

Chest computed tomography in coronavirus disease 2019 pneumonia subjects: Call for judicious use

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Abstract

Since the novel coronavirus disease 2019 (COVID-19) outbreak, there has been an unprecedented increase in the number of patients undergoing chest computed tomography (CT). More than 689 million cases have been infected by COVID-19 worldwide till date, of whom many were subjected to CT scanning. Several national and international bodies recommended against the routine use of chest CT for COVID-19 cases. However, evidence points to overuse. This review attempts to briefly describe when and why a chest CT is clinically indicated for COVID-19 patients to judicious use and enhance the benefit–risk ratio.

Keywords: Chest, computed tomography, coronavirus disease 2019, overuse

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Received: 19-02-2023 **Revised:** 01-06-2023 **Accepted:** 03-06-2023 **Published:** 18-07-2023

INTRODUCTION

Radiography and computed tomography (CT) of the chest are the two most common diagnostic procedures that are frequently requested by physicians for addressing a wide variety of chest diseases. Chest radiography is the first imaging test for assessing chest disease, yet it remains prone to malpractice issues due to low diagnostic sensitivity. Numerous lung lesions of a wide variety of chest diseases may be missed on a chest radiograph, especially in hidden areas.^[1,2] An estimate of 12%–90% of lung carcinomas could be missed on chest radiographs.^[1,3] Chest CT is higher sensitive than a chest radiograph and is usually indicated when the patient is symptomatic, yet a chest radiograph is normal or when a chest radiograph is abnormal and further assessment is required.^[1] However, CT carries

higher radiation exposure and risk than a chest radiograph and should be prescribed only when clinically indicated.

Since the novel coronavirus disease 2019 (COVID-19) outbreak, the role of chest CT for screening, diagnosis and management of the disease has garnered increasing attention.^[4,5] Till 27 May 2023, more than 689 million cases of COVID-19 have been identified worldwide,^[6] many of whom were subjected to CT scanning.^[7,8] In the early months of the pandemic, the rapid spread of the disease had limited availability of viral testing kits. This situation, along with reporting delays of up to 7 days, prompted some healthcare sites to turn to chest CT as a fast diagnostic tool in known and suspected COVID-19 cases, especially because some reports demonstrated that chest

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Quick Response Code:	Website: www.jpsiconline.com
	DOI: 10.4103/jpsic.jpsic_2_23

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How to cite this article: Karami V, Moazen J, Arianezhad A, Khajehrezaei S, Sharifi M. Chest computed tomography in coronavirus disease 2019 pneumonia subjects: Call for judicious use. J Patient Saf Infect Control 2022;10:82-6.

CT suggested for viral pneumonia in some negative reverse transcription–polymerase chain reaction (RT-PCR) tests.^[9] However, evidence points to overuse and lack of adherence to evidence-based practice. It is estimated that each hospitalised patient infected by COVID-19 has undergone 2–8 chest CT in a short span of time.^[7,10–13] In a retrospective data collection study coordinated by the International Atomic Energy Agency, including 62 healthcare sites from 34 countries across four continents of Africa, Asia, Europe and Latin America, 22% used chest CT as the primary diagnostic tool for evaluating COVID-19. In 76% of the sites, chest CT was used to assess the severity of the disease and in 51% for routine follow-up.^[13] Moreover, 11 sites used multiphase chest CT,^[13] whereas the diagnostic value of multiphase chest CT scanning is questionable for managing COVID-19.^[13,14] In some cases, the stress of the disease has led to an illness anxiety disorder that leads to healthy persons being subjected to CT scanning.^[12] This is of particular concern because chest CT exposes patients to hazardous ionising radiation. One recent report estimated that if we presume each surviving person infected by COVID-19 was exposed to a single standard-dose chest CT, a significant number of 472,500–1,868,500 new cases of cancer incidence and 237,300–938,400 cancer deaths could be expected in the near future throughout the world.^[8] Accordingly, several regulatory bodies such as the American College of Radiology,^[15] the American Centres for Disease Control and Prevention^[16] and the Royal College of Radiologists^[17] have issued position statements against the routine use of chest CT for screening COVID-19 without RT-PCR or antigen tests. Therefore, understanding when and why a chest CT is clinically indicated for COVID-19 patients can lead to judicious use of this diagnostic investigation and enhance the benefit–risk ratio.

DIAGNOSTIC SENSITIVITY OF CHEST COMPUTED TOMOGRAPHY FOR CORONAVIRUS DISEASE 2019 PNEUMONIA

Several studies investigated the diagnostic sensitivity of chest CT for COVID-19 pneumonia. A primary meta-analysis on six studies comprising 1431 patients who were mainly symptomatic for COVID-19, reported a chest CT pooled sensitivity of 94.6% (95% confidence interval [CI]: 91.9%–96.4%) and a pooled specificity of 46% (95% CI: 31.9%–60.7%) for detecting COVID-19.^[18] The included studies, however, had methodological quality issues and all had a high or potential risk of bias, suggesting that the reported sensitivity is probably overestimated.^[18] Another meta-analysis, which included 60 primary studies comprising a total of 5744 patients who were mainly

symptomatic for COVID-19, reported a chest CT sensitivity of 87% (95% CI: 85%–90%) and specificity of 46% (95% CI: 29%–63%), compared to RT-PCR.^[19] There are 14 other meta-analyses^[20–33] and 2 umbrella reviews^[34,35] on this topic. In an umbrella review on 11 systematic reviews and 15 primary diagnostic test accuracy studies, the pooled sensitivity and specificity of chest CT were reported 91% (95% CI: 88%–93%) and 73% (95% CI: 61%–82%), respectively. However, all systematic reviews showed a risk of bias in virtually all primary studies.^[34] The most recent umbrella review on 14 systematic reviews, including a total of 185,700 patients who were mainly symptomatic for COVID-19, reported chest CT sensitivity to be 90% and specificity to vary between 25% and 83%.^[35]

ECONOMIC CONSIDERATIONS AND INFECTION CONTROL

Infection control considerations in imaging equipment further complicate the issue. After CT scanning of a patient with suspected or known COVID-19, disinfection of the scanner, adequate ventilation of the imaging room and a 1-h inter-patient time should be respected; otherwise, imaging equipment may serve as a source for the transition of the infection.^[15] Therefore, when possible, one CT room may be allocated for imaging of known and suspected COVID-19 cases. Our experience from the beginning of the pandemic to date shows that there are practical limitations for the implementation of such an approach in practice. In our institution with three active CT rooms, to date, more than 70,000 chest CT scans have been performed in patients with suspected or known COVID-19 cases. On some days, we experienced ~200 chest CT scans in three consecutive work shifts (3 h × 6-h) in one CT room. The highly increased number of patient referrals resulted in repeated X-ray tube failure as well as the installation of new CT scanners in some healthcare sites, imposing huge economic costs on the healthcare system.

LOW-DOSE CHEST COMPUTED TOMOGRAPHY PROTOCOLS

The rapid spread of the disease and concerns over the radiation-related risks have led to introducing of several low-dose chest CT protocols for COVID-19 pneumonia patients with approximately 88%–91% reduction in radiation dose, without compromising patients care. Garg *et al.* estimated the radiation-related cancer risk from a single low-dose chest CT at 2–8/100,000 people. In a qualitative approach, this could translate into a ‘very low’ level of risk. In comparison, in standard-dose chest CT, the radiation-related cancer risk was 15–195/100,000 people which is consistent with ‘low’ level of risk.^[8]

Therefore, radiologic technologists should learn to use low-dose chest CT protocols for COVID-19 patients. The creation of a good risk-benefit dialogue between referring physicians and radiologists before prescribing chest CT in COVID-19 patients may also be helpful.

CLINICAL JUDGEMENT

Several studies indicated that chest radiographs, especially portable, can be useful in situations where there is no access to CT and to reduce cross infection. However, a chest radiograph does not help in the early stages of lung involvement unless the respiratory involvement is severe or there are some forms of radiological manifestations such as consolidation.^[36]

Usually, lung involvement in COVID-19 occurs in the 2nd week of the onset of symptoms. In the first 1–2 weeks, we have the viral phase of the disease, when the virus is replicating and usually patients have early symptoms of infection such as fever, mild non-productive cough, headache, myalgia, sore throat and malaise. Although these two phases do not have a precise border and there may be an overlap, a normal chest CT, especially in the early stages of the disease, does not rule out COVID-19 infection.^[37] On the other hand, it should be noted that not all patients who are infected with COVID-19 will have lung involvement. A large number of COVID-19 patients have a mild form of the disease, which is usually not associated with lung involvement. Evidence suggests that 15%–50% of COVID-19 cases never develop lung involvement on chest CT.^[38] Furthermore, a chest CT with lung involvement consistent with the disease does not necessarily confirm COVID-19 since CT findings overlap with several other infections such as influenza, H1N1, SARS and MERS, which may lead to false-positive results.^[37] Therefore, it seems that most patients do not need imaging. However, the role of chest CT in managing the disease, especially for moderate-to-severe COVID-19 cases with lung involvement and in determining the severity of the disease, is undeniable. Chest CT is also valuable for detecting pulmonary radiological manifestations such as ground-glass opacities and crazy paving patterns.^[39]

It has been shown that most hospitalised patients with pulmonary involvement due to COVID-19 are elderly or patients with an underlying disease. Of course, pregnant women, especially in the third trimester and throughout delivery, should always be considered high-risk people for disease exacerbation.^[40,41] Therefore, old age and underlying diseases can be important factors for clinical judgement.

A series of clinical and laboratory findings are related to the severity or inflammatory phase of the COVID-19. For example $\text{PaO}_2/\text{FiO}_2 < 300$ mmHg, respiratory rate (RR) > 30 breath/min, respiratory distress, O_2 saturation $< 90\%$ on room air, D-dimer > 1000 ng/mL, quantitative C-reactive protein > 75 mg/L, lactate dehydrogenase > 250 and erythrocyte sedimentation rate > 100 .^[42–44] However, it is necessary to understand that although these criteria are helpful, they are not enough for decision-making. Therefore, further evaluation, such as imaging, may be required.

COVID-19 is a complex disease and cannot be approached with a fixed formula for all patients. If the decision is based on a specific item, it may cause an error. For example, some people with chronic lung diseases such as chronic obstructive pulmonary disease may have a lower O_2 saturation level at baseline, whereas they do not have obvious dyspnoea, respiratory distress or tachypnoea. Therefore, one should always look at these patients comprehensively. It is emphasised that some clinical findings are very important in decision-making, such as tachypnoea (RR > 30), rapid drop in O_2 saturation or increased O_2 demand. It seems that to make a decision about performing a chest CT in a patient with COVID-19, the duration of symptoms, comorbidity disease, clinical conditions during the patient visit and some laboratory findings should be considered. However, according to the best evidence and our experience, the patient's clinical condition may be the most reliable factor for deciding on chest CT scanning.

In summary, the common indications for the use of chest CT in COVID-19 patients include:

1. Respiratory symptomatic patients with false-negative RT-PCR or when RT-PCR is not available
2. Patients admitted due to COVID-19 with suspected complications or deterioration of respiratory status
3. COVID-19 cases with fever lasting more than 5 days despite treatment measures
4. To assess the severity of lung involvement or pulmonary sequel, including fibrosis, in patients with a known COVID-19 infection
5. To evaluate for pulmonary embolism when clinically and laboratory suspected.

CONCLUSION

Although the frequency of chest CT is decreased compared to the early months of the pandemic, the COVID-19 pandemic is still ongoing. Chest CT provides valuable diagnostic information for managing COVID-19 and is

clinically indicated in some situations, but its routine use or use as a primary diagnostic tool for COVID-19 patients is unjustifiable. Judicious use of chest CT should be a part of patient's care. Unjustified chest CT scans can expose patients to hazardous ionising radiation and impose additional economic costs on the healthcare system, whereas it will not add something to the correct assessment of the diseases.

Acknowledgements

The authors would like to thank the Clinical Research Development Unit of Ganjavian Hospital, Dezful University of Medical Sciences, Dezful, Iran, for their support, cooperation and assistance throughout the period of the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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