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## CASE REVIEW

# Computed tomography of covid-19 pneumonia

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On 23 January 2020, a man in his late 60s presented to hospital in Zhuhai, China, with a four day history of fever ( $\sim 38^\circ\text{C}$ ) and no other symptoms. His wife, who was in her early 70s, also had a fever and was admitted to hospital at the same time.

His blood pressure was 130/75 mm Hg, pulse 62 beats/min, respiratory rate 20 breaths/min, and oxygen saturation 95–98% on air. On auscultation, slightly coarse chest sounds were heard.

Unenhanced chest computed tomography showed multifocal ground glass opacity in the bilateral subpleural area (fig 1) and he was admitted. He was given intravenous antibiotics (the standard local treatment for bilateral pneumonia), and covid-19 reverse transcriptase polymerase chain reaction (RT-PCR) assay was performed on nasal and pharyngeal swabs, in accordance with World Health Organization protocol.<sup>1</sup> The results were available on day 2 after presentation (table 1).

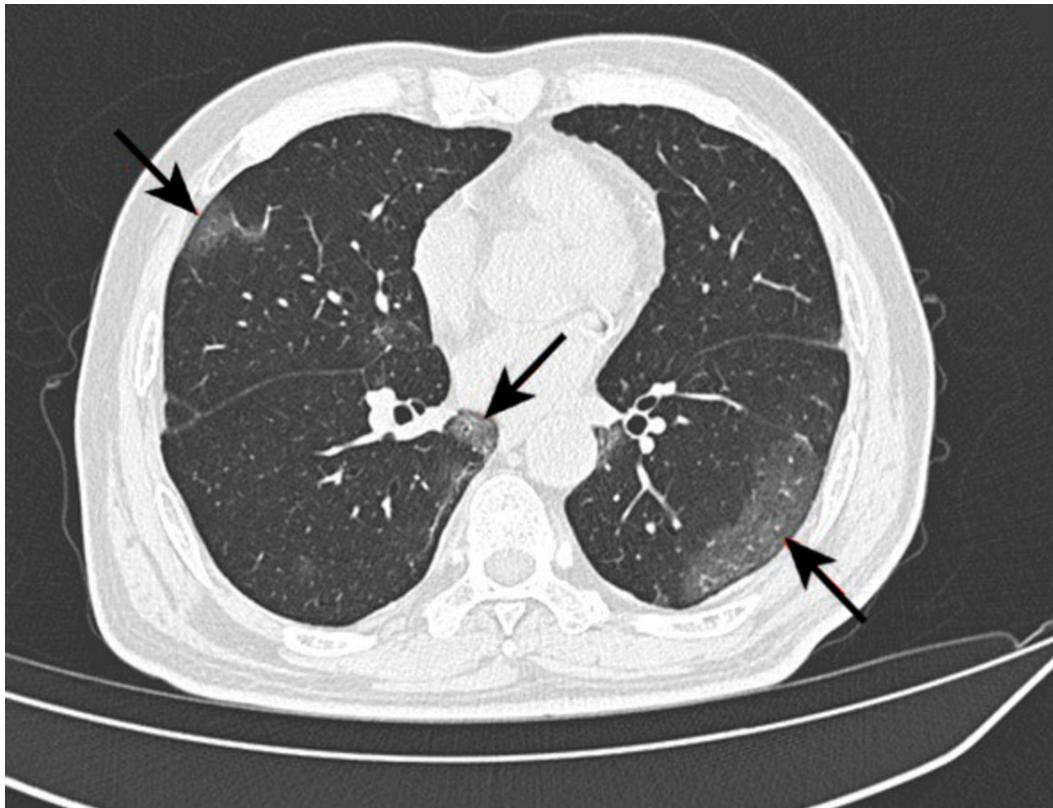


Fig 1 | Unenhanced chest computed tomogram on admission showing ground glass opacities in left lower lobe and right middle lobe (black arrows)

**Table 1 | Relevant blood test results each day since presentation**

Test	Day since presentation				Normal range
	1	3	4	5	
White cell count ( $\times 10^9/\text{L}$ )	3.71	6.51	5.00	6.24	(4-10)
Lymphocyte count ( $\times 10^9/\text{L}$ )	0.71	0.66	0.61	0.83	(1.1-3.2)
C reactive protein (mg/L)	38.6	22.02	39.84	117.21	(<5)
Partial pressure of carbon dioxide (mm Hg)	33.9	31.2	29.4	26.9	(35-45)
Partial pressure of oxygen (mm Hg)	92.4	61.5	58.4	52.2	(80-100)
Oxygenated haemoglobin (%)	94.9	90.6	90.8	85.2	(90-95)
Lupus anticoagulant (mmol/L)	2.1	1.9	2.6	2.5	(0.9-1.7)
Calcium (mmol/L)	1.08	1.10	1.07	1.04	(1.15-1.29)
Covid-19 reverse transcriptase PCR assay	Positive	N/A	N/A	N/A	negative

N/A=not applicable; PCR=polymerase chain reaction

On day 5 after presentation, he developed sudden shortness of breath while walking around the ward. His oxygen saturation decreased to 83-86%, arterial blood gas showed PO<sub>2</sub> of 52.2 mm Hg (table 1), and oxygen treatment was initiated. Repeat computed

tomography showed enlarged subpleural ground glass opacities, new small consolidations, and extensive interlobular and intralobular septal thickening in the lower lung regions (fig 2).

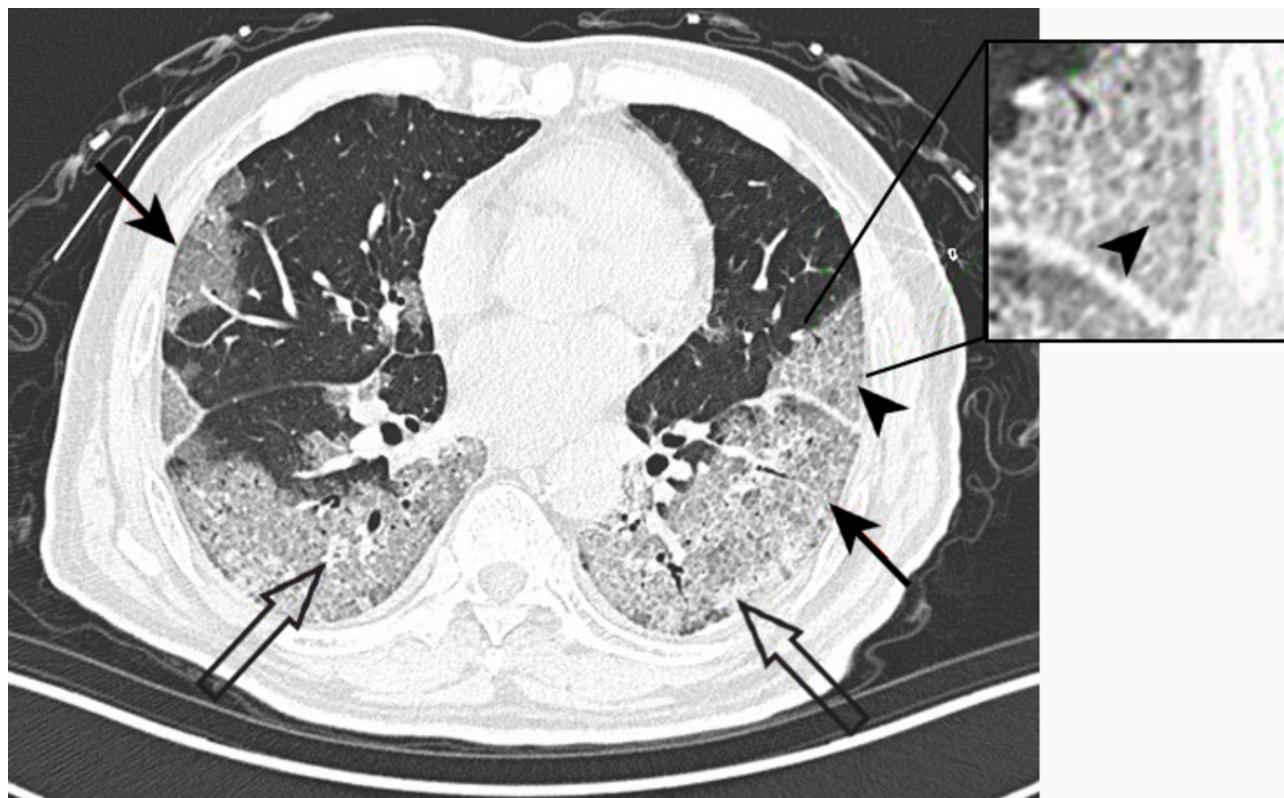


Fig 2 | Unenhanced computed tomogram on day 5 showing lower lung predominant extensive bilateral ground glass opacities (black arrows) with interlobular and intralobular septal thickening (arrowhead), forming a “crazy paving” pattern (showed by local amplification). A few small confluent consolidations are also seen (clear arrows)

On day 7 he developed mild diarrhoea.

### Questions

- What is the diagnosis?
- What is the role of radiological investigations?

- What are the differential diagnoses?

### Answers

#### 1 What is the diagnosis?

Covid-19 pneumonia—confirmed by a positive covid-19 RT-PCR assay result and indicated by the patient's clinical presentation, geographical location at time of presentation, and presence of bilateral pneumonia on computed tomograms.

Data from 1099 patients with covid-19 (confirmed by laboratory test results) from 552 hospitals across China until 29 January 2020<sup>2</sup> suggest that clinical manifestations of covid-19 can include fever (44% of patients on admission, 89% during hospital stay), cough (68%), nausea or vomiting (5%), and diarrhoea (4%). Information about covid-19 is continually evolving; however, in its current clinical management guidance WHO listed the non-specific symptoms as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnoea, nasal congestion, headache, diarrhoea, and nausea and vomiting.<sup>3</sup>

A statement from the British Society of Thoracic Imaging suggests that “bilateral, subpleural ground glass opacity, ill defined margins, and a slight right lower lobe predilection” are the most common initial computed tomography findings of covid-19 pneumonia.<sup>4</sup> The statement also suggests that, with disease progression, findings can range from “focal unilateral abnormality to diffuse bilateral opacities,” and might evolve to “consolidation, reticulation, and mixed pattern disease.”<sup>4</sup>

By “mixed pattern disease”, the British Society of Thoracic Imaging is referring to a mixture of ground glass opacity and consolidation

## 2 What is the role of radiological investigations?

Pneumonia and ground glass opacity can sometimes be detected by computed tomography before patients develop classic symptoms, as in this case; however, computed tomography might also be normal in early disease, and it does not confirm which organism is responsible for the pneumonia.

Computed tomography is routinely used in China when patients with suspected covid-19 are admitted to hospital. Chest radiography is not routinely performed in China because it is believed that the changes associated with covid-19, such as ground glass opacity, can be more difficult to see on plain films, especially in the early stages of the disease.

However, at the time of writing, the British Society of Thoracic Imaging recommends that computed tomography is performed only in seriously ill patients who have a normal or uncertain chest radiograph,<sup>5</sup> and the Society of Thoracic Radiology in the United States only recommends computed tomography for patients with positive covid-19 RT-PCR results when there are suspected complications such as abscess or empyema.<sup>6</sup> The American College of Radiology also recommends against using computed tomography to screen as a first line test to diagnose covid-19.<sup>7</sup>

In this case, follow-up computed tomography was performed when the patient's condition changed, but there is no established protocol on the number of scans required.

It should be noted that repeated computed tomography might increase the radiation dose for patients and could increase risk of cross infection in other vulnerable patients who require imaging. Computed tomography might also not be available in low resource settings.

## 3 What are the differential diagnoses?

These clinical characteristics and computed tomography results are not specific to covid-19 and might be found in patients with

H1N1 influenza, cytomegalovirus pneumonia, community acquired pneumonia, and other coronavirus infections such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).<sup>4,8</sup>

The authors of the case series of 1099 patients also suggested that the clinical characteristics of covid-19 mimic those of SARS<sup>2</sup>; they suggest that the absence of fever in covid-19 is thought to be more common than in SARS and MERS. These authors also suggested that because fever and cough are the dominant symptoms and gastrointestinal symptoms are not common in covid-19, there is a difference in the viral tropism of covid-19 compared with that of SARS, MERS, and seasonal influenza.<sup>2</sup> Covid-19 infection can be confirmed with an RT-PCR assay, although test reliability varies with reported false negative rates of around 30%.<sup>9</sup>

### Patient outcome

Because a standard treatment protocol for covid-19 pneumonia had not been established, the patient received standard pneumonia treatment for the duration of his hospital stay.

As the clinical features of covid-19 were deemed similar to those of SARS, while he was an inpatient he also had treatments that had been effective in China for the treatment of SARS (chloroquine phosphate and traditional Chinese medicine (*qingfei paidu* decoction)); according to local protocol.<sup>10-14</sup>

On day 15 after presentation, the result of RT-PCR assays was negative.

On day 18, the patient had recovered clinically, and nasal and pharyngeal swab RT-PCR assays were negative. Computed tomography to monitor improvement showed considerable but incomplete resolution of bilateral ground glass opacity and consolidations, and he was discharged in line with WHO recommendations.<sup>4</sup>

The patient's wife also had a diagnosis of covid-19, and she made a complete recovery. She was discharged at the same time.

Their daughter, in her 30s, lived in the same house. She self-isolated while her parents were in hospital and tested negative for covid-19. She remained without any symptoms.

### Learning point

Covid-19 pneumonia might be detected with radiological interventions before patients develop classic symptoms; however, it is important to remember that computed tomograms and chest radiographs might also appear normal, especially if the disease is in the early stages, and they do not offer organism specific results.

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1 World Health Organization. Coronavirus disease (COVID-19) technical guidance: laboratory testing for 2019-nCoV in humans. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance>.

2 Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of Coronavirus disease 2019 in China. *N Engl J Med* 2020.

- 3 World Health Organization. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance. 2020. [https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected).
- 4 Rodrigues JCL, Hare SS, Edey A, et al. An update on COVID-19 for the radiologist: A British Society of Thoracic Imaging statement. *Clin Radiol* 2020.
- 5 British Society of Thoracic Imaging. Radiology decision tool for suspected COVID-19. [https://www.bsti.org.uk/media/resources/files/NHSE\\_BSTI\\_APPROVED\\_Radiology\\_on\\_CoVid19\\_v6\\_modified1\\_\\_-Read-Only.pdf](https://www.bsti.org.uk/media/resources/files/NHSE_BSTI_APPROVED_Radiology_on_CoVid19_v6_modified1__-Read-Only.pdf)
- 6 Society of Thoracic Radiology, American Society of Emergency Radiology. <https://thoracirad.org/wp-content/uploads/2020/03/STR-ASER-Position-Statement-1.pdf>
- 7 American College of Radiology. ACR recommendations for the use of chest radiography and computed tomography (CT) for suspected COVID-19 infection. March 11, 2020. Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection. <https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection>.
- 8 Zu ZY, Jiang MD, Xu PP, et al. Coronavirus disease 2019 (COVID-19): a perspective from China. *Radiology* 2020;295.
- 9 Watson J. Interpreting a covid-19 test result. *BMJ* 2020;369:m1808. doi: 10.1136/bmj.m1808.
- 10 Vincent MJ, Bergeron E, Benjamet S, et al. Chloroquine is a potent inhibitor of SARS coronavirus infection and spread. *Virology* 2005;2:69.
- 11 Multicenter collaboration group of Department of Science and Technology of Guangdong Province and Health Commission of Guangdong Province for chloroquine in the treatment of novel coronavirus pneumonia. Expert consensus on chloroquine phosphate for the treatment of novel coronavirus pneumonia. *Zhonghua Jie He He Hu Xi Za Zhi* 2020;43:185-8.
- 12 Cascella M, Rajnik M, Cuomo A, Dulebohn SC, Di Napoli R. *Features, Evaluation and Treatment Coronavirus (COVID-19)*. StatPearls Publishing, 2020.
- 13 Yao X, Ye F, Zhang M, et al. In vitro antiviral activity and projection of optimized dosing design of hydroxychloroquine for the treatment of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). *Clin Infect Dis* 2020.
- 14 Ren JL, Zhang AH, Wang XJ. Traditional Chinese medicine for COVID-19 treatment. *Pharmacol Res* 2020;155.

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