



# Thoracic Imaging in COVID-19 Infection

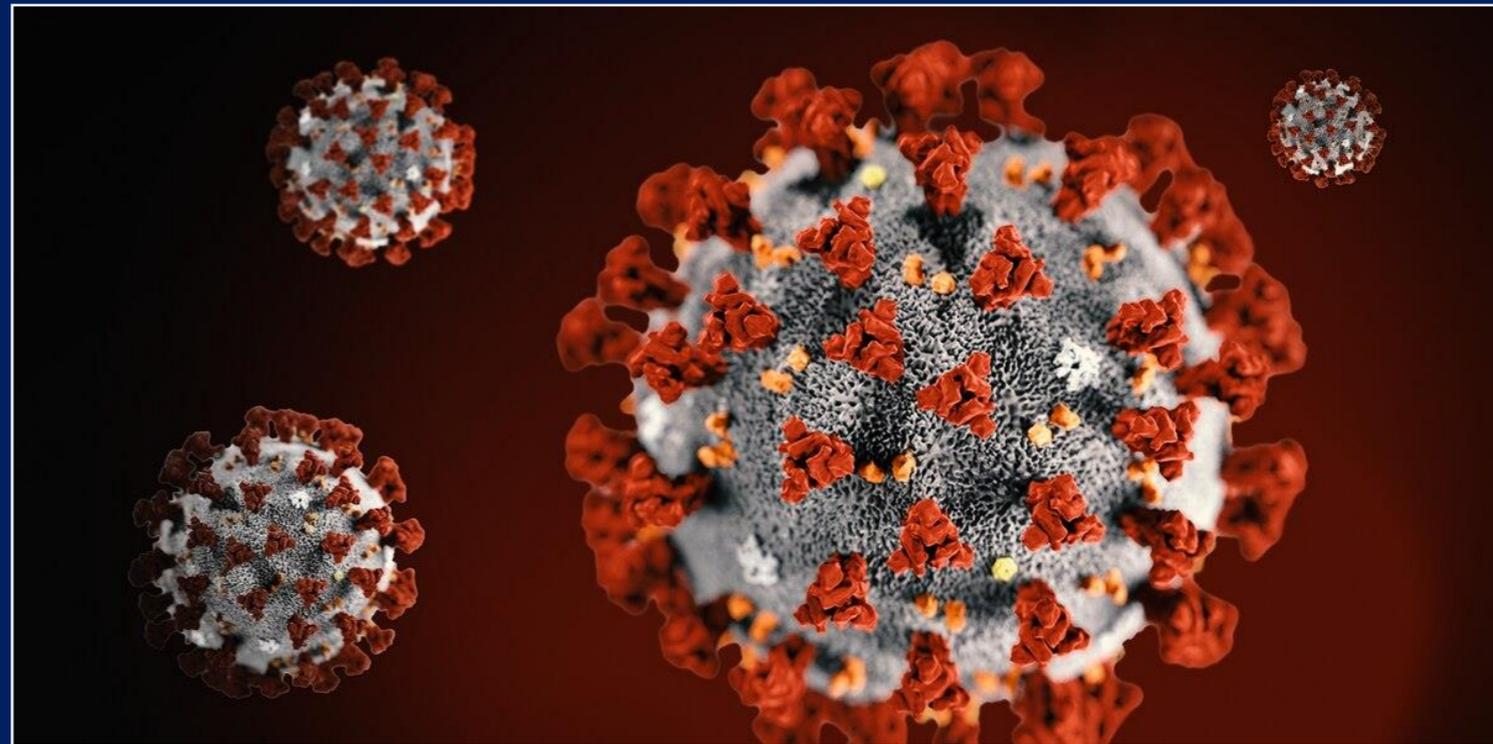
Guidance for the Reporting Radiologist  
British Society of Thoracic Imaging

Version 2  
16<sup>th</sup> March 2020

# Background COVID-19



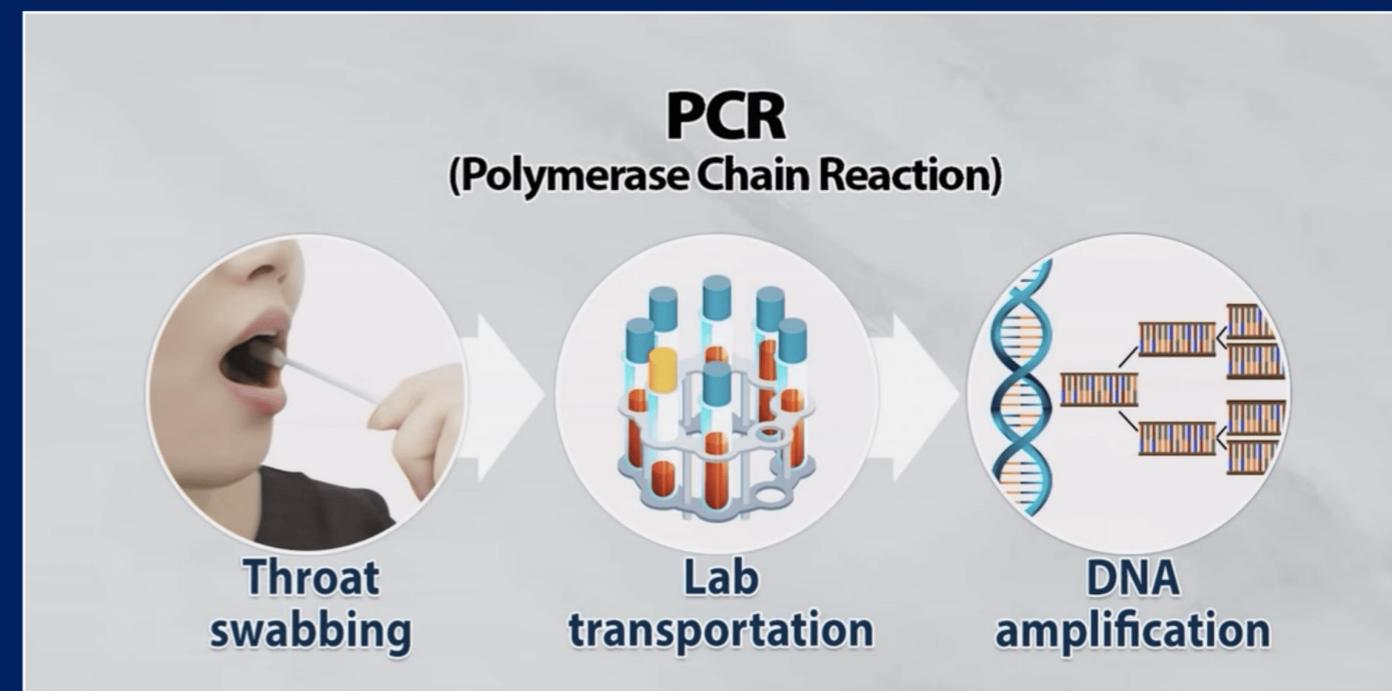
- First cases Wuhan City China December 2019
- Large outbreak Northern Italy February 2020
- First UK cases seen February 2020
- WHO Pandemic March 2020



# PCR



- Throat swab
- Concern re availability
- When the demand increases processing times may significantly increase
- China - ran out of PCR testing kits so implemented CT scanning as a diagnostic tool
- PCR sensitivity 60-70% and can give a false negative result initially
- Retesting patients - precipitates further delays in turnaround of PCR results



# Departmental Protocols



Standard operating procedures should be developed locally based around:

- Minimising risk to staff
- Infection control
- Portable CXR
- Standard departmental CXR
- Transferring patient to and from the Radiology department
- CT scanning & deep cleaning



# Imaging Requests



## Sufficient Information needs documenting on all Imaging referrals

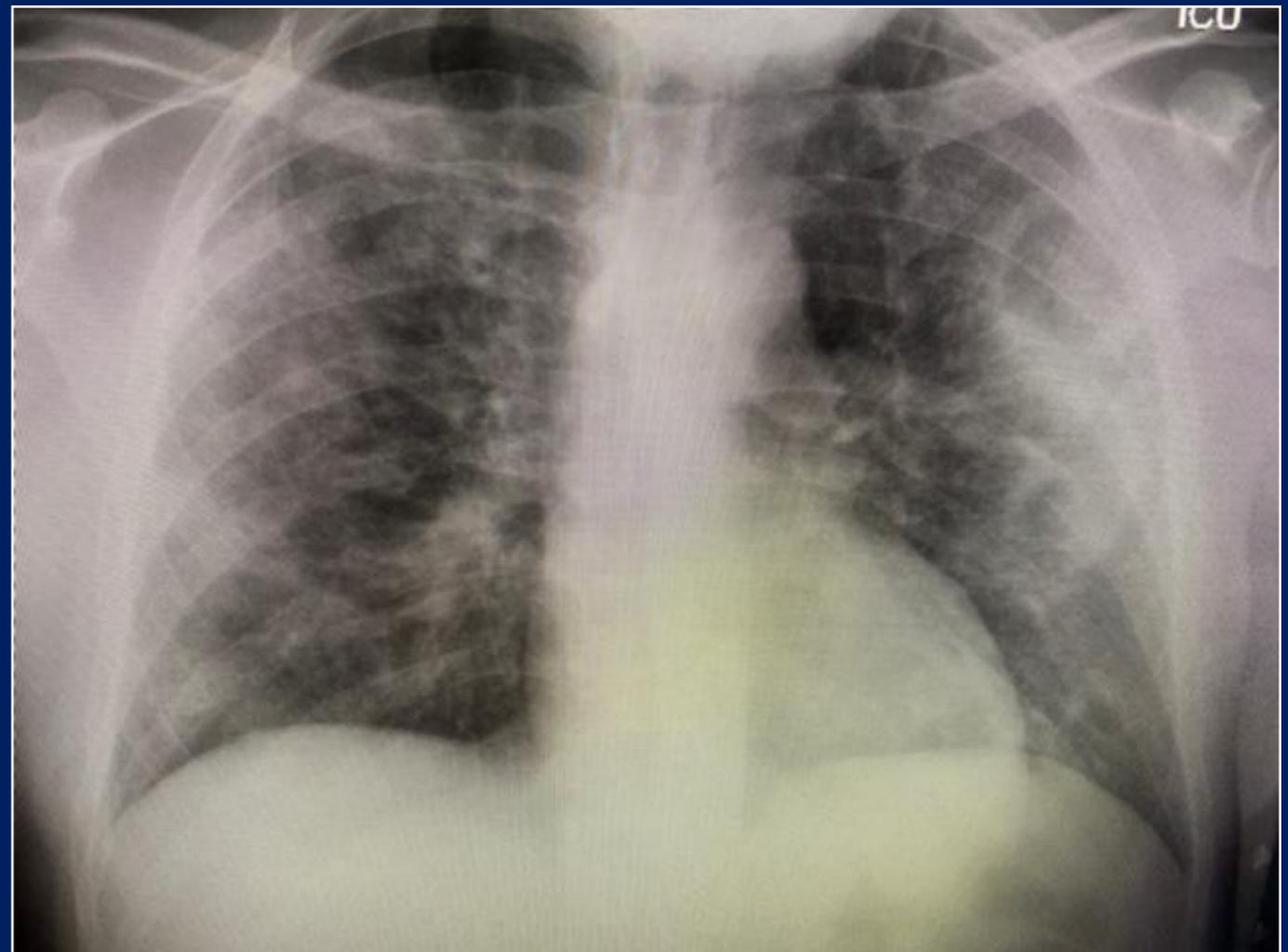
**Departments should work with local clinicians to ensure relevant clinical information on all imaging requests**

- Suspicion of COVID-19
- Infection risk - impacts on how, where and when patients are imaged
- Raised WCC / lymphopaenia - usually present in COVID-19
- CRP - unusual to be COVID-19 +ve if CRP is normal
- Relevant respiratory history
- Smoking history

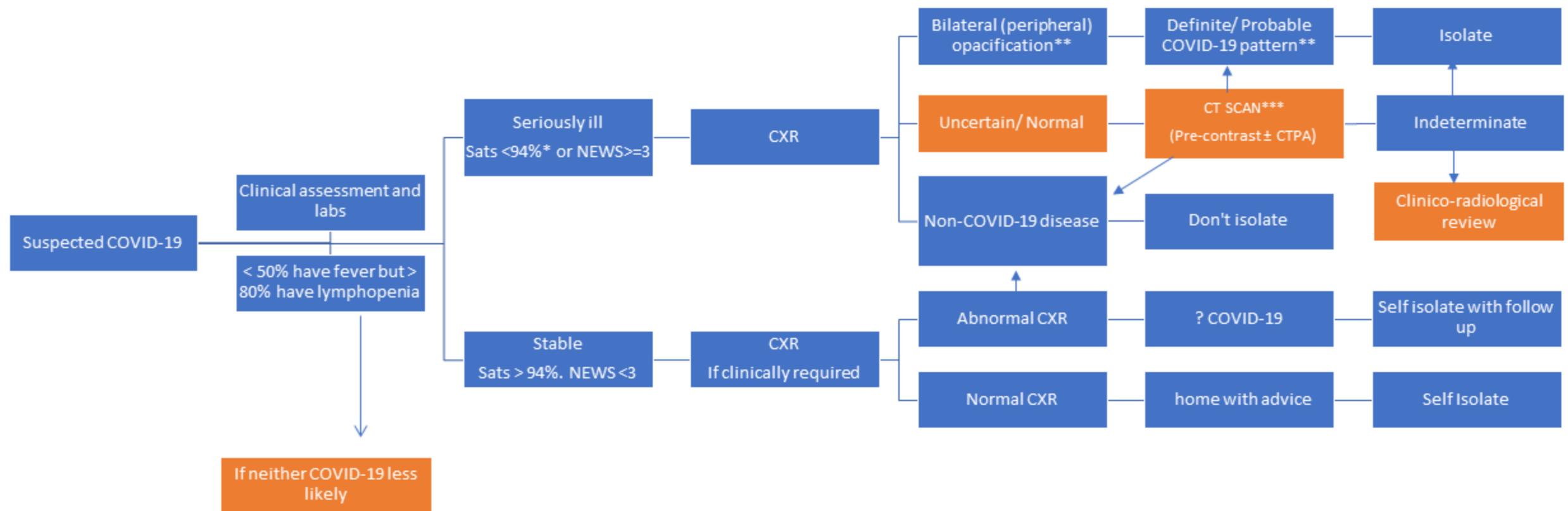
# Imaging



- No role for CT imaging in the **diagnosis** of COVID-19 unless the patient is **seriously ill OR** if **PCR unavailable**
- Imaging (CXR & CT) may guide individual patient **management decisions**, deal with **complications** or looking for an **alternative diagnosis**



# Radiology decision tool for suspected COVID-19



\*94% unless known COPD in which case ≤90%

\*\* Unsuspected/ unexpected cases may be incidentally discovered on CXR/ CT at this stage; should be reviewed in the context of clinical suspicion as to likelihood of COVID-19.

\*\*\*Classic and Indeterminate CTs should be scored either: 'mild' or 'moderate/severe'

# CT patterns



Pattern	Description
<b>CLASSIC COVID-19</b> (100% confidence for COVID)	Lower lobe predominant, peripheral predominant, multiple, bilateral* foci of GGO ± <ul style="list-style-type: none"><li>• Crazy-paving</li><li>• Peripheral consolidation**</li><li>• Air bronchograms</li><li>• Reverse halo/ perilobular pattern**</li></ul>
<b>PROBABLE COVID-19</b> (71-99% confidence for COVID)	<ul style="list-style-type: none"><li>• Lower lobe predominant mix of bronchocentric and peripheral consolidation</li><li>• Reverse halo/ perilobular pattern**</li><li>• GGO scarce</li></ul>
<b>INDETERMINATE</b> (<70% confidence for COVID)	<ul style="list-style-type: none"><li>• Does not fit into definite, probable or Non-Covid</li><li>• Manifests above patterns, but the clinical context is wrong, or suggests an alternative diagnosis (e.g. an interstitial lung disease in a connective tissue disease setting)</li></ul>
<b>NON-COVID</b> (70% confidence for alternative)	<ul style="list-style-type: none"><li>• Lobar pneumonia</li><li>• Cavitating infections</li><li>• Tree-in bud/ centrilobular nodularity</li><li>• Lymphadenopathy, effusions</li><li>• Established pulmonary fibrosis</li></ul>

\*>1 lesion, but could still be unilateral; usually but not universally bilateral'

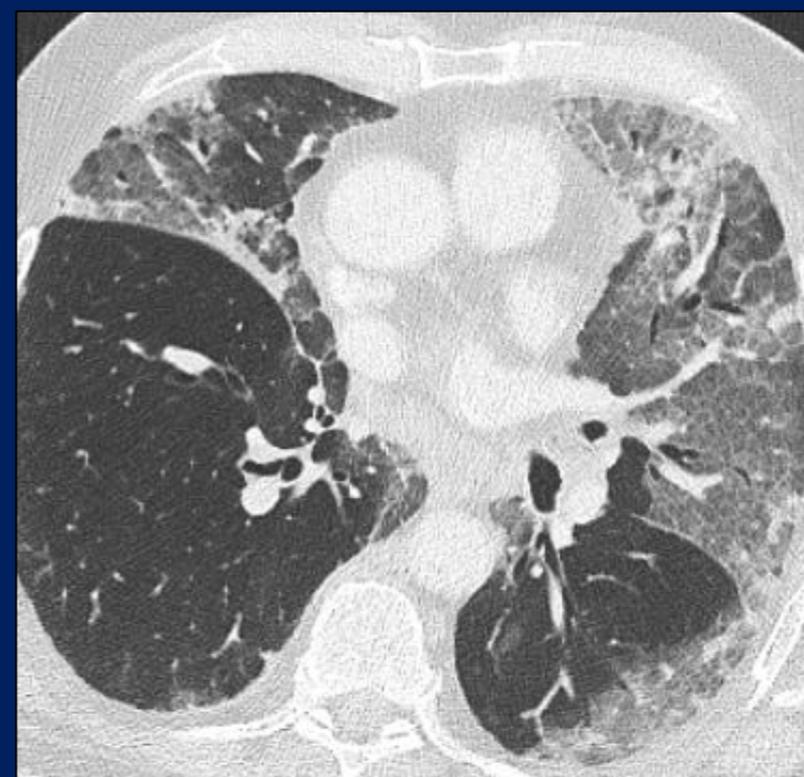
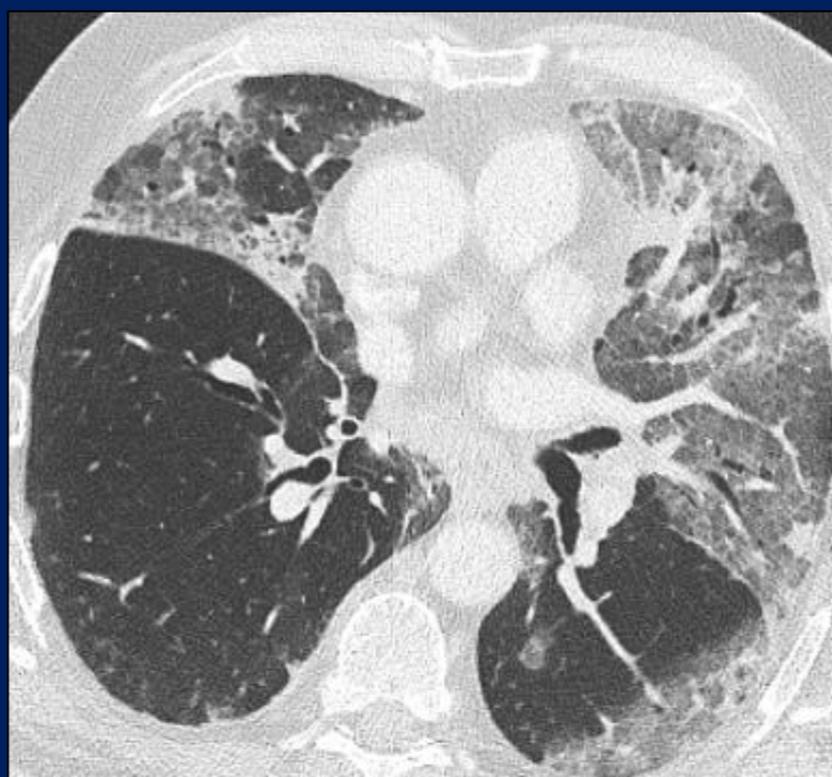
\*\*i.e. organising pneumonia patterns

# EXAMPLES

- The following examples are from recent UK cases
- Note that the clinical suspicion is IMPERATIVE
- Without the suspicion, the radiology is non-specific and could easily represent so many other processes

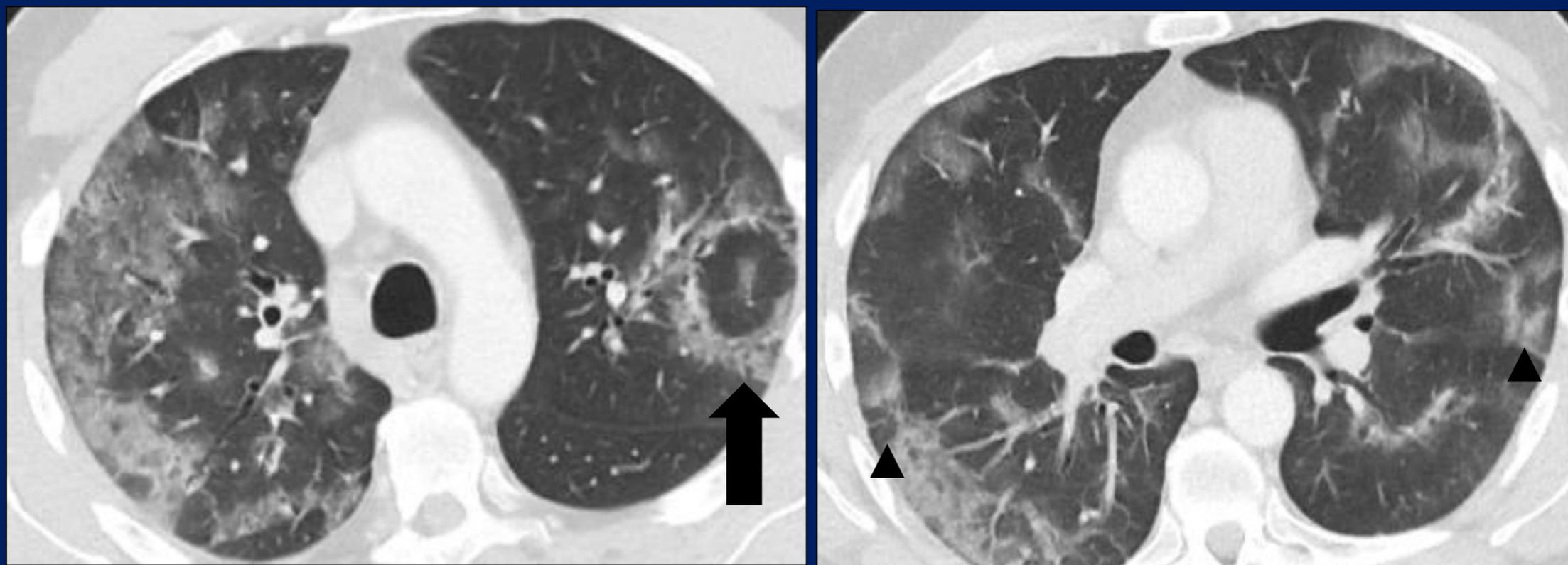
# CLASSIC COVID19

Crazy-paving and consolidation



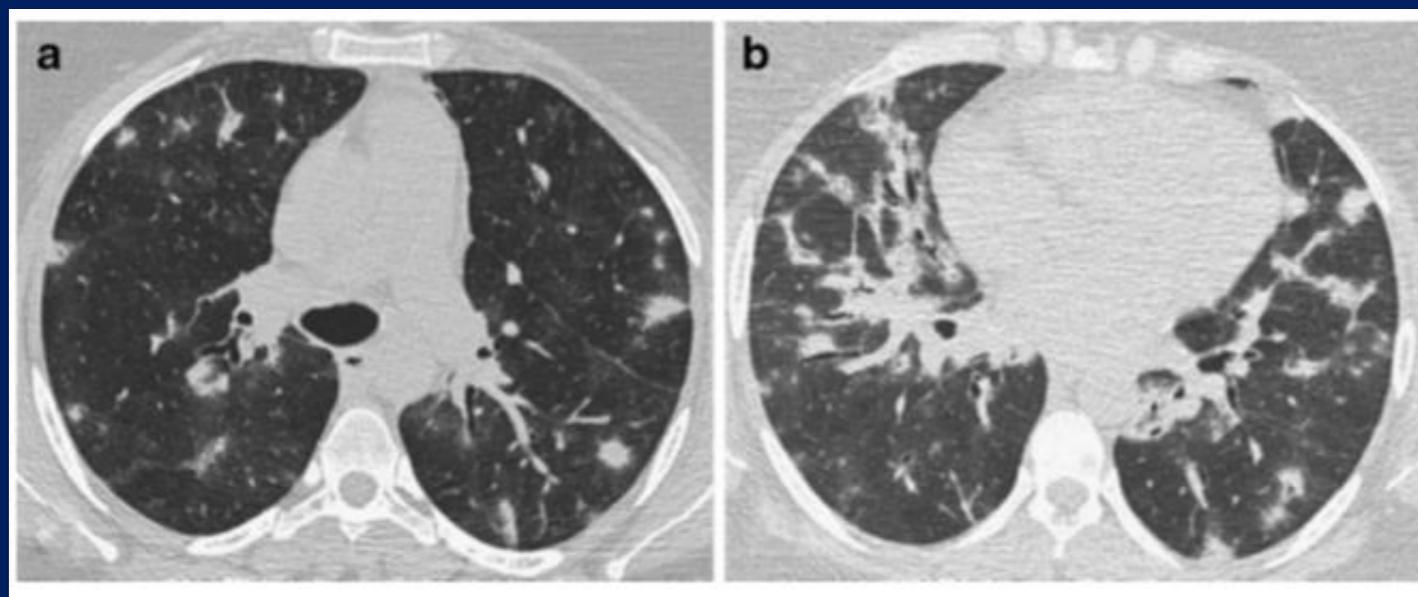
## CLASSIC COVID19

GGO, reverse halo and perilobular

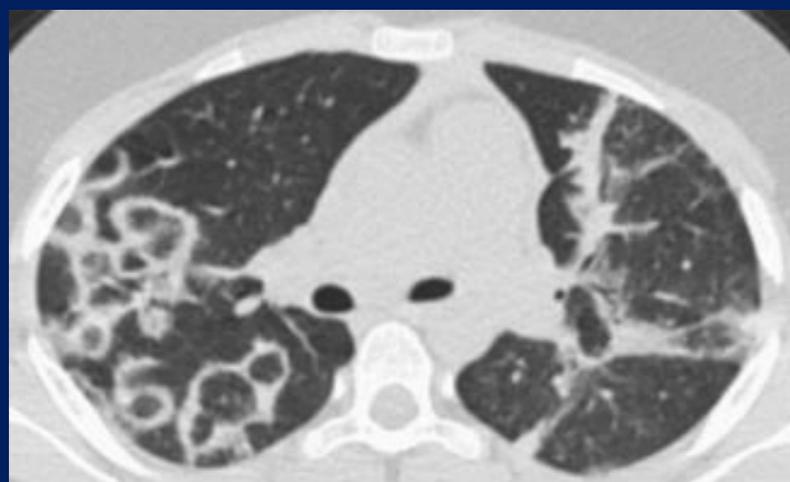


Reverse halo (arrow) and Perilobular opacities (arrowheads) are a sign of organising pneumonia

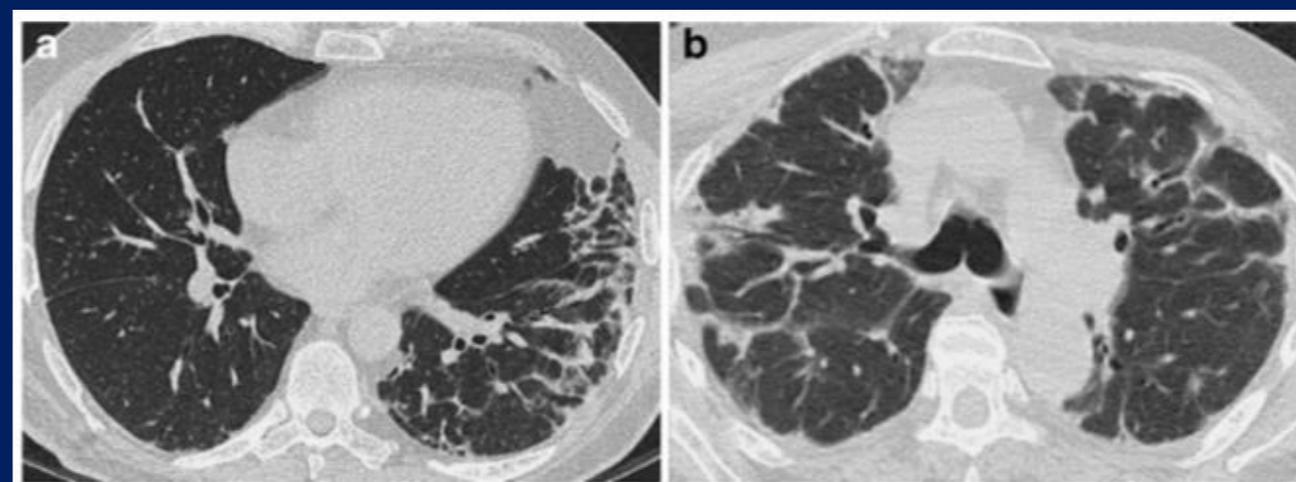
# Organising pneumonia patterns



Bronchocentric consolidation and irregular nodules



Reverse halo pattern



Perilobular pattern  
“fuzzy arcades”

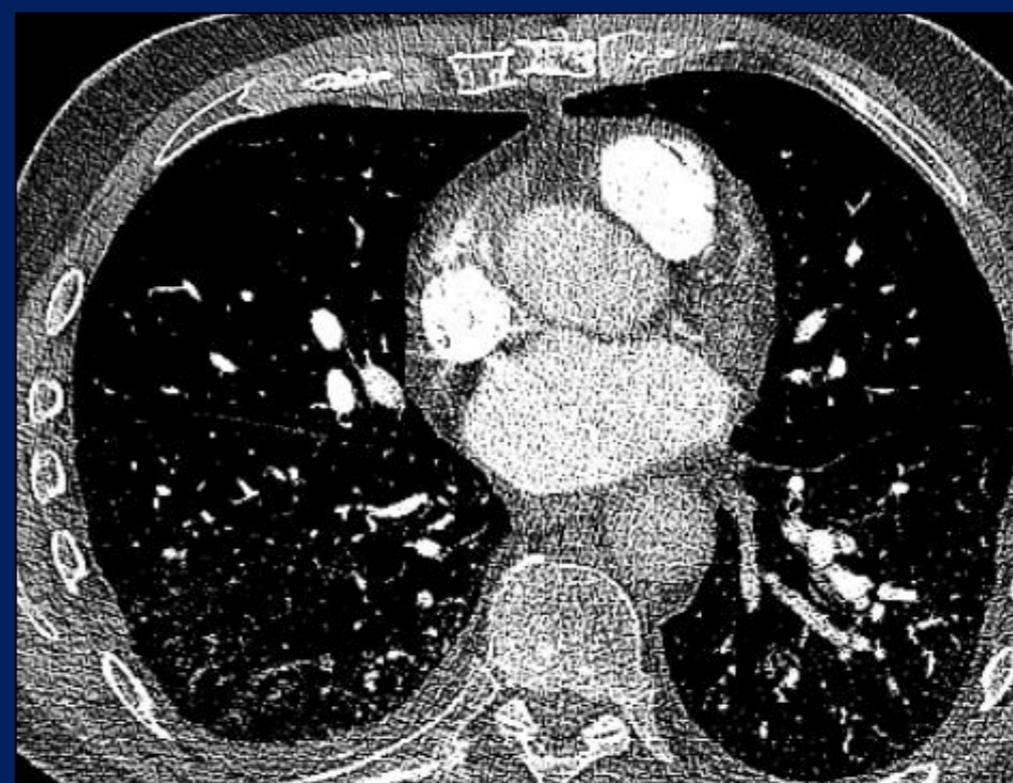
## PROBABLE COVID19

Bronchocentric and nodular organising pneumonia patterns, air bronchogram, but no GGO



# INDETERMINATE COVID19

GGO ?from contrast and/or dependent



Needs clinic-radiology review. Fever, CRP and especially a **lymphopaenia**, would make COVID19 more likely

## NON-COVID19



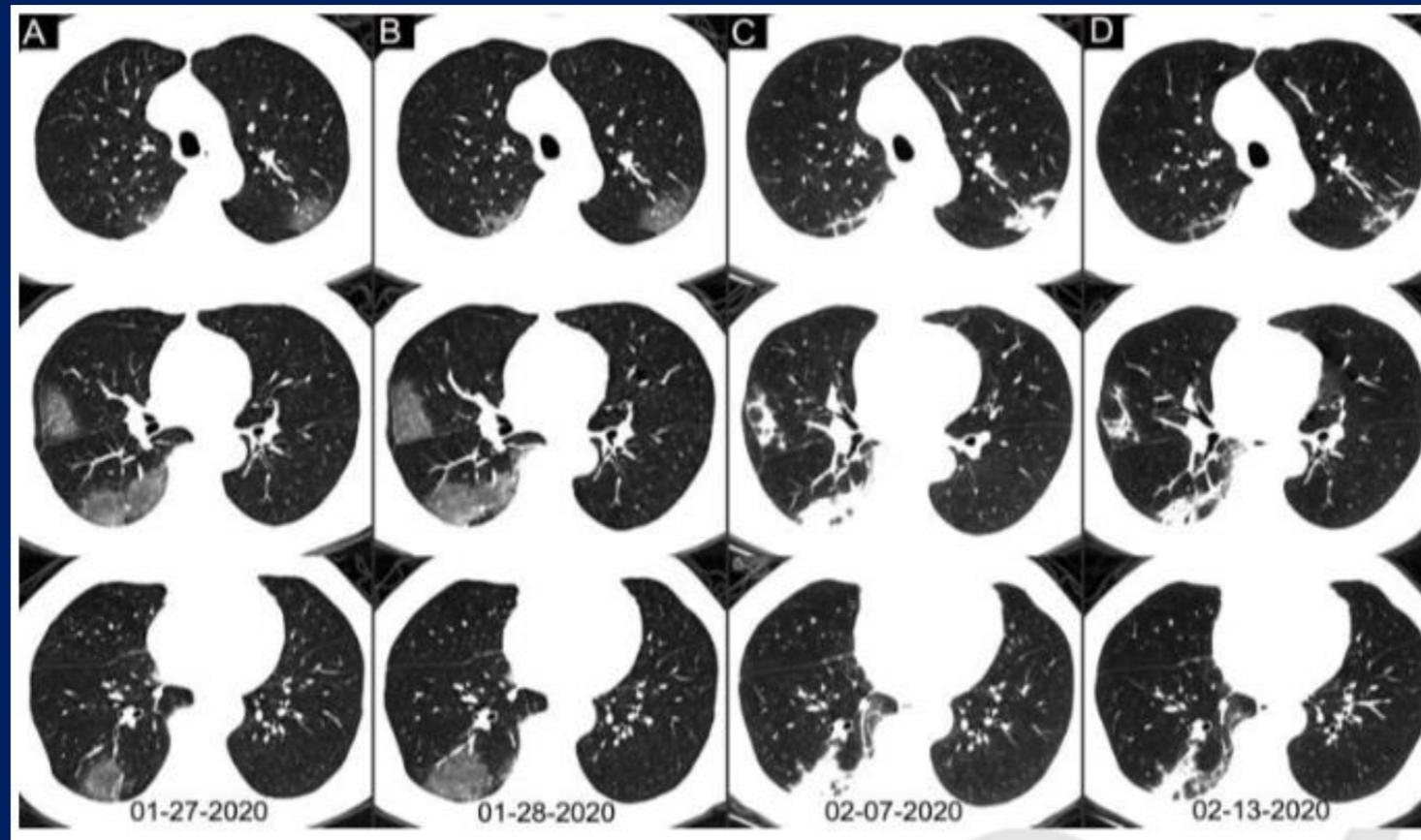
**0.6mm lung recon**



**8mm MIP lung recon**

Burkitt's lymphoma, pancytopenic. febrile 5 days with diarrhoea.  
**tree in bud (MIPs useful)** and acinar- COVID negative (initial swab)

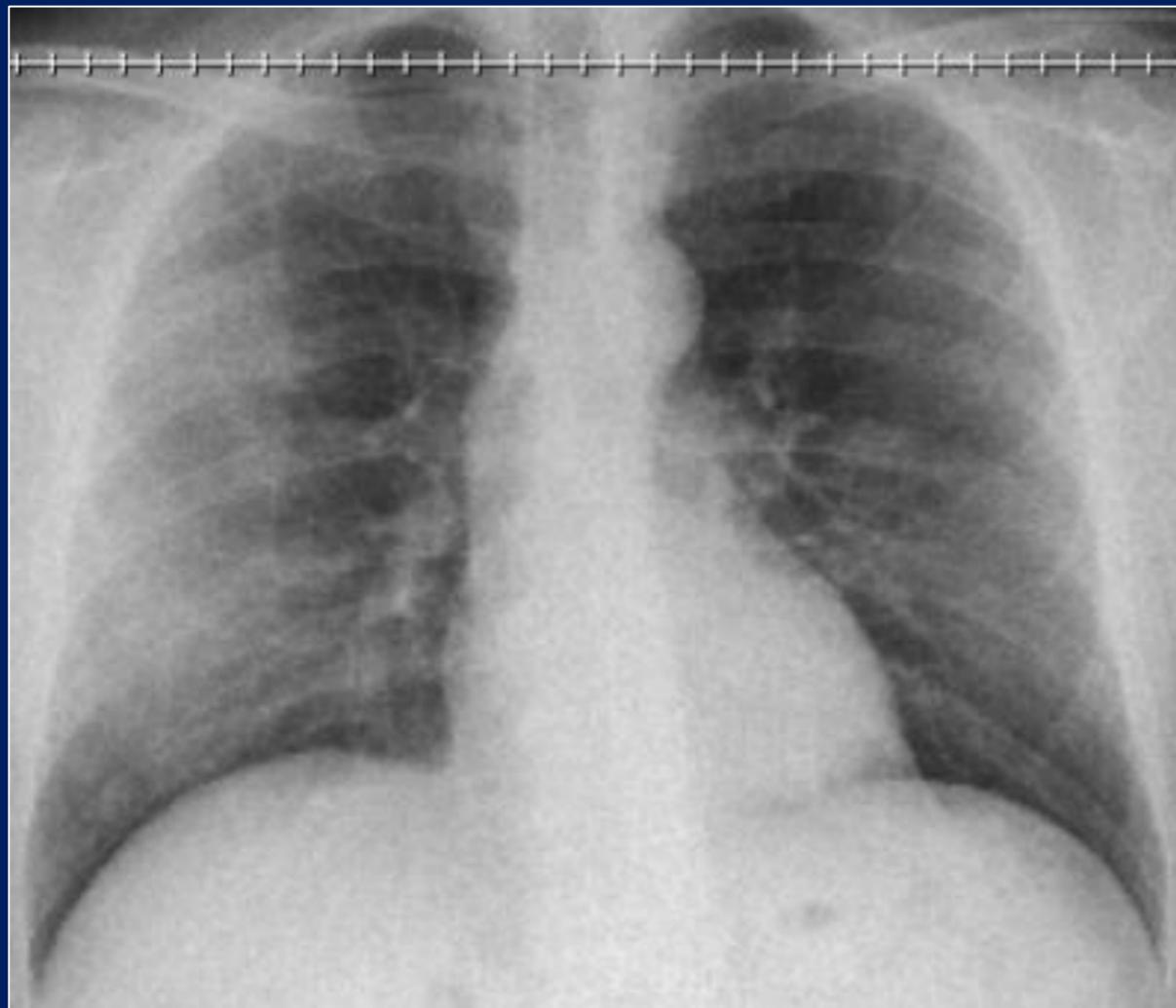
# Serial change



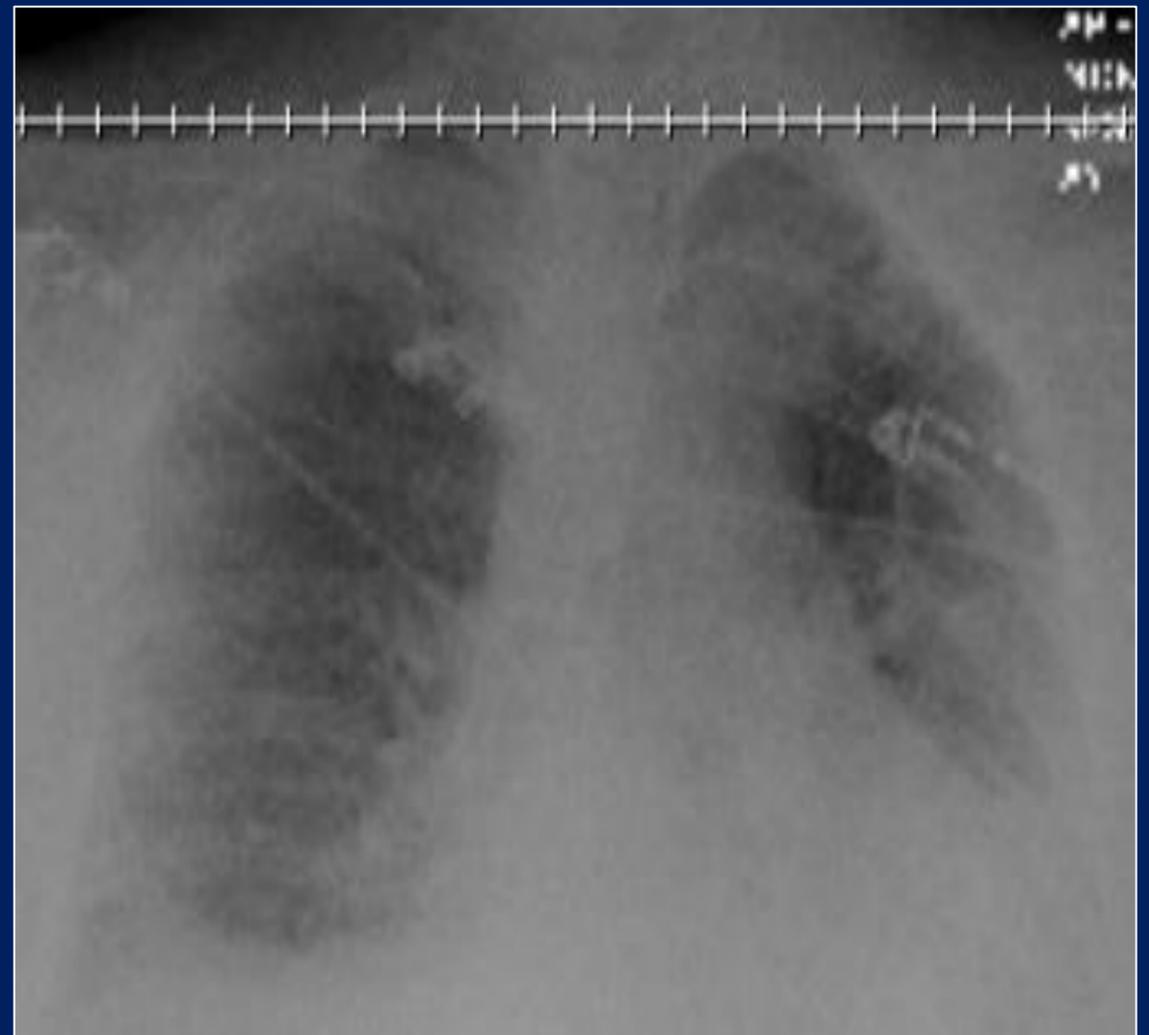
Chest CT images of a 62-year-old man with fever for 2 weeks, and dyspnea for 1 day. Negative results of RT-PCR assay for the SARS-CoV-2 using a swab samples were obtained on February 3 and 11, 2020, respectively. (column A) Chest CT with multiple axial images shows multiple ground-glass opacities in the bilateral lungs. (column B) Chest CT with multiple axial images shows enlarged multiple ground-glass opacities. (column C) Chest CT with multiple axial images shows the progression of the disease from ground-glass opacities to multifocal organizing consolidation. (D column) chest CT with multiple axial images shows partial absorption of the organizing consolidation.

***Ai et al. Radiology. 2020 Feb  
26:200642. doi:  
10.1148/radiol.2020200642.***

# CXR categorisation



**CLASSIC**  
**Bilateral peripheral**  
**air-space disease**

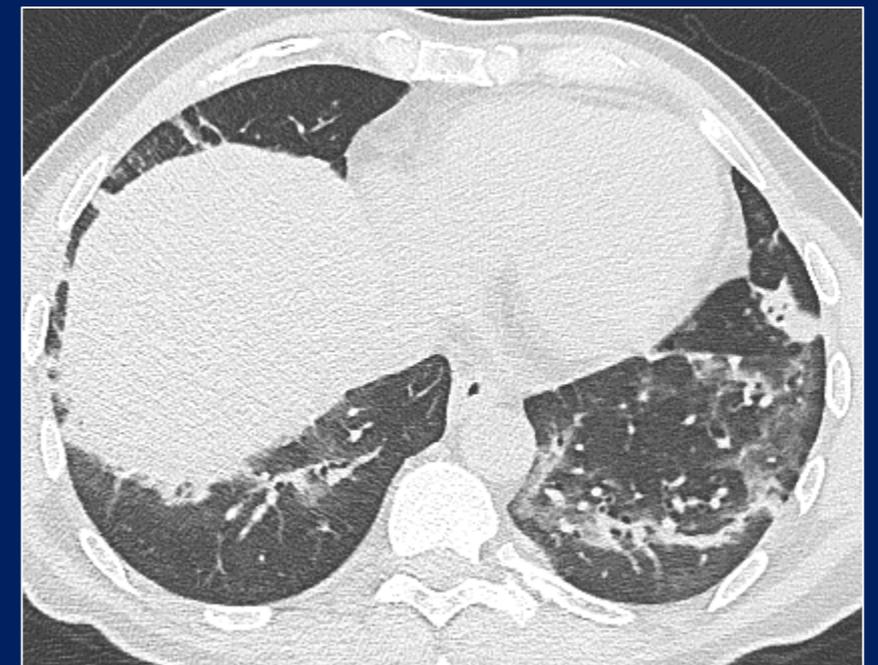
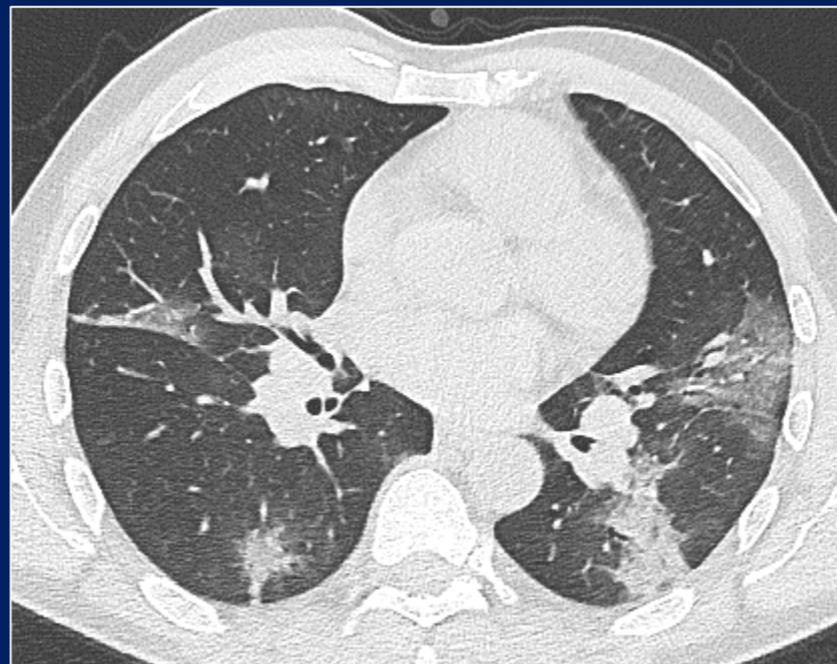
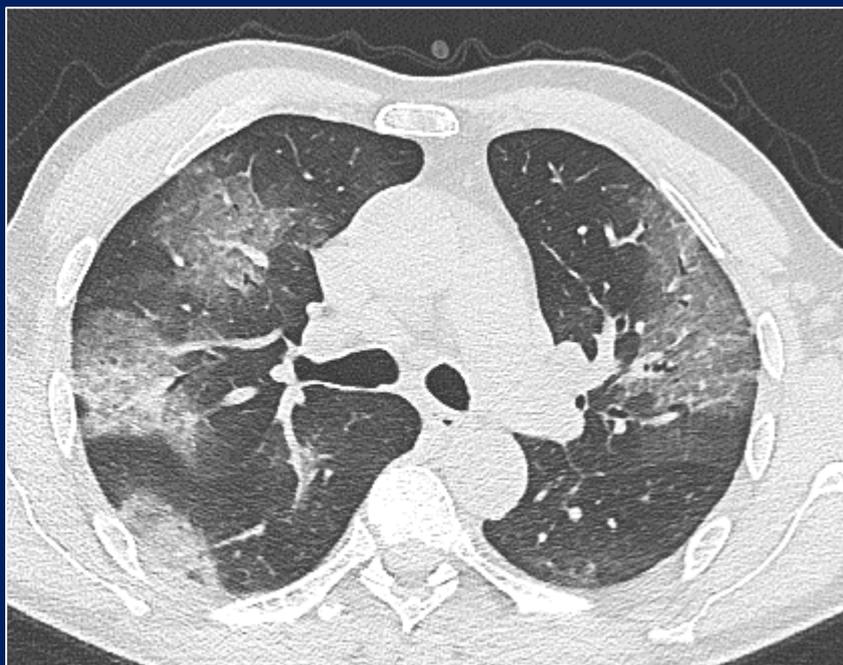


**Unhelpful/**  
**INDETERMINATE**  
**Poor quality film**

# CLASSIC COVID-19



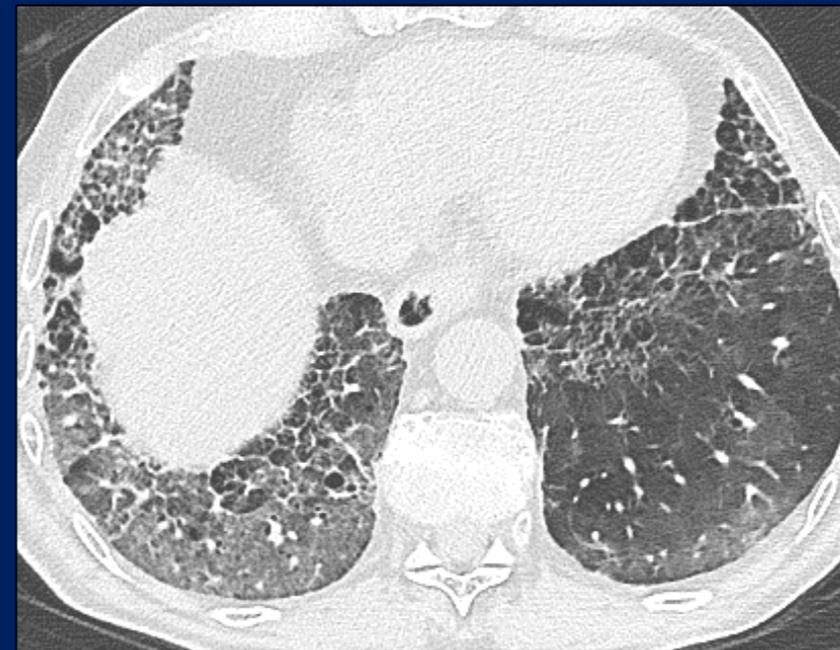
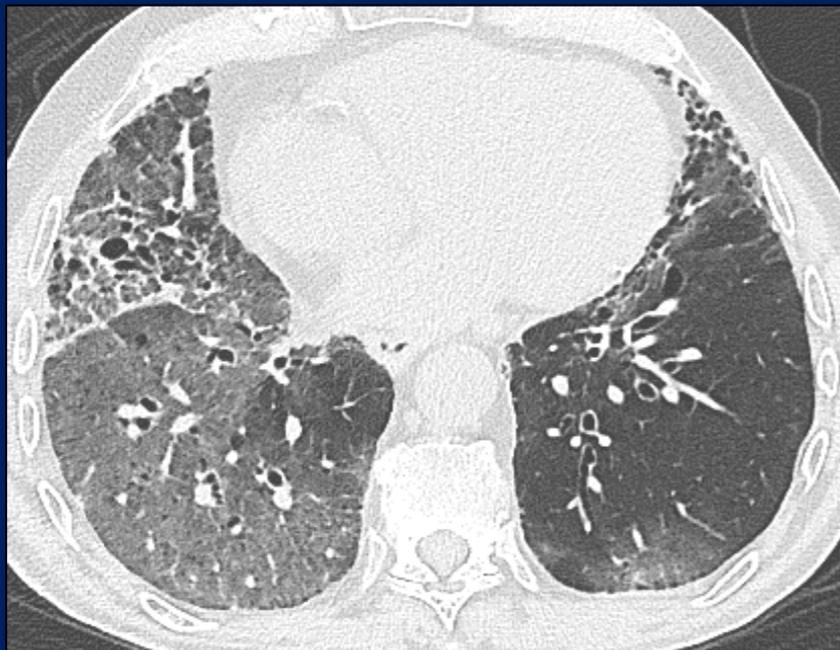
- Peripheral ground-glass opacities
- Crazy paving may be present
- Organising pneumonia



# INDETERMINATE for COVID-19



- Ground-glass / patchy / non peripheral changes
- Fibrosis with ground glass
- Complex patterns

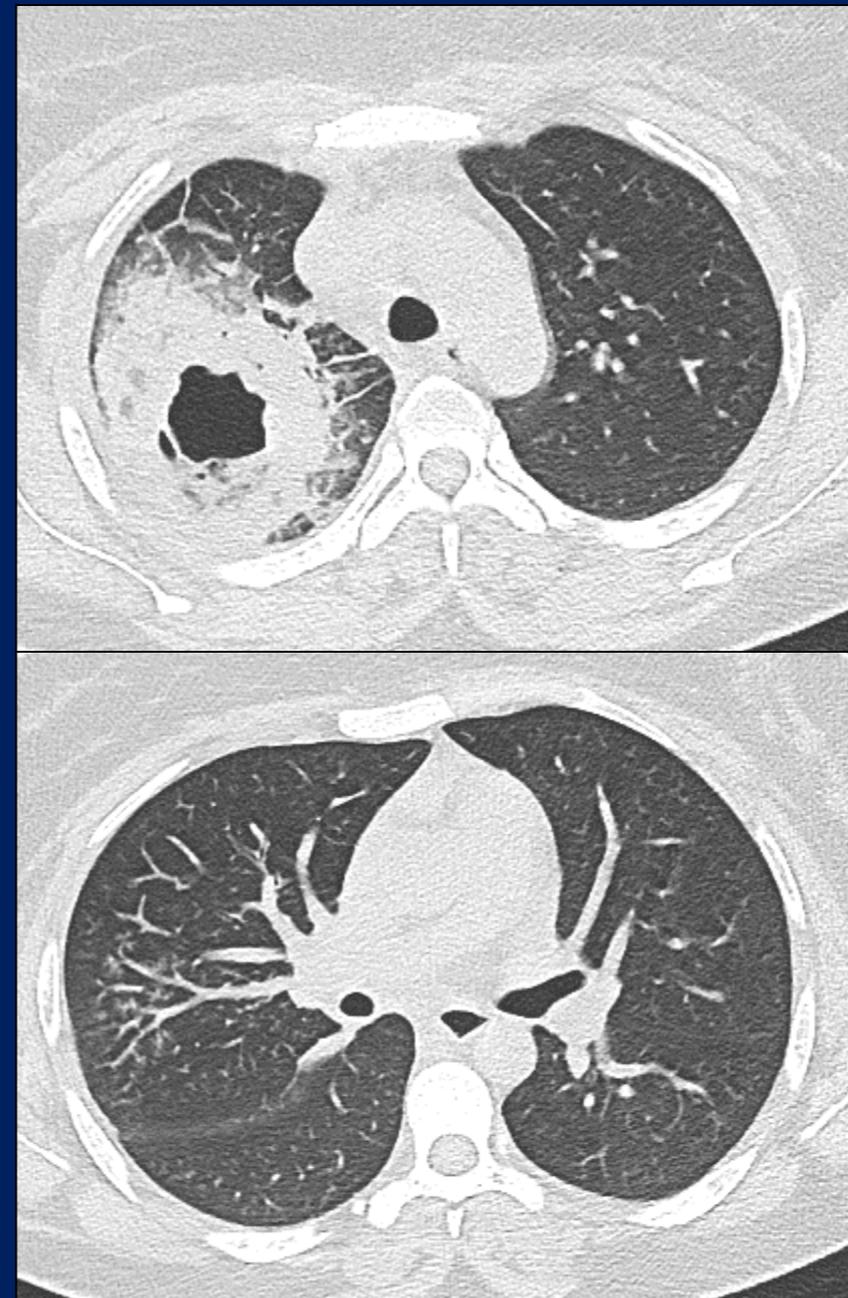


# NON COVID19



The following would be unusual  
in COVID -19 infection:

- Lobar pneumonia
- Cavitating infections
- Tree-in bud changes
- Effusion(s)

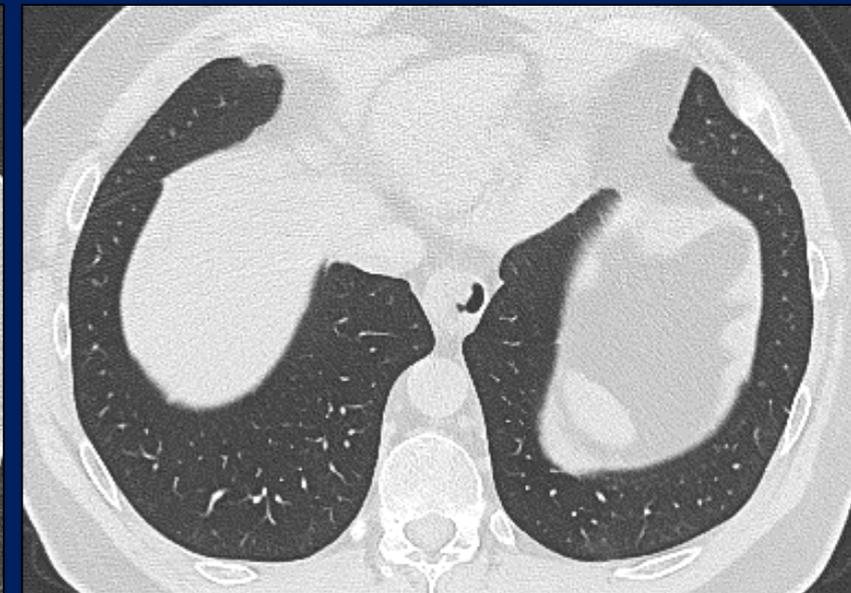
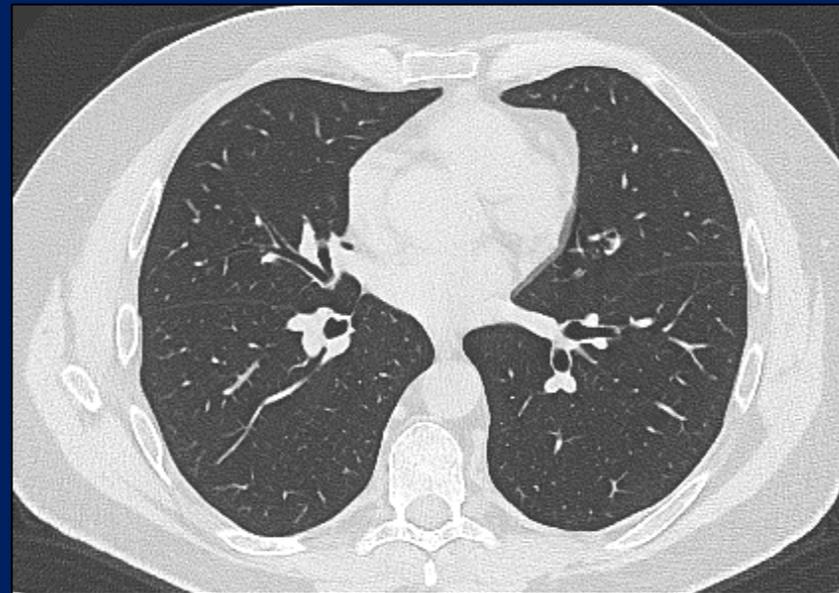
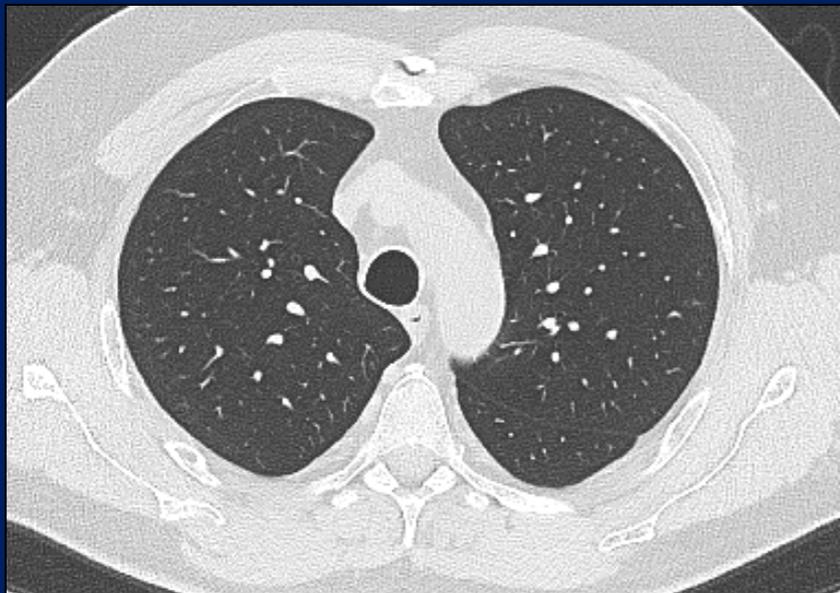


Differentiating abnormalities in the presence of underlying emphysema or interstitial lung disease maybe difficult

# Normal



- It is important to remember that a normal CT can be seen in early COVID-19 infection



# CT pattern and quantifying disease

Radiology	Parenchymal lung changes	Severity
<b>Classic/Probable/Indeterminate</b>	Up to 3 focal abnormalities 3cm in max diameter	Mild
	More than 3 focal abnormalities or max diameter >3cm	Moderate / Severe*

\* The difference between moderate and severe is subjective and will likely differ between reporters. This should be used in conjunction with clinical assessment.

# CT pattern and quantifying disease (2)

Radiology in probable COVID-19		Severity
<b>Pure ground glass opacities</b>	Up to 3 focal abnormalities < 3cm in max diameter	Mild
<b>Pure ground glass opacities</b>	More than 3 focal abnormalities or max diameter >3cm	Moderate / Severe*
<b>Focal ground glass opacities mixed with early consolidation</b>		Moderate / Severe*
<b>Diffuse ground glass opacities or consolidation with signs of architectural distortion</b>		Severe

\* The difference between moderate and severe is subjective and will likely differ between reporters. This should be used in conjunction with clinical assessment.



# BSTI: CT reporting proforma: COVID-19



## Pre-existing lung findings

Emphysema none / mild / moderate / severe

Fibrosis none / mild / moderate / severe

## Findings

### Normal

### Classic/Probable COVID-19

Predominant pattern: Bilateral, basal, GGO/ Crazy-Paving / Peripheral consolidation / Reverse halo / Perilobular

Other patterns:

### Indeterminate for COVID-19

Does not fit Classic or Non-COVID-19 patterns or clinical context

Non-peripheral GGO / Complex / Unilateral / Other

### Non-COVID-19

Lobar pneumonia / Cavitation / Tree-in-bud / Centrilobular nodules / Lymphadenopathy / effusion(s)

Other patterns

## Disease Distribution

Upper Middle Lower Random

Central 2/3 Peripheral 1/3

Bronchocentric (y/n)

## Other findings

## Conclusion

1. **Normal** Correlate with RT-PCR as CT can be normal in early infection

2. **Classic/Probable COVID-19 infection**

### CT severity score

**Mild** Pure GGO,  $\leq 3$  focal abnormalities and all  $\leq 3$  cm

**Mod/Severe** Pure GGO,  $> 3$  focal abnormalities or  $> 3$  cm max diameter, consolidation, architectural distortion

3. **Indeterminate for COVID-19 infection**

### CT severity score

**Mild**  $\leq 3$  focal abnormalities and all  $\leq 3$  cm max diameter

**Mod/Severe**  $> 3$  focal abnormalities or  $> 3$  cm max diameter

4. **Non-COVID-19**

Correlate with RT-PCR

Codes for RIS searches: CVCT0 = Normal CVCT1 = Classic/probable CVCT2 = Indeterminate CVCT3 = Non-COVID-19

Please consider case upload to [https://bit.ly/BSTICovid19\\_Database](https://bit.ly/BSTICovid19_Database)



## BSTI COVID-19 CXR Report Proforma



### Findings

#### **Normal**

COVID-19 not excluded. Correlated with RT-PCR

#### **Classic/Probable COVID-19**

Lower lobe and peripheral predominant multiple opacities that are bilateral (>> unilateral)

#### **Indeterminate for COVID-19**

Does not fit Classic or Non-COVID-19 descriptors

#### **Non-COVID-19**

Pneumothorax / Lobar pneumonia / Pleural effusion(s) / Pulmonary oedema

Other

### Quantifying disease

**Mild / Moderate / Severe**

### Other findings

Codes for subsequent Radiology Information System search:

CVCX0 = Normal CVCX1 = Classic CVCX2 = Indeterminate CVCX3 = Non-COVID-19

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# Scenarios to consider



- Incidental or unexpected finding on CXR. Clear advice needs to be given to radiographers regarding who to contact and what to do next in such a situation
- Dealing with unexpected findings on CT e.g. abnormal lung bases on CT abdomen & pelvis
- Workforce planning: departmental cover and on call provisions in the case of staff absence
- Unexpected findings on GP CXR suggesting Covid 19: based on clinical scenario – if patient not significantly ill as per suggested algorithm = mention classic/probable Covid infection, for self-isolation and clinical re-review where appropriate.

# Case Database



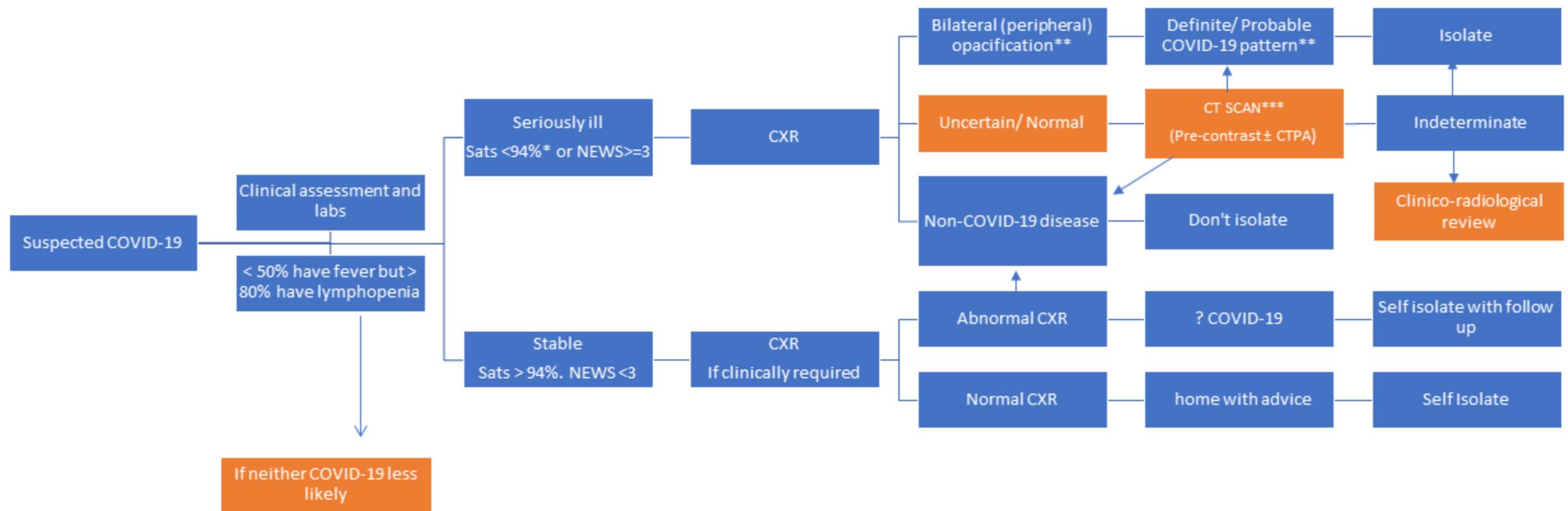
- Refer a case [https://bit.ly/BSTICovid19\\_Database](https://bit.ly/BSTICovid19_Database)
- Teaching Library [https://bit.ly/BSTICOVID19\\_Teaching\\_Library](https://bit.ly/BSTICOVID19_Teaching_Library)



- Updates can be found on [www.bsti.org.uk](http://www.bsti.org.uk) or via our Facebook (@BSTImaging) or Twitter (@BSTImaging) feeds.

The BSTI would like to thank Prof Nicola Sverzellati and his team in Parma Italy for sharing information and images.

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