



Thoracic Imaging in COVID-19 Infection

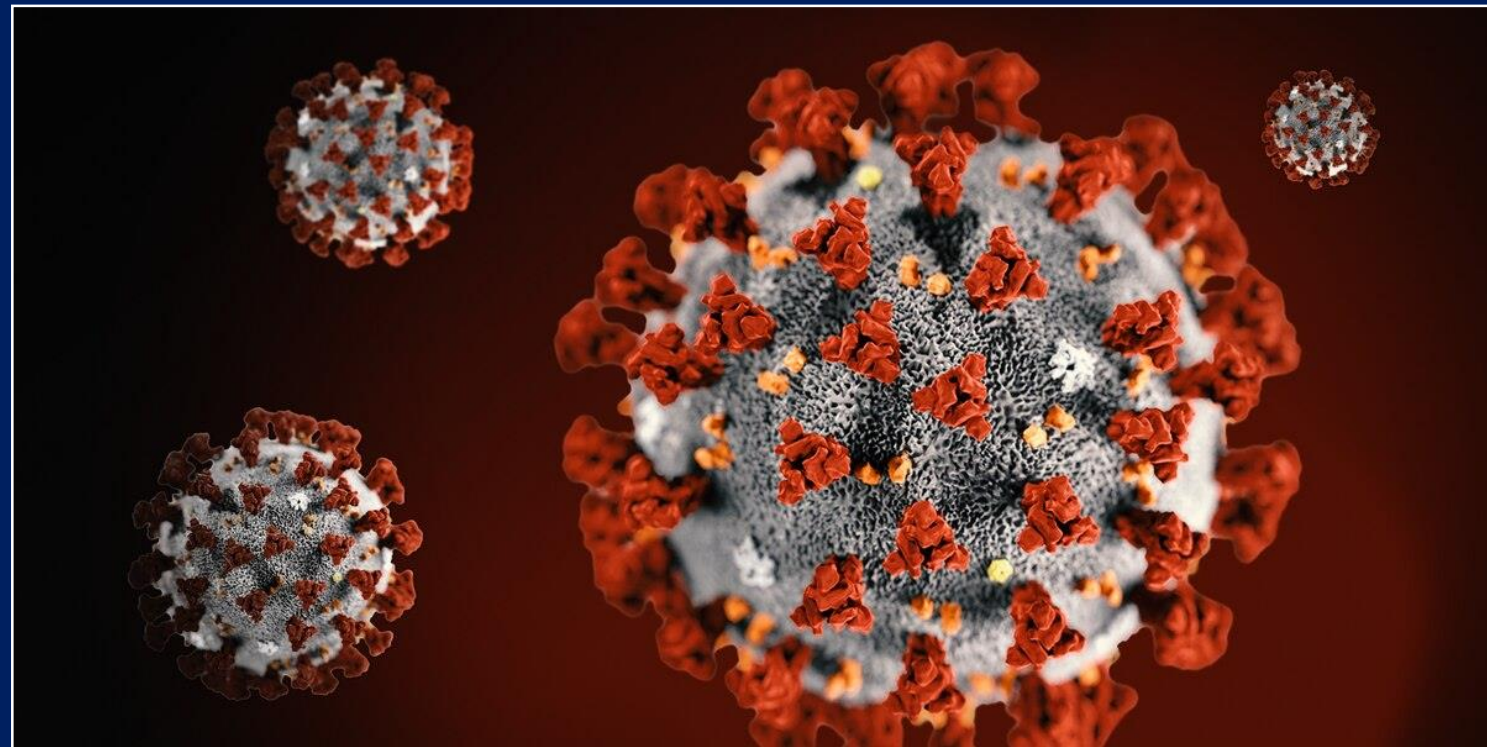
Guidance for the Reporting Radiologist
British Society of Thoracic Imaging

Version 2
16th March 2020

Background COVID-19



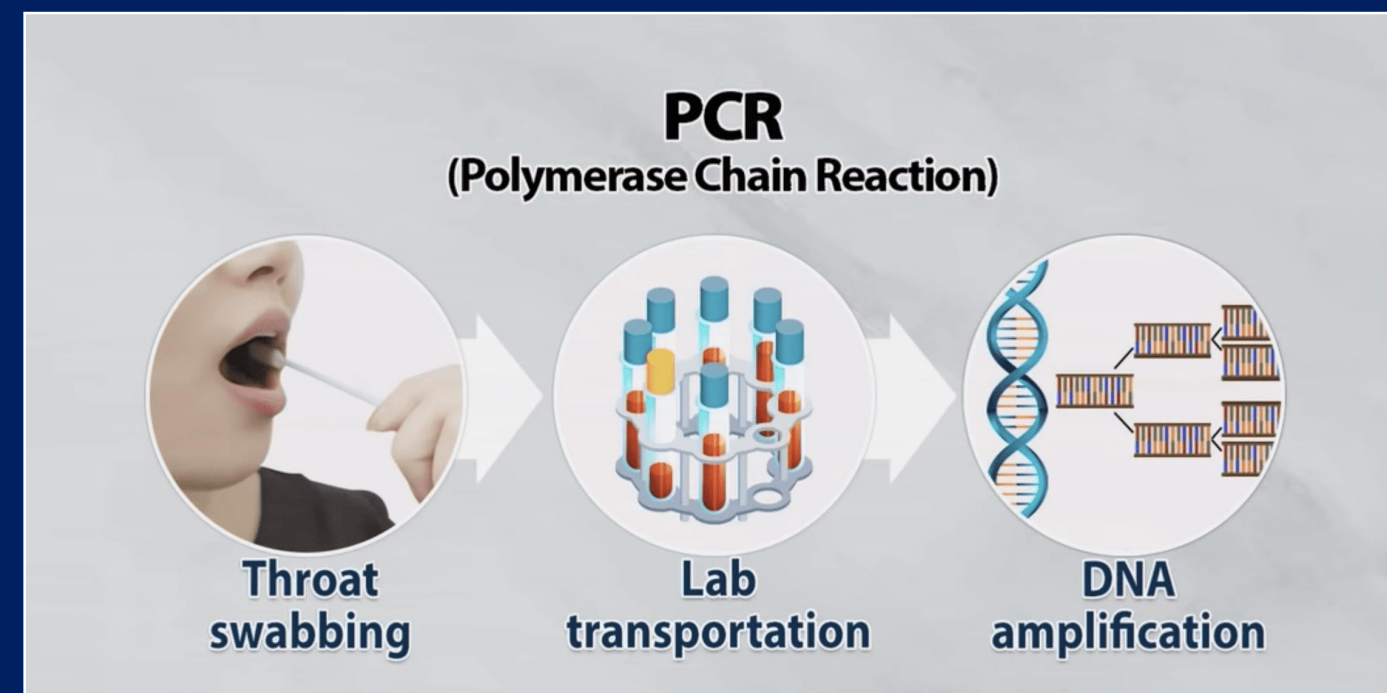
- First cases Wuhan City China
December 2019
- Large outbreak Northern Italy
February 2020
- First UK cases seen February
2020
- WHO Pandemic March 2020



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

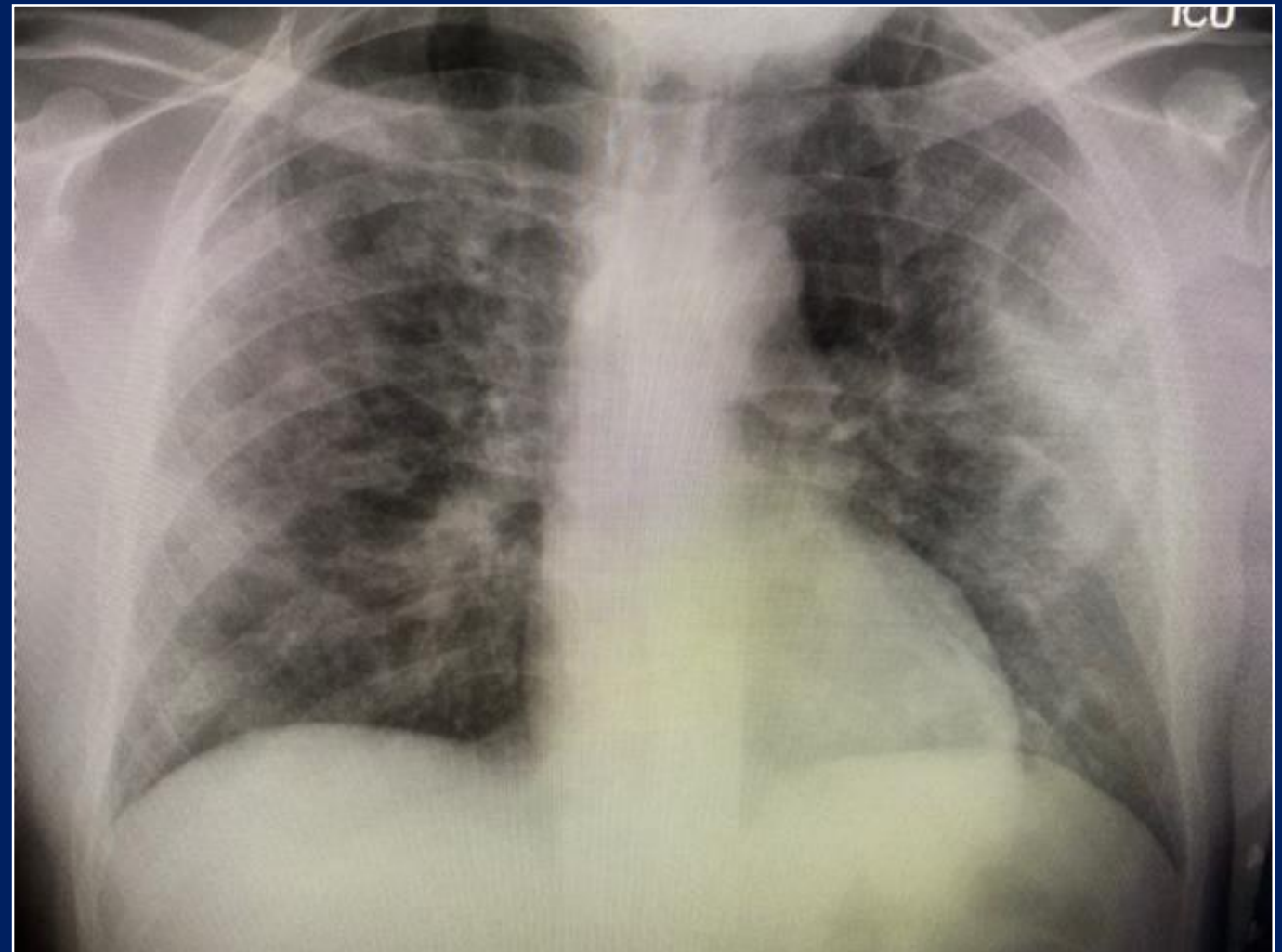
Departments should work with local clinicians to ensure relevant clinical information on all imaging requests

- 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

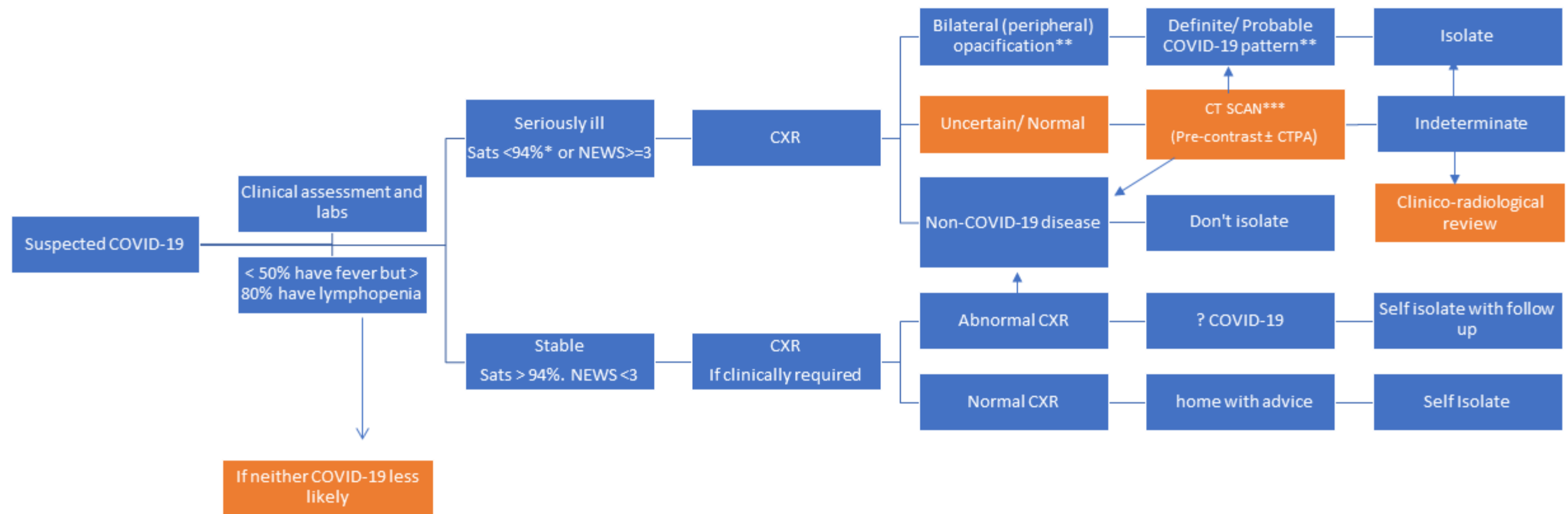
Imaging



- 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'

Please upload all COVID 19 cases to BSTI database: <https://www.bsti.org.uk/training-and-education/covid-19-bsti-imaging-database/>

CT patterns



Pattern	Description
CLASSIC COVID-19 (100% confidence for COVID)	Lower lobe predominant, peripheral predominant, multiple, bilateral* foci of GGO ± • Crazy-paving • Peripheral consolidation** • Air bronchograms • Reverse halo/ perilobular pattern**
PROBABLE COVID-19 (71-99% confidence for COVID)	• Lower lobe predominant mix of bronchocentric and peripheral consolidation • Reverse halo/ perilobular pattern** • GGO scarce
INDETERMINATE (<70% confidence for COVID)	• Does not fit into definite, probable or Non-Covid • 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)
NON-COVID (70% confidence for alternative)	• Lobar pneumonia • Cavitating infections • Tree-in bud/ centrilobular nodularity • Lymphadenopathy, effusions • Established pulmonary fibrosis

*>1 lesion, but could still be unilateral; usually but not universally bilateral¹

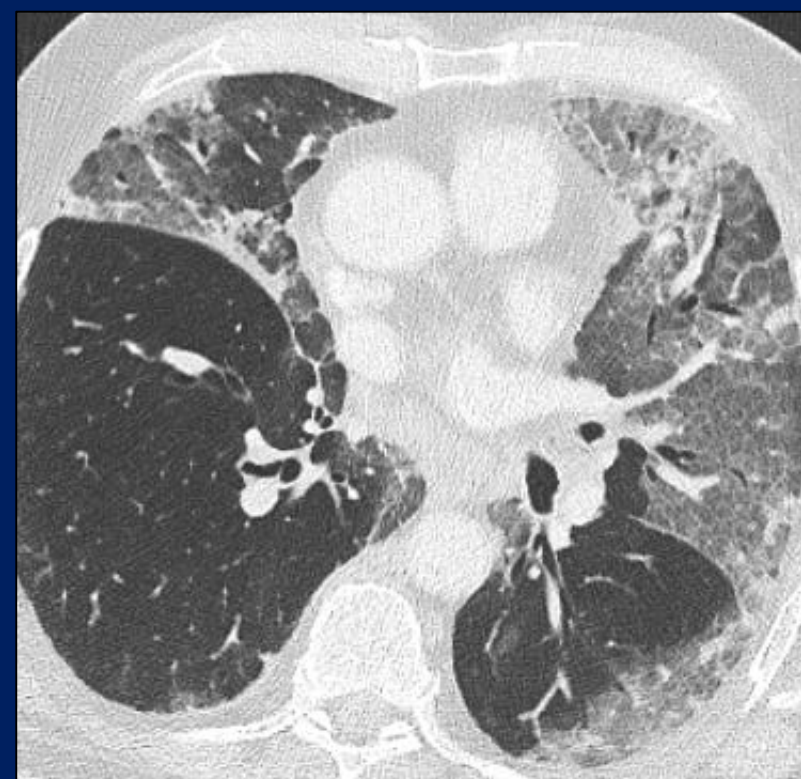
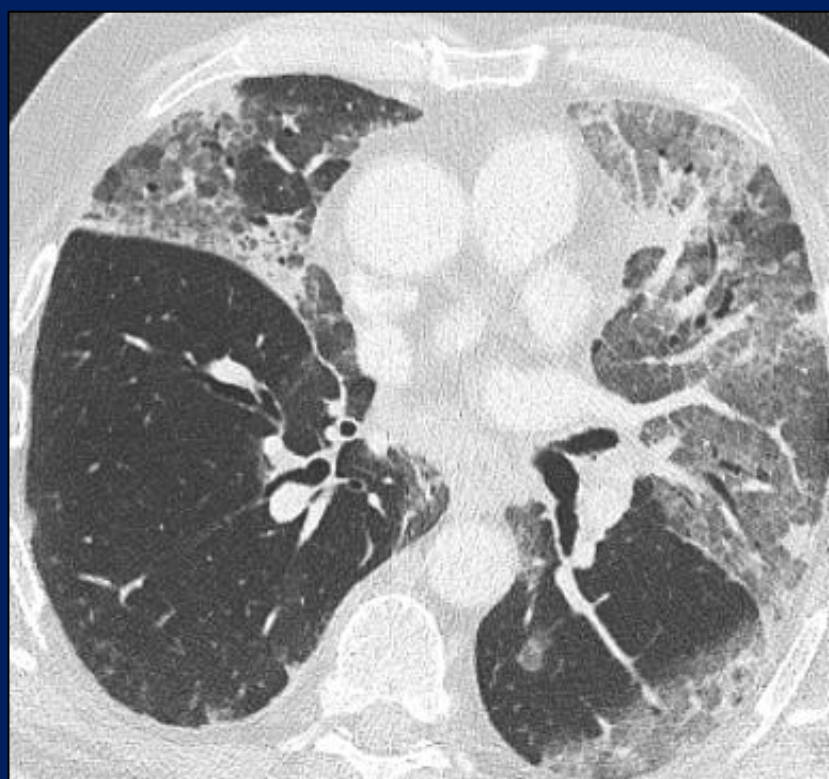
**i.e. organising pneumonia patterns

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

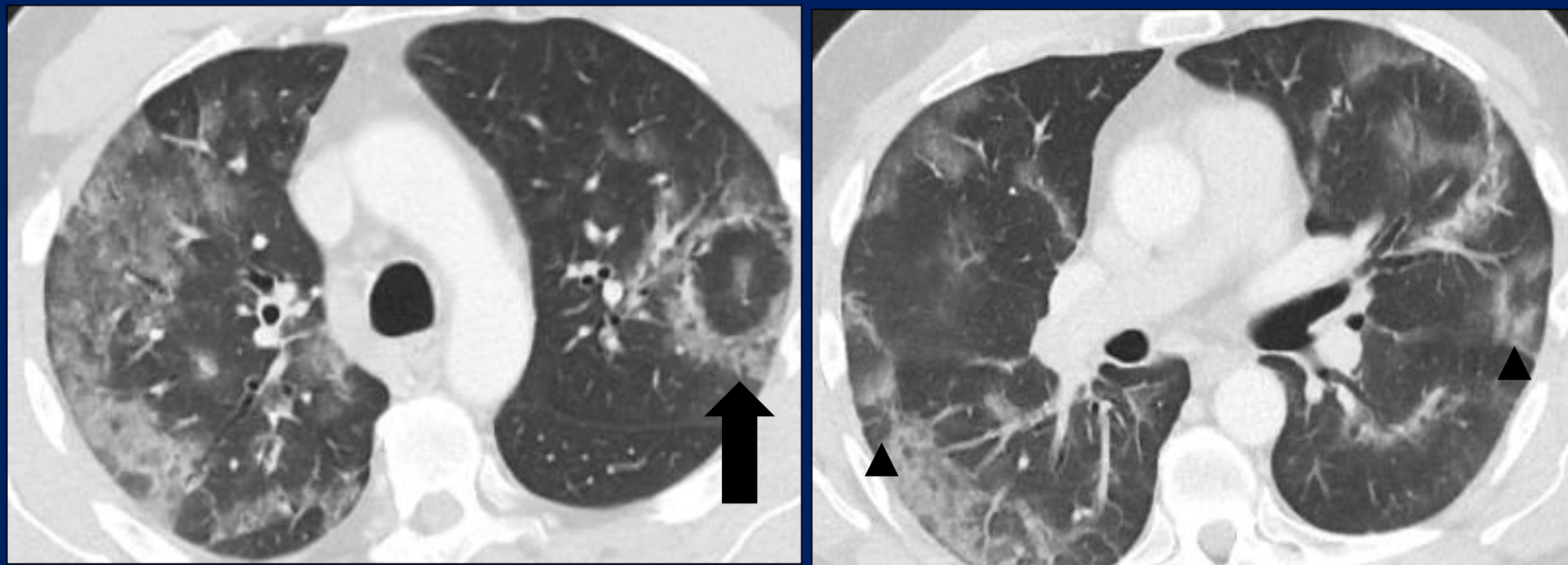
CLASSIC COVID19

Crazy-paving and consolidation



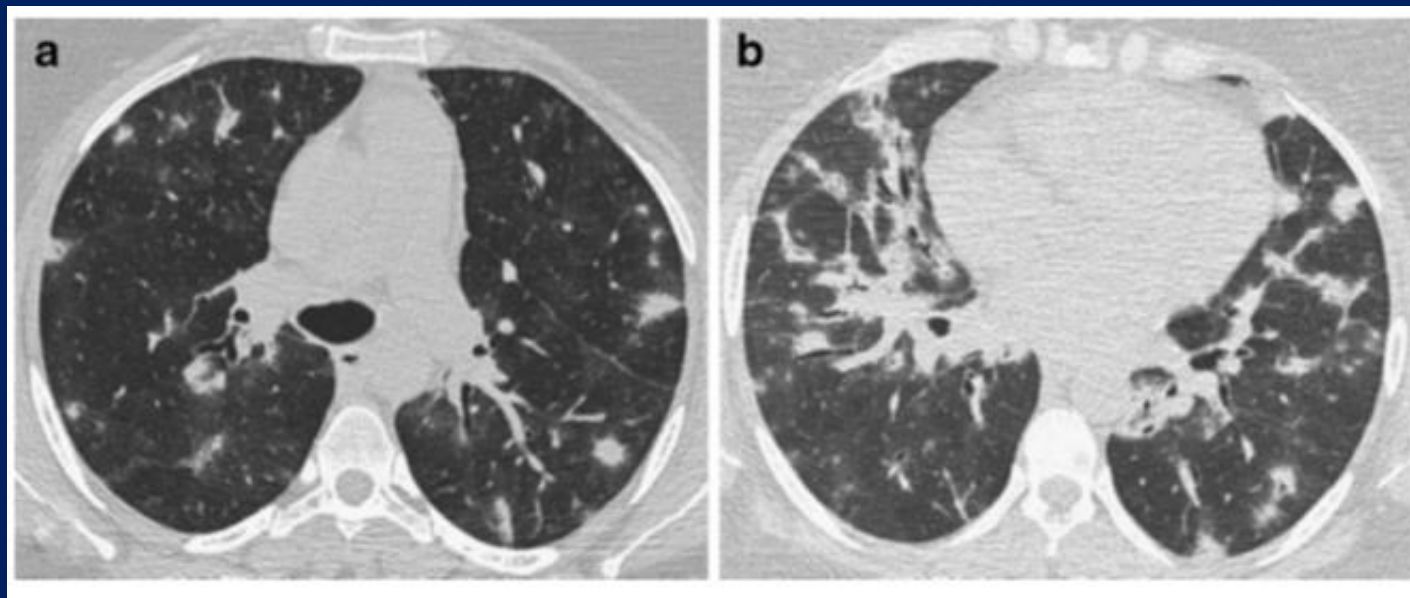
CLASSIC COVID19

GGO, reverse halo and perilobular

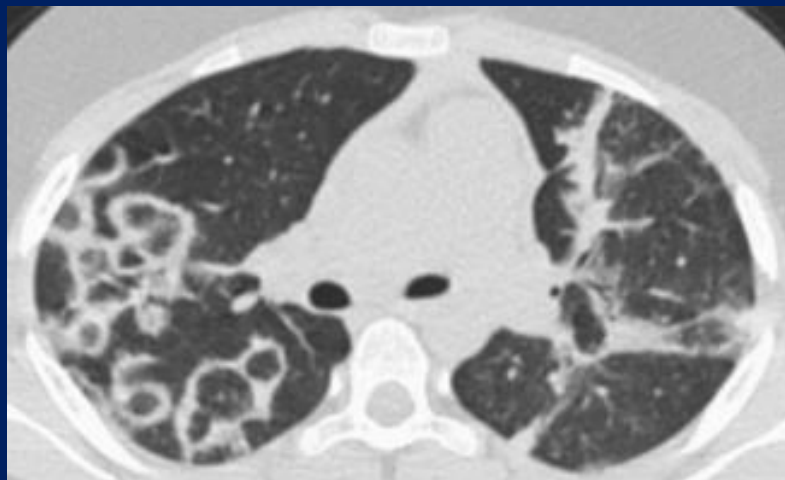


Reverse halo (arrow) and Perilobular opacities (arrowheads) are a sign of organising pneumonia

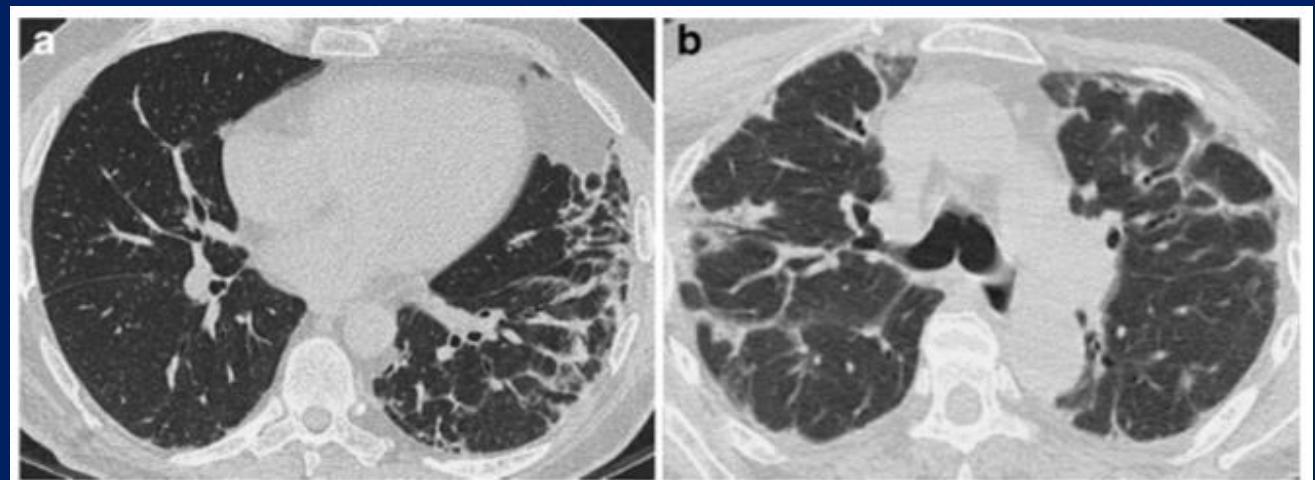
Organising pneumonia patterns



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

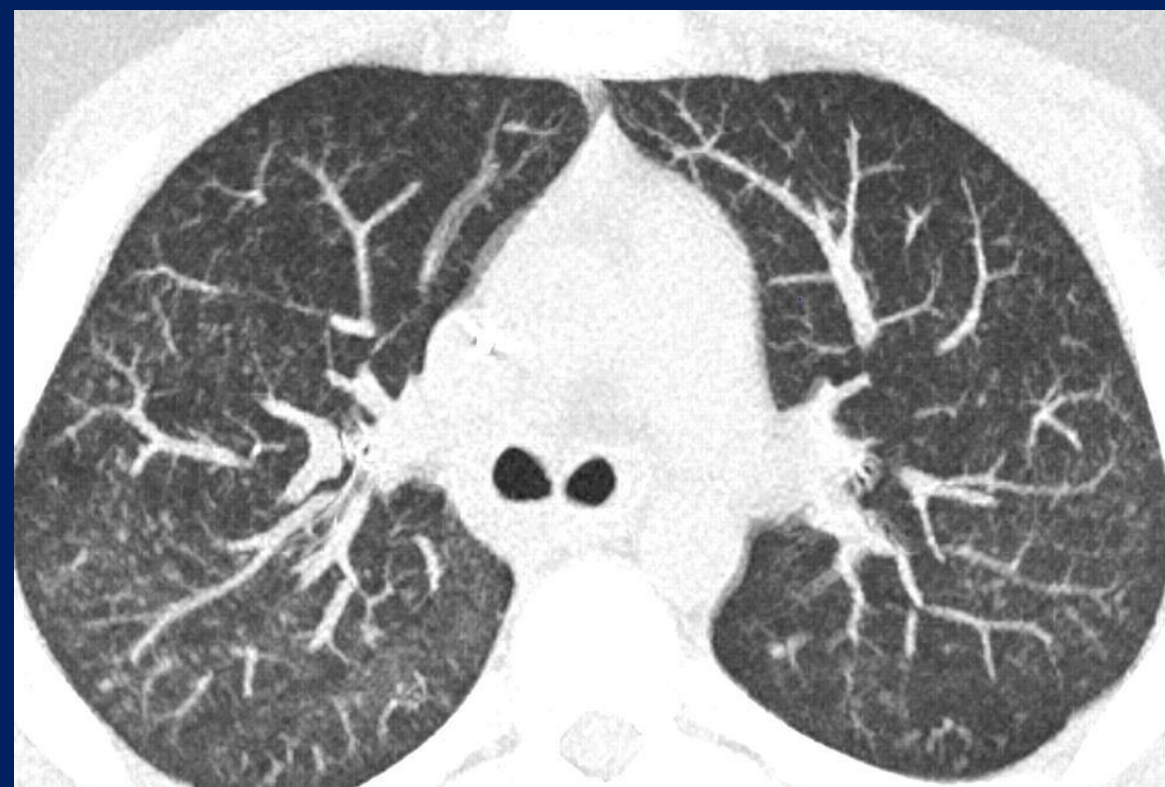


Needs clinic-radiology review. Fever, CRP and especially a **lymphopaenia**, would make COVID19 more likely

NON-COVID19



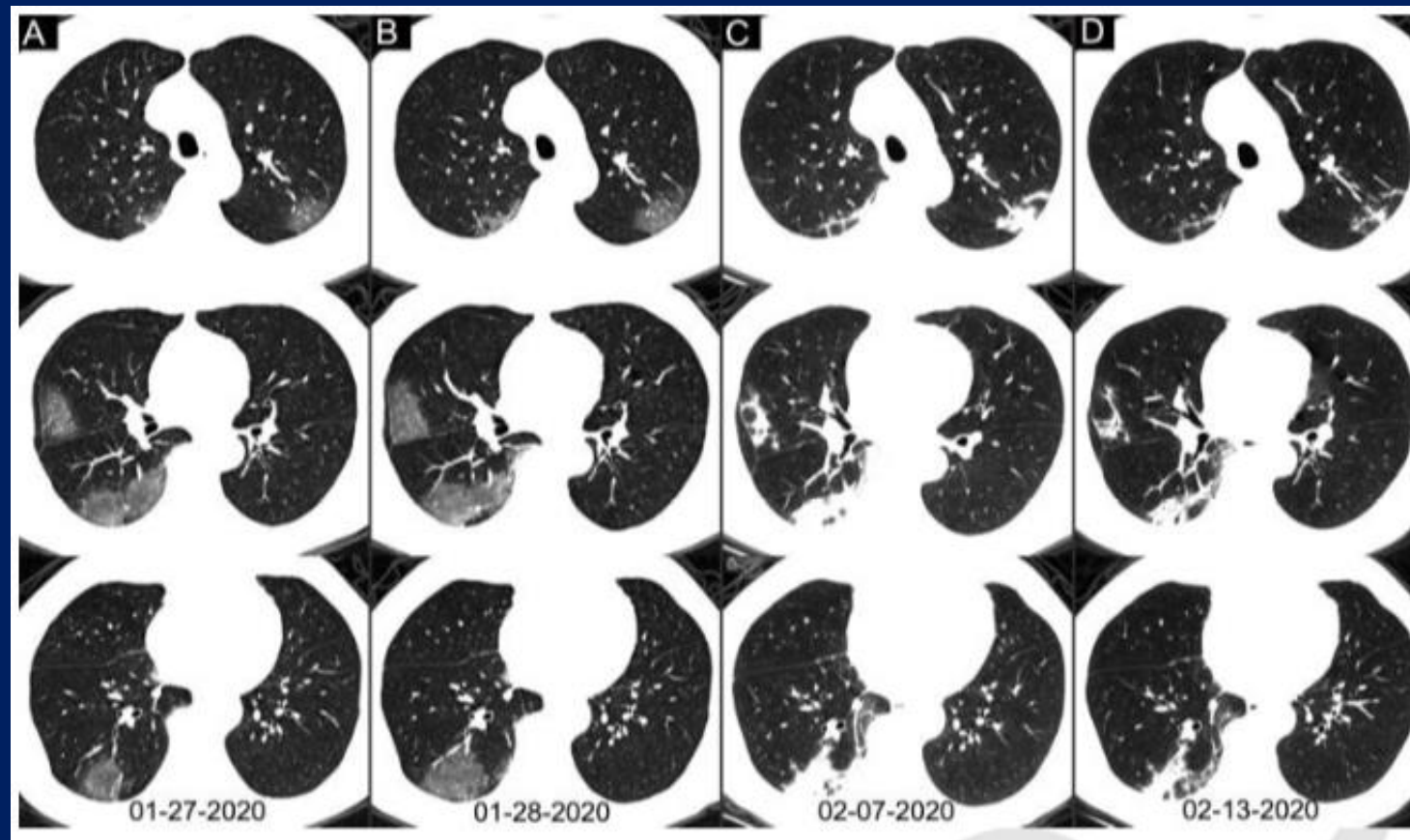
0.6mm lung recon



8mm MIP lung recon

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

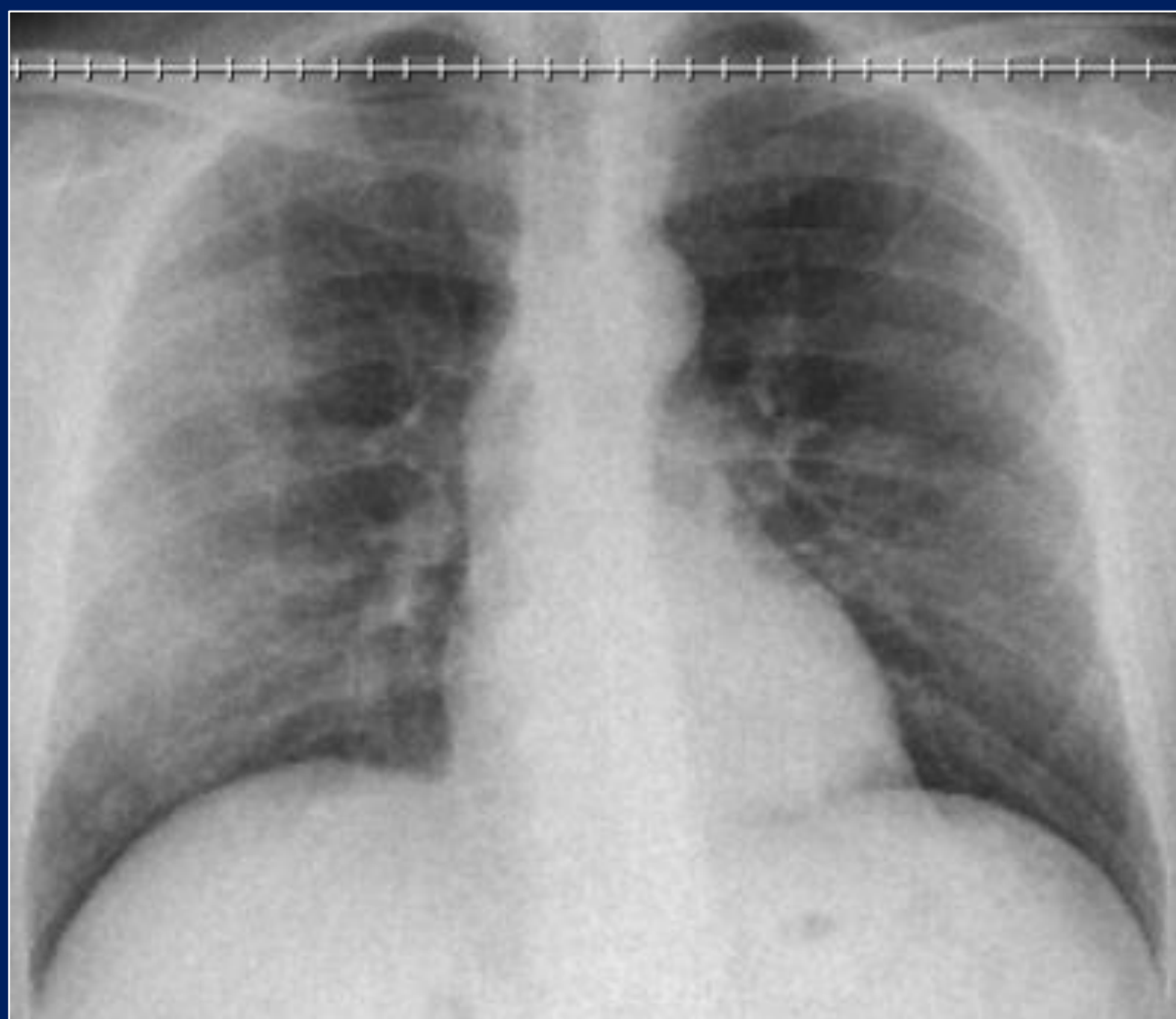
Serial change



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

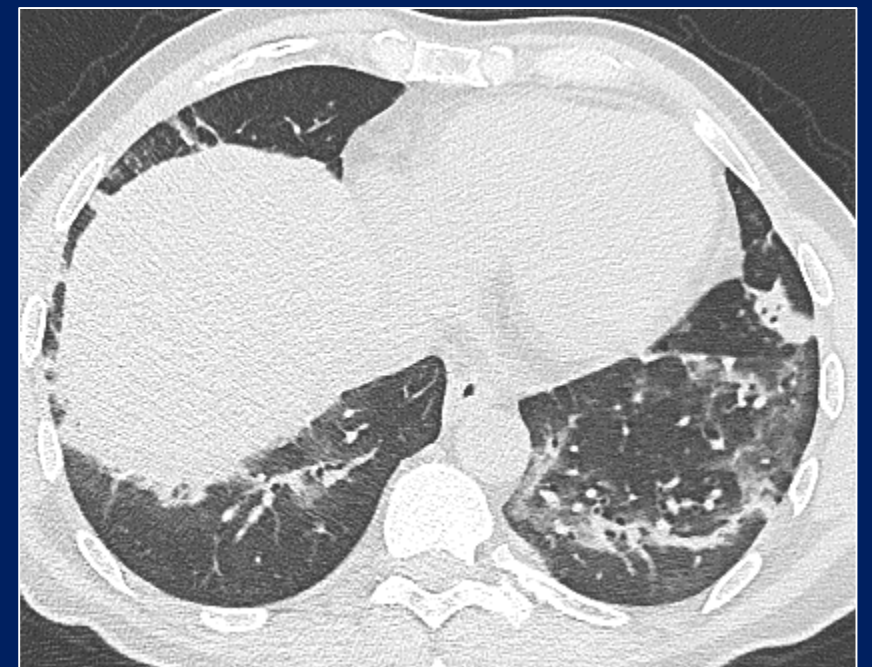
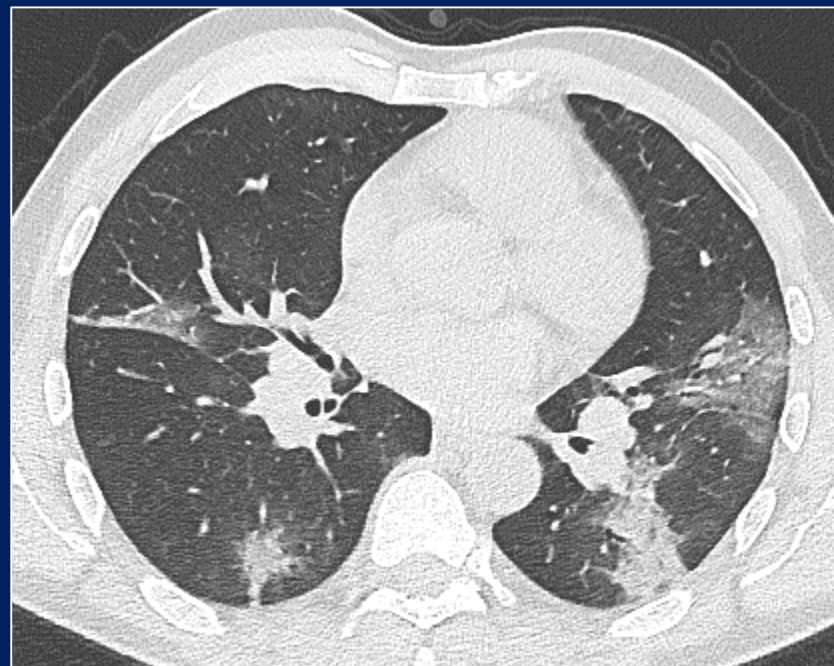
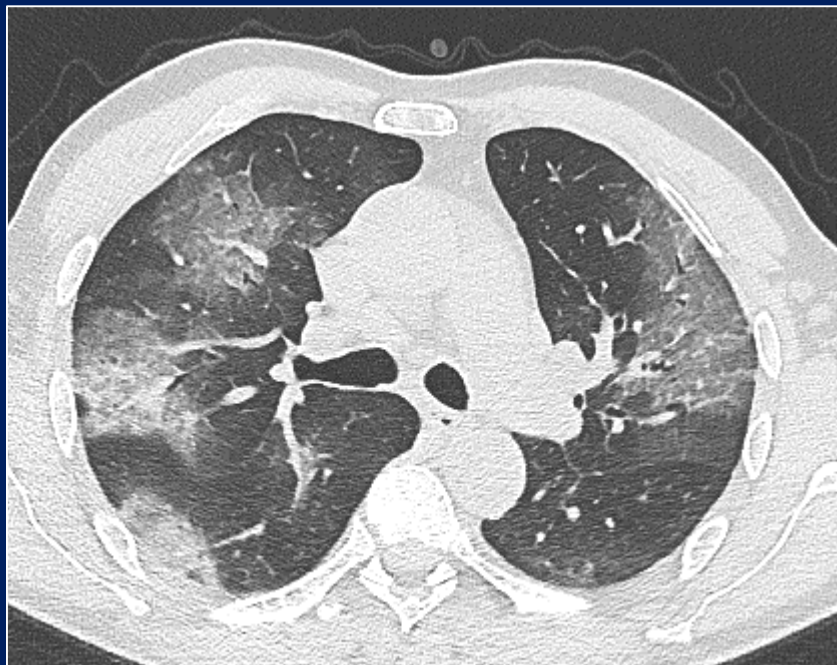


Unhelpful/
INDETERMINATE
Poor quality film

CLASSIC COVID-19

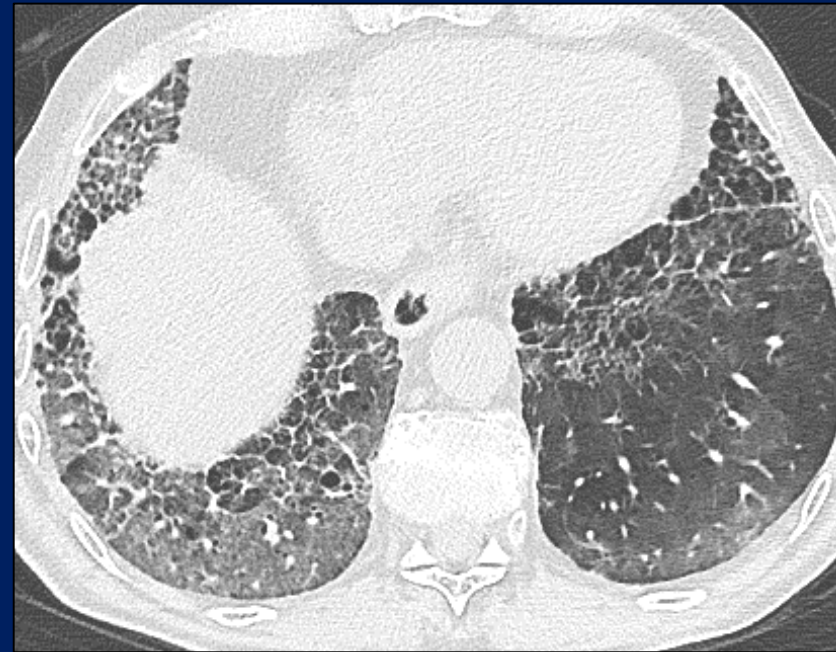
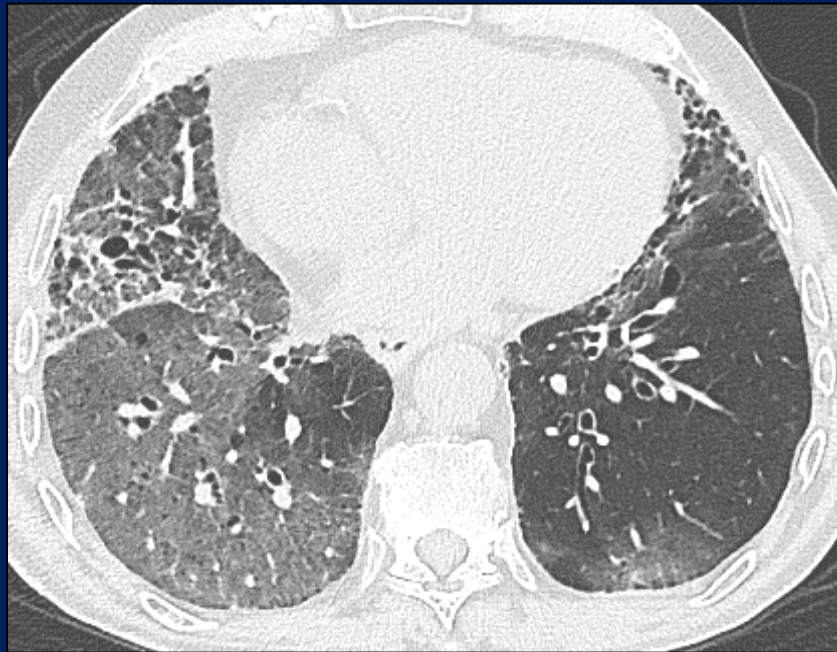


- Peripheral ground-glass opacities
- Crazy paving may be present
- Organising pneumonia



INDETERMINATE for COVID-19

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

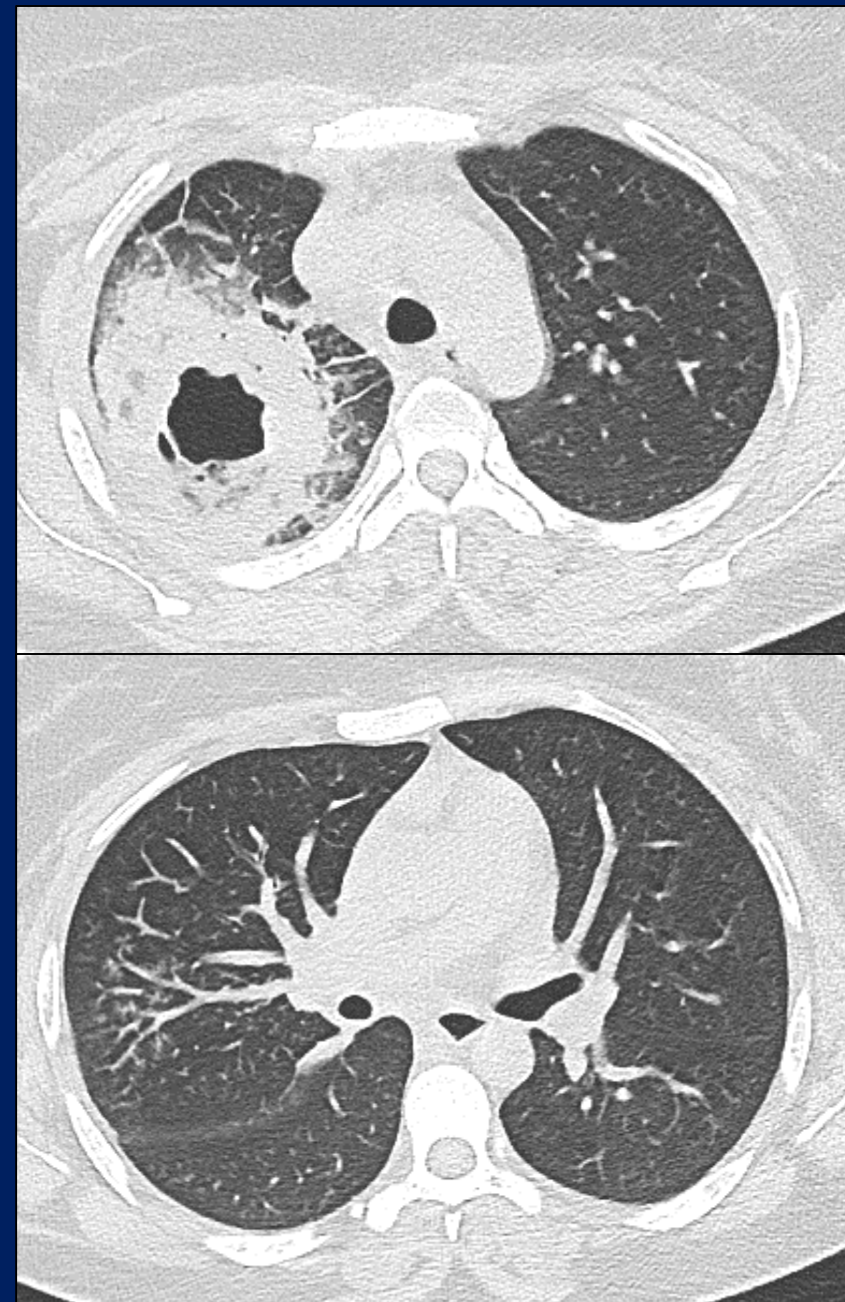


NON COVID19



The following would be unusual
in COVID -19 infection:

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

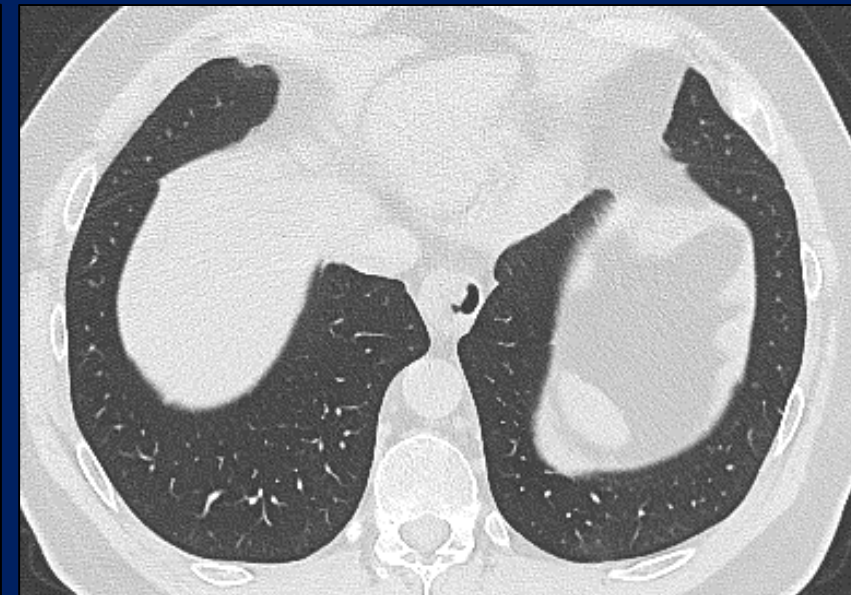
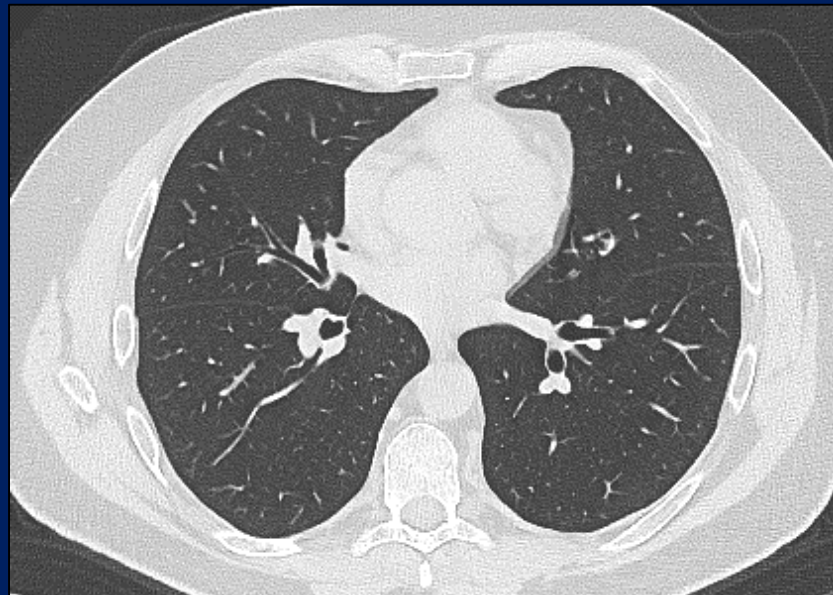
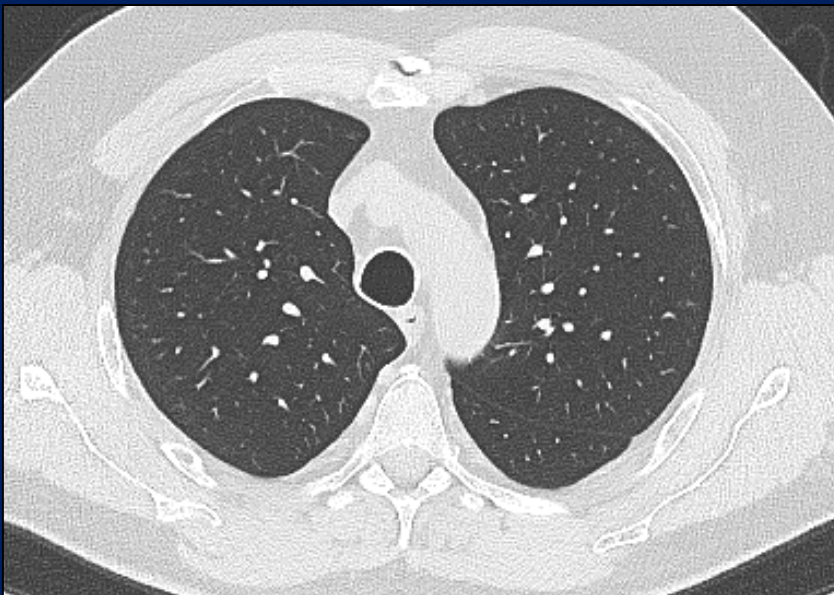


Differentiating abnormalities in the presence of underlying emphysema or interstitial lung disease maybe difficult

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
Classic/Probable/Indeterminate	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
Pure ground glass opacities	Up to 3 focal abnormalities < 3cm in max diameter
Pure ground glass opacities	More than 3 focal abnormalities or max diameter >3cm
Focal ground glass opacities mixed with early consolidation	Moderate / Severe*
Diffuse ground glass opacities or consolidation with signs of architectural distortion	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, ≤ 3 focal abnormalities and all ≤ 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 ≤ 3 focal abnormalities and all ≤ 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



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

Please consider case upload to https://bit.ly/BSTICovid19_Database

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



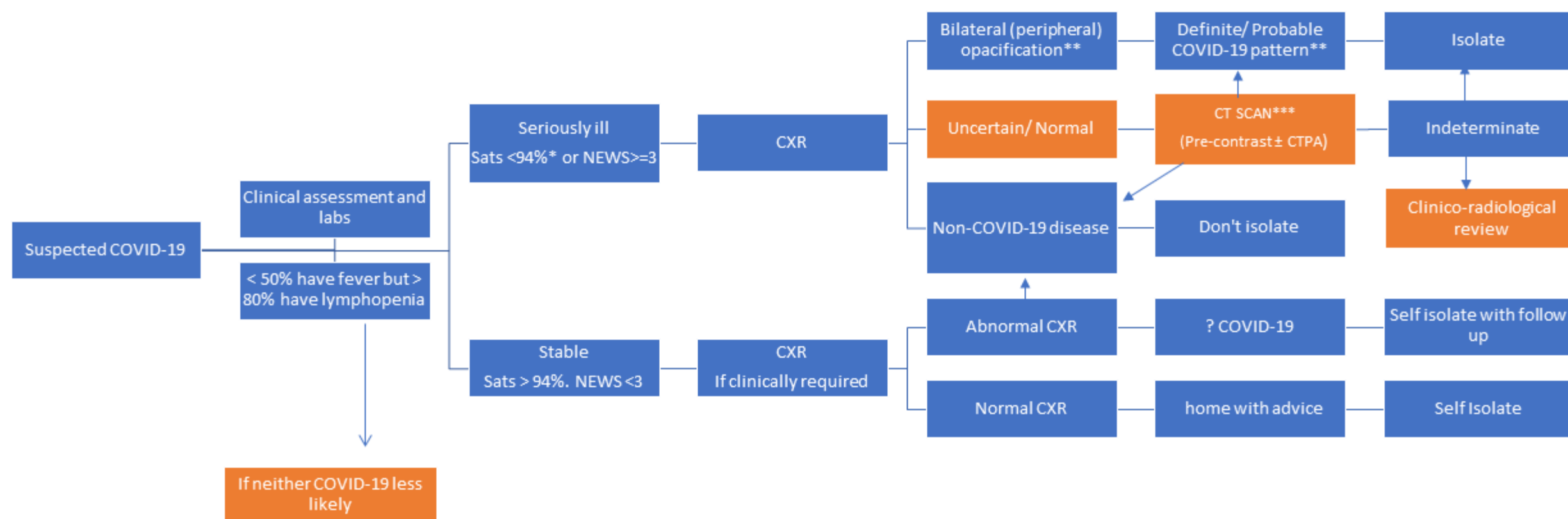
- Refer a case https://bit.ly/BSTICovid19_Database
- Teaching Library https://bit.ly/BSTICOVID19_Teaching_Library



- Updates can be found on 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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