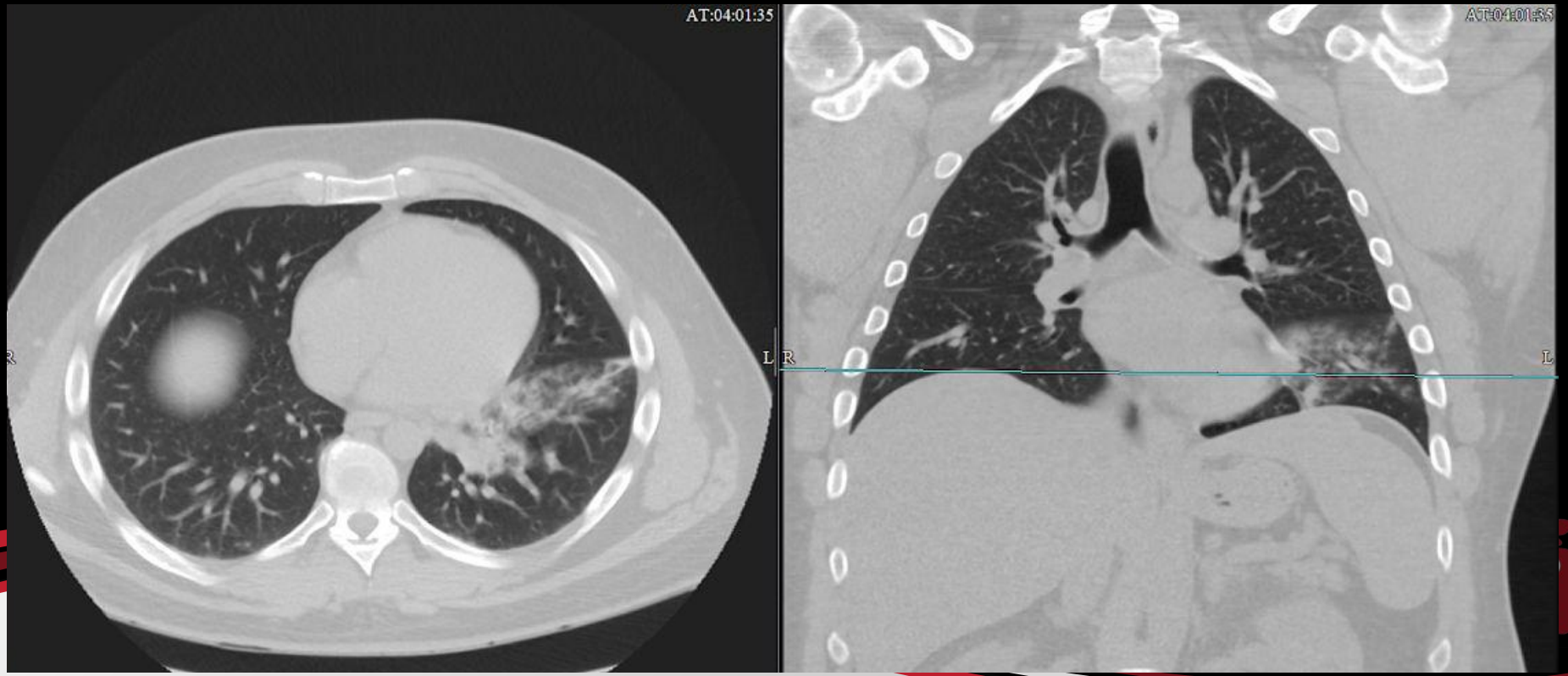
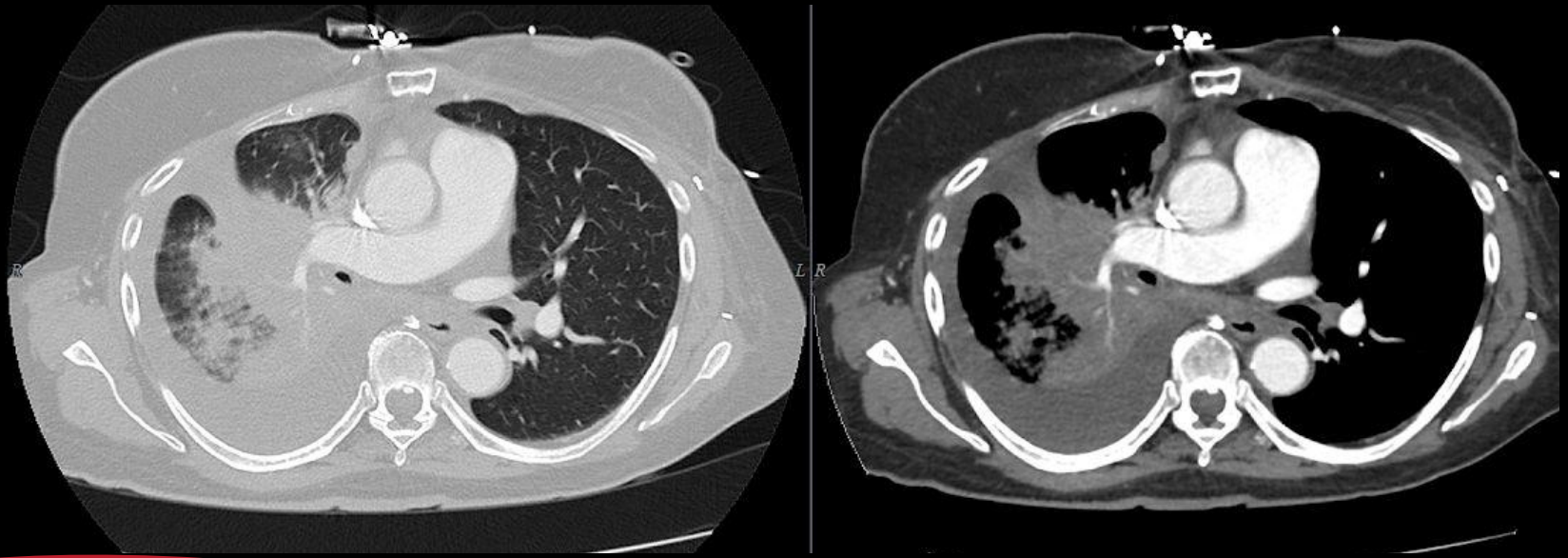


# COVID Radiology Webinar

# Lobar pneumonia

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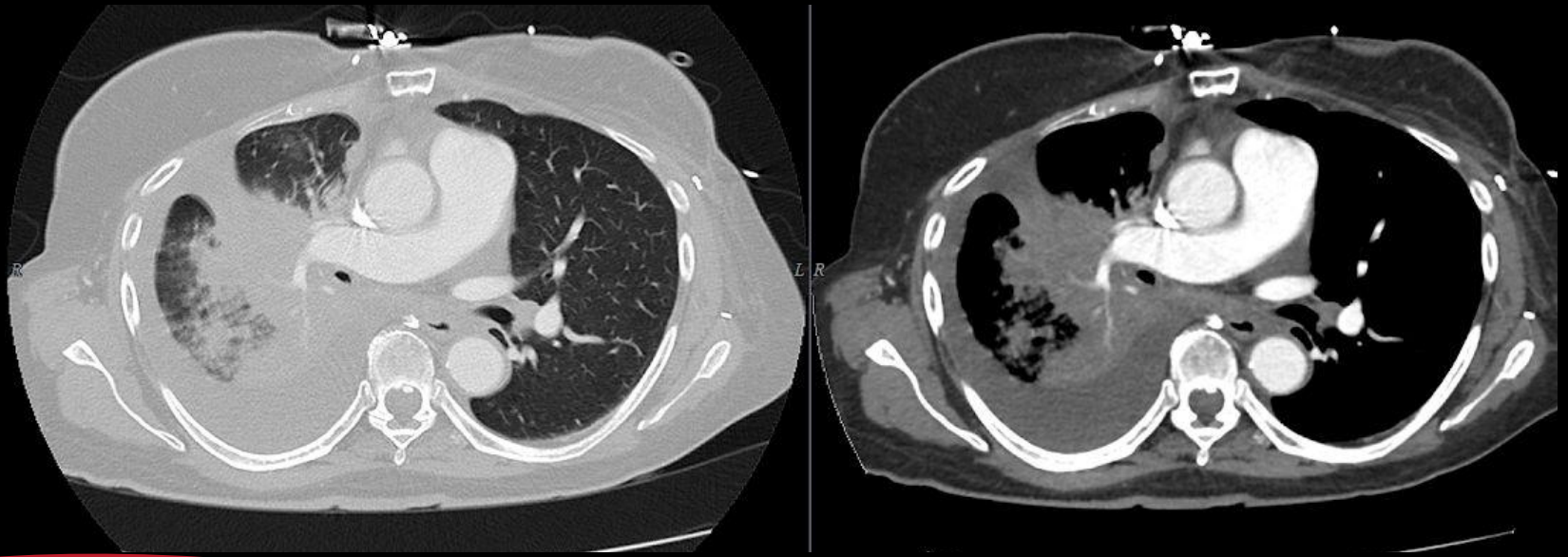
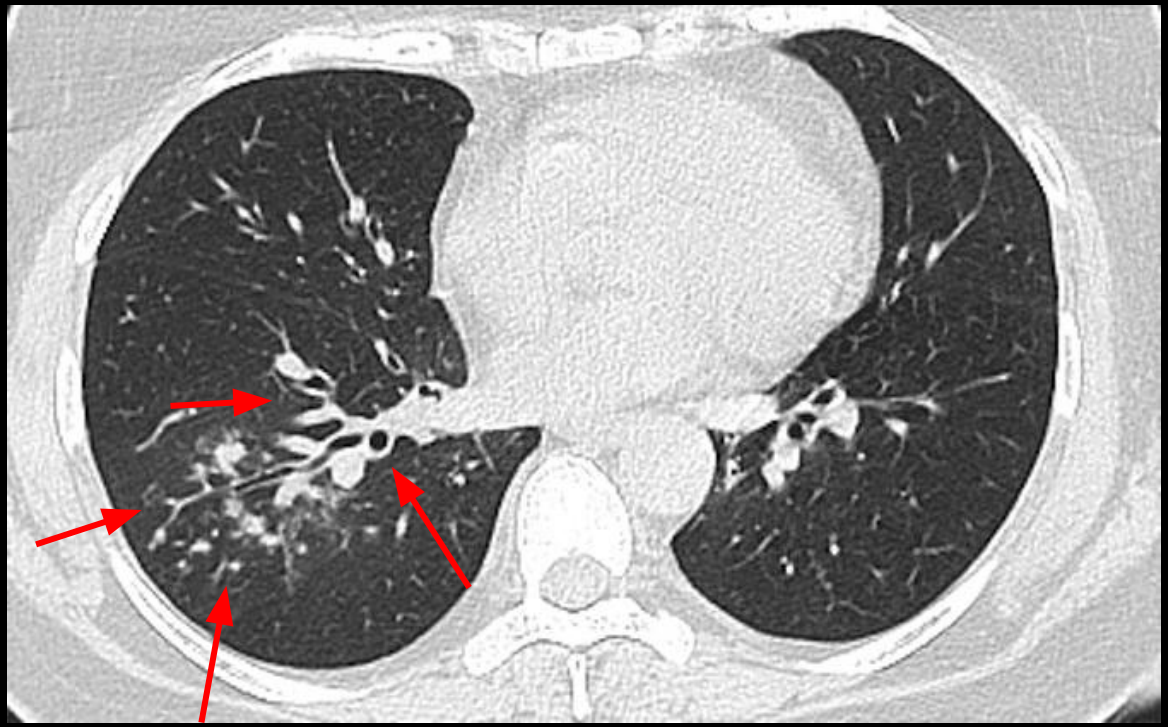
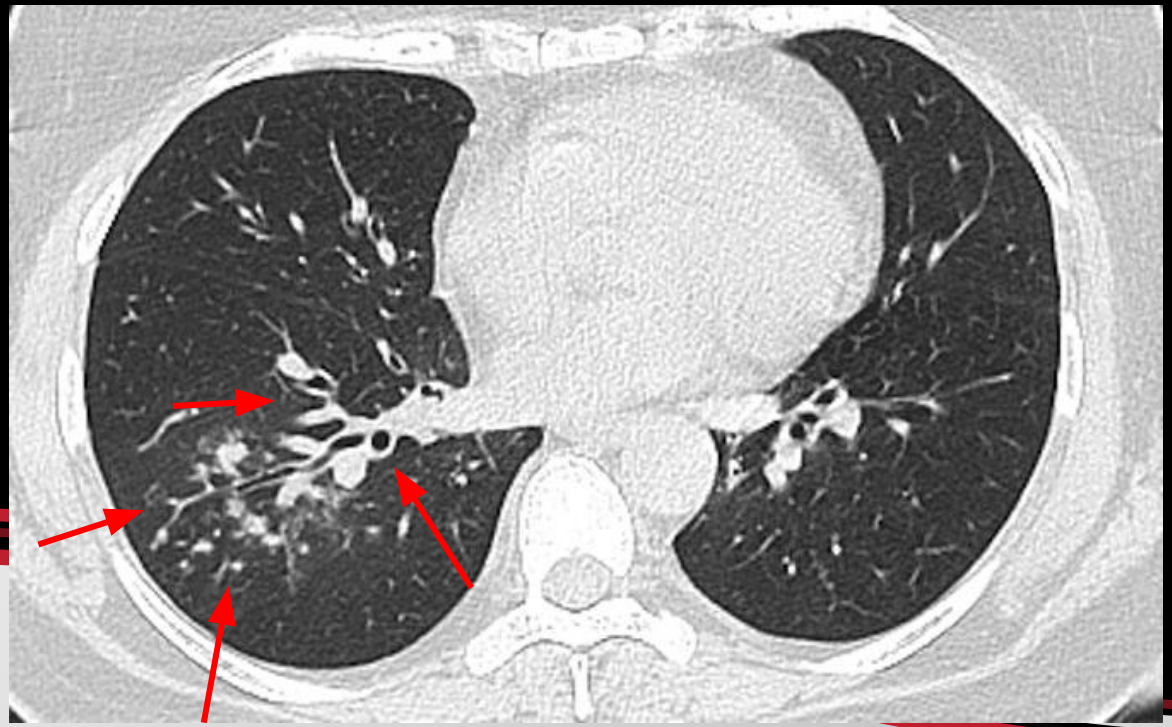
# COVID Radiology Webinar

# Multi-lobar pneumonia w/para-pneumonic effusion

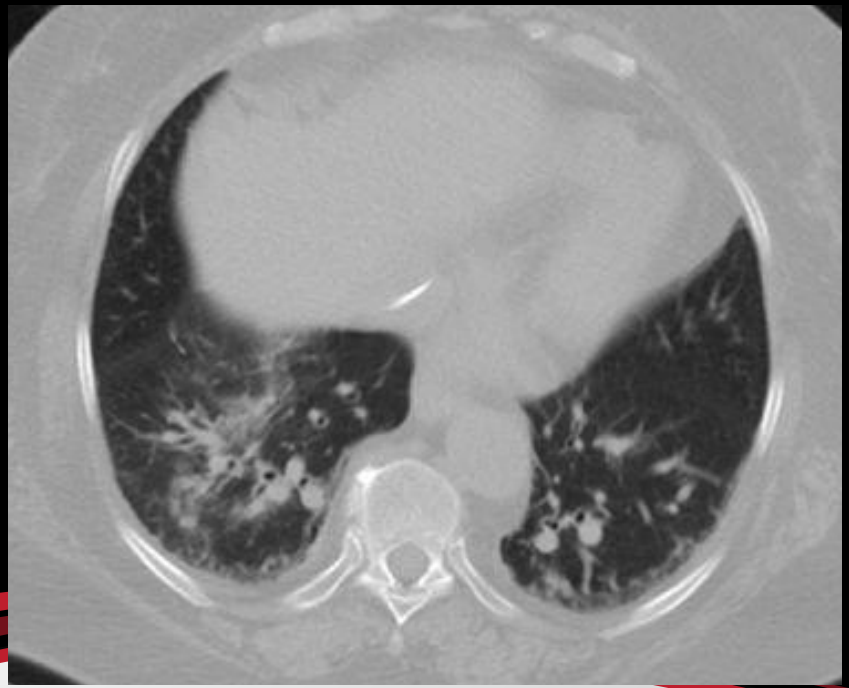




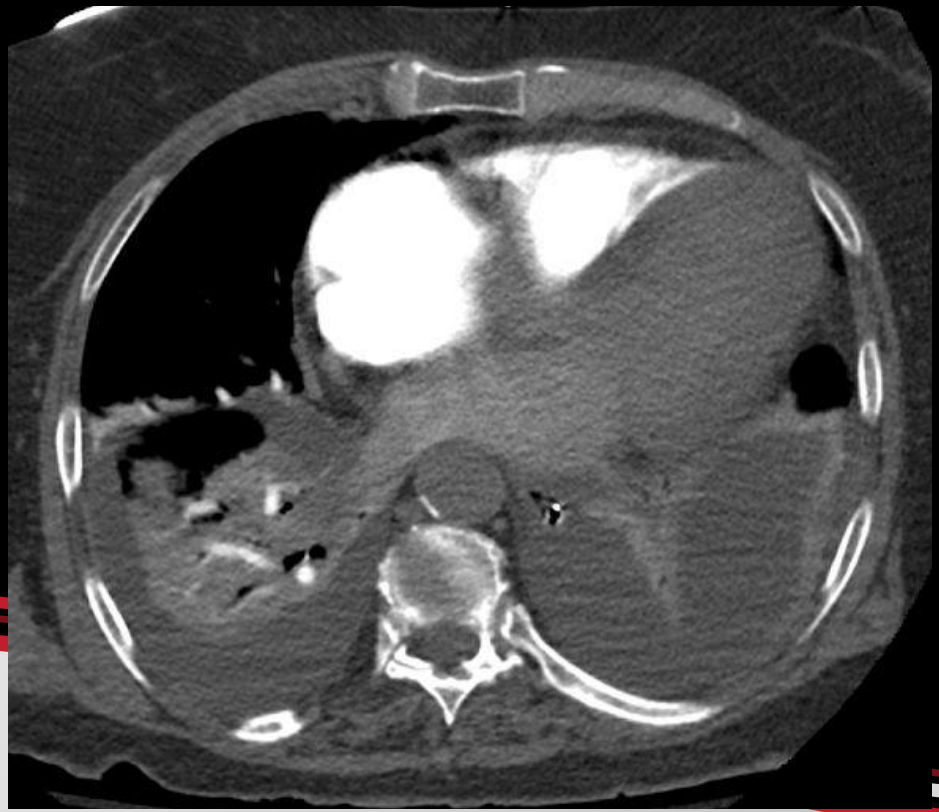
# Influenza



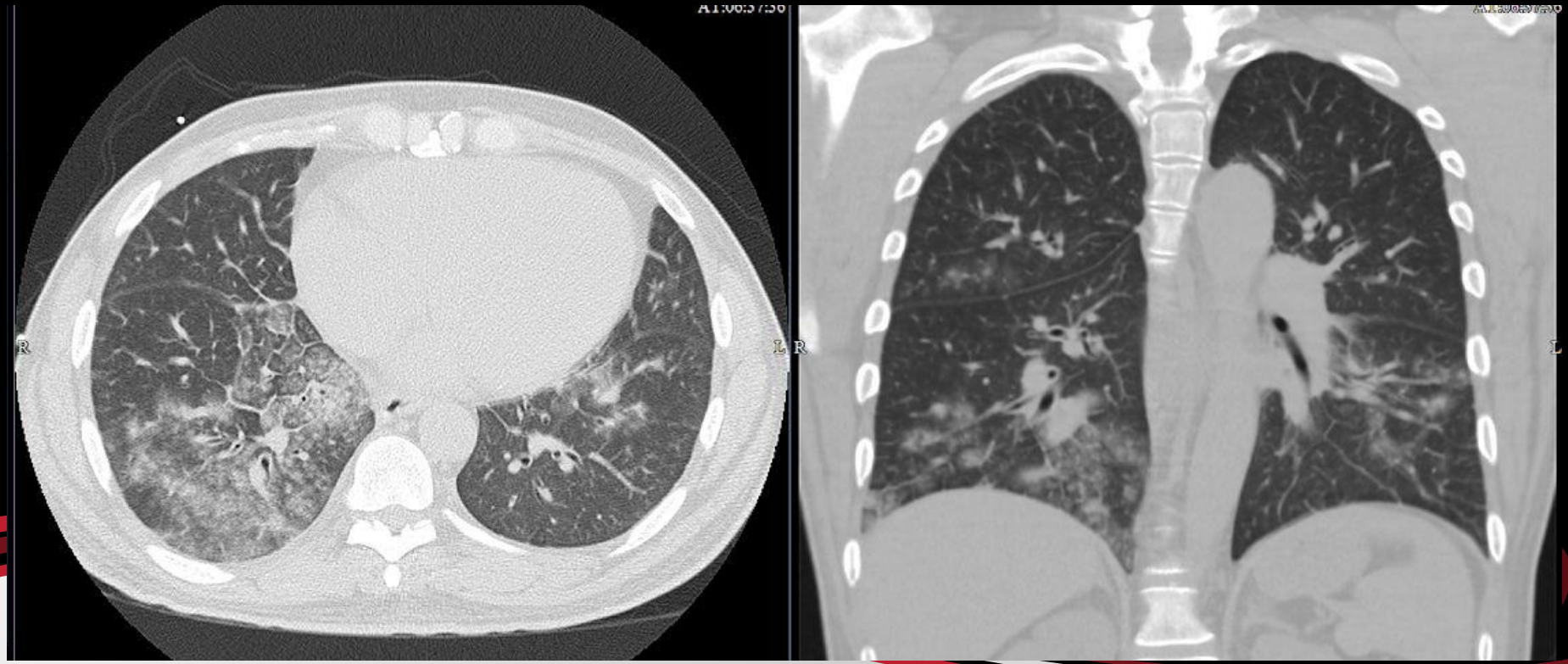
# Co-infection?
# Likely bronchopneumonia/flu. Possible COVID?

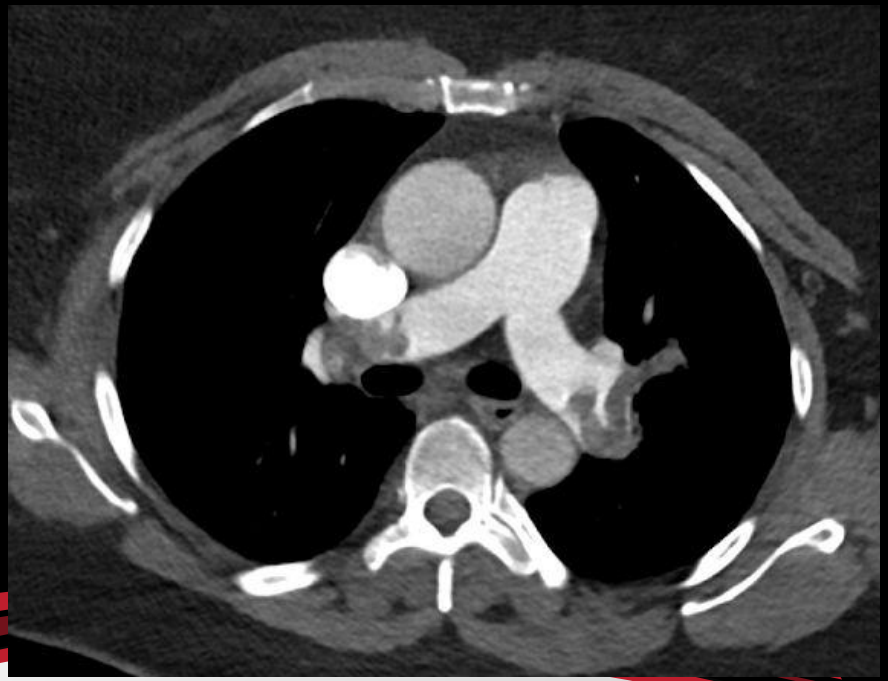


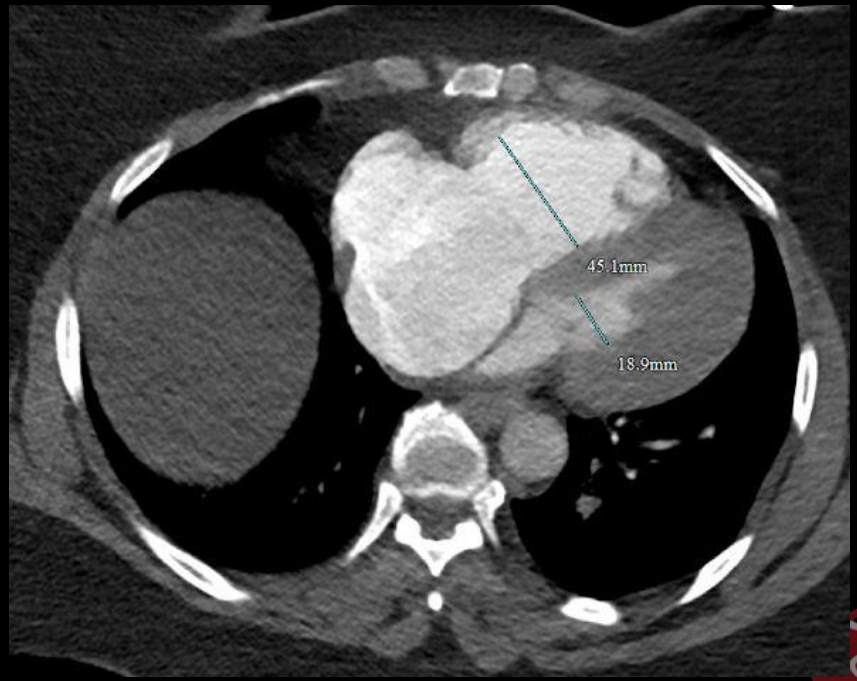
# Pulm edema



# Likely Influenza. Superimposed Edema






45.1mm
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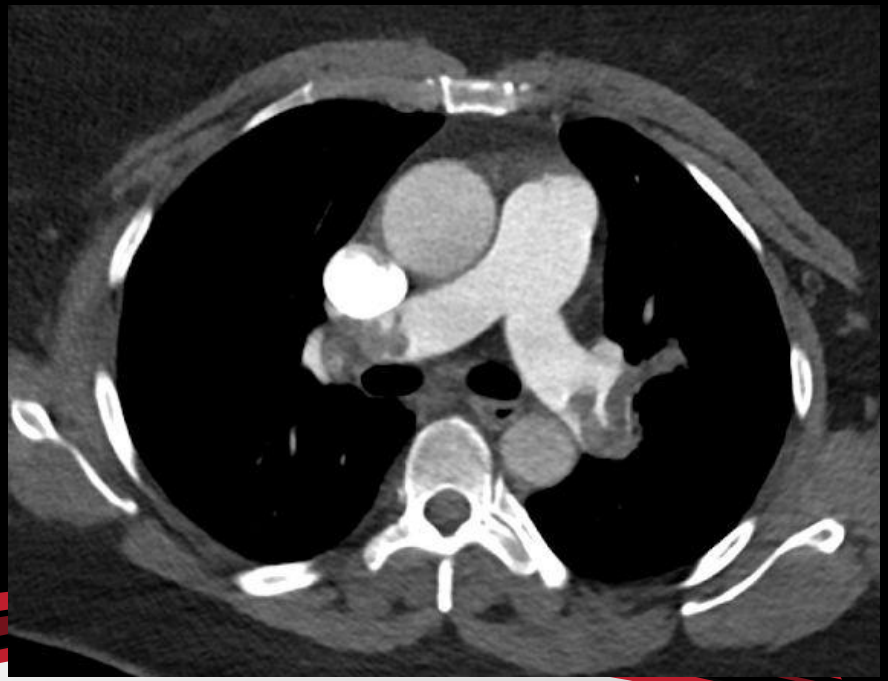
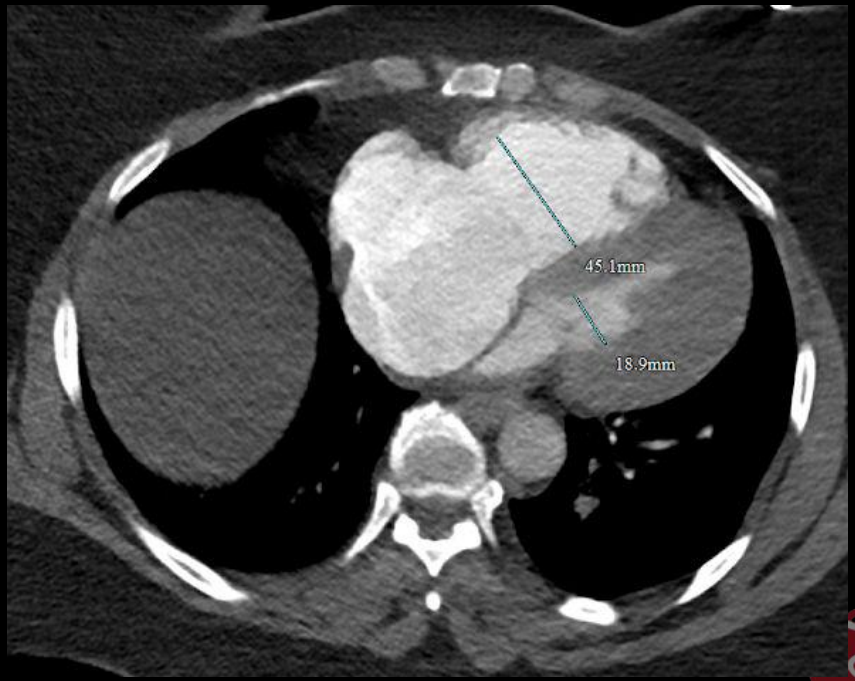
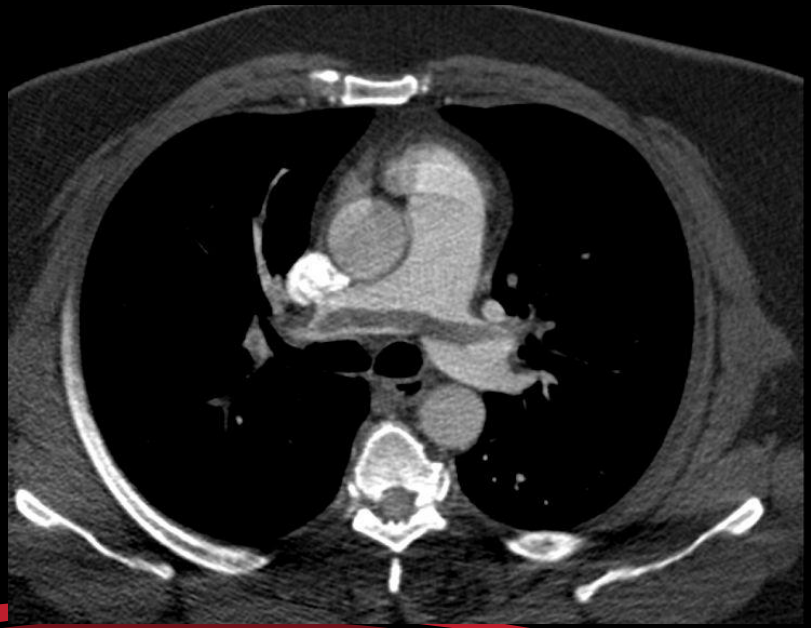
# COVID Radiology Webinar

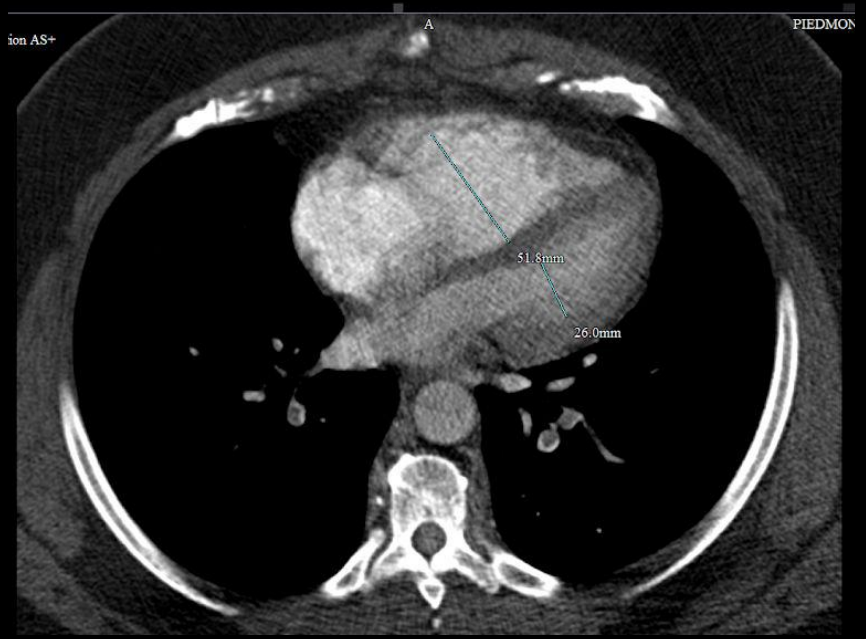
# Pulmonary Emboli





# Pulmonary Emboli






X-REVOLUTION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AT:05:40:20
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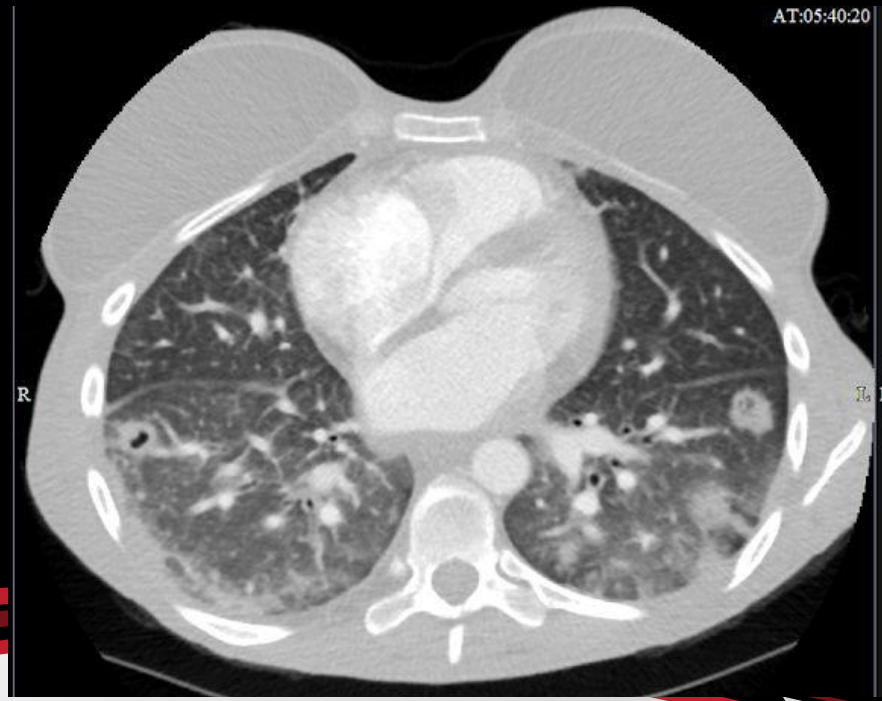
# COVID Radiology Webinar

# Septic emboli




# Motion artifact

# Amer. College of Radiology Recommendation

CT should not be used to screen for or as a first-line test to diagnose COVID-19

Use CT sparingly & reserve for hospitalized, symptomatic patients w/ specific clinical indications. Follow infection control procedures

Consider portable radiography, esp ambulatory care. CXR machines can be easily cleaned, removes need to bring pts into radiography rooms.

**Updated 3/22/20: Some using chest CT to inform decisions on COVID-19 testing, admission, and other tx.  ACR strongly urges caution**

# COVID

- Sx's: fever, non-productive cough, malaise
- Imaging appearance:
  - Initially: ground glass opacities (ggo's), peripheral, bilateral, multiple lobes.
  - Progression: crescentic consolidation, diffuse patchy involvement, ggo's +
  - Very rarely: effusions,airway thickening, septal thickening
- Imaging choice:
  - X-ray: insensitive but available--good for monitoring progression
  - CT: very very sensitive for dz.
    - Non-con CT
    - CTA & w/IV con also good


# NON-COVID

- Influenza: similar sx's but different appearance
  - Attacks airways→ small solid nodules in clusters
- Bacterial Pneumonia: segmental or lobar
  - Focal consolidations in a segmental or lobar pattern
- Pulm Edema: pleural effusions, interlobular septal thickening, dependent, cardiomegaly
- PE's: filling defects, look for RV heart strain

**Questions/Comments**:
marcel@elitemedicalprep.com

**Copy of slides & recording**:
**https://elitemedicalprep.com/covid-19-imaging-for-medical-students-residents/**