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
• 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
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

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Description</th>
</tr>
</thead>
</table>
| **CLASSIC COVID-19**           | Lower lobe predominant, peripheral predominant, multiple, bilateral* foci of GGO ±  
                                 | • Crazy-paving  
                                 | • Peripheral consolidation**  
                                 | • Air bronchograms  
                                 | • Reverse halo/ perilobular pattern** |
| **PROBABLE COVID-19**          | Lower lobe predominant mix of bronchocentric and peripheral consolidation  
                                 | • Reverse halo/ perilobular pattern**  
                                 | • GGO scarce |
| **INDETERMINATE**              | 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**                  | 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 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
Reverse halo (arrow) and Perilobular opacities (arrowheads) are a sign of organising pneumonia
Organising pneumonia patterns

Reverse halo pattern

Bronchocentric consolidation and irregular nodules

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

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
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 may be difficult.
It is important to remember that a normal CT can be seen in early COVID-19 infection.
CT pattern and quantifying disease

<table>
<thead>
<tr>
<th>Radiology</th>
<th>Parenchymal lung changes</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic/Probable/Indeterminate</td>
<td>Up to 3 focal abnormalities 3cm in max diameter</td>
<td>Mild</td>
</tr>
<tr>
<td></td>
<td>More than 3 focal abnormalities or max diameter &gt;3cm</td>
<td>Moderate / Severe*</td>
</tr>
</tbody>
</table>

* The difference between moderate and severe is subjective and will likely differ between reporters. This should be used in conjunction with clinical assessment.
<table>
<thead>
<tr>
<th>Radiology in probable COVID-19</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure ground glass opacities Up to 3 focal abnormalities &lt; 3cm in max diameter</td>
<td>Mild</td>
</tr>
<tr>
<td>Pure ground glass opacities More than 3 focal abnormalities or max diameter &gt;3cm</td>
<td>Moderate / Severe*</td>
</tr>
<tr>
<td>Focal ground glass opacities mixed with early consolidation</td>
<td>Moderate / Severe*</td>
</tr>
<tr>
<td>Diffuse ground glass opacities or consolidation with signs of architectural distortion</td>
<td>Severe</td>
</tr>
</tbody>
</table>

* 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 / Peribular
  - 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 / Cavitition / Tree-in-bud / Centrilobular nodules / Lymphadenopathy / Effusion(s)
  - Other patterns

Disease Distribution
- Upper
- Middle
- Lower
- Random
  - Central 2/3
  - Peripheral 1/3
- Bronchoconstriction (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 ≤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 ≤3 cm max diameter
     - Mod/Severe: >3 focal abnormalities or >3 cm max diameter
4. Non-COVID-19
   - Correlate with RT-PCR

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

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:
CVX0 = Normal CVX1 = Classic CVX2 = Indeterminate CVX3 = Non-COVID-19

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


• Updates can be found on www.bsti.org.uk or via our Facebook (@BSTIImaging) or Twitter (@BSTIImaging) feeds.

The BSTI would like to thank Prof Nicola Sverzellati and his team in Parma Italy for sharing information and images.
Radiology decision tool for suspected COVID-19

- **Suspected COVID-19**
  - Clinical assessment and labs
    - < 50% have fever but > 80% have lymphopenia
- **Suspected COVID-19**
  - CXR
    - **Seriously ill**
      - Sats <94%* or NEWS≥3
    - **Stable**
      - Sats >94%. NEWS<3
      - CXR
        - **Normal CXR**
          - home with advice
        - **Abnormal CXR**
          - ? COVID-19
          - ? COVID-19
          - Self Isolate
- **Suspected COVID-19**
  - **Uncertain/Normal**
    - CT SCAN***
      - (Pre-contrast± CTPA)
      - Don’t Isolate
      - Clinico-radiological review
      - Indeterminate
      - Isolate
  - **Non-COVID-19 disease**
    - Don’t Isolate
  - **Bilateral (peripheral) opacification***
    - Definite/Probable COVID-19 pattern***
    - Isolate
  - **If neither COVID-19 less likely**

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