Radiological profile in COVID-19 patients during second wave in Nepal Police Hospital: A descriptive cross-sectional study

Subash Thapa[1], MD; Bijaya Ram Shrestha[1], MD; Santosh Joshi[1], Deepa Nhuchhe Pradhan[1], DMRD; Nirmal Ghimire[2], PhD

[1]Department of Radiodiagnosis, Nepal Police Hospital, Kathmandu, Nepal
[2]Department of Internal Medicine, Nepal Police Hospital, Kathmandu, Nepal

Corresponding Author

Subash Thapa, MD
Email: subashthapa.hod@gmail.com

Received 1 August 2021
Accepted 22 November 2021

ABSTRACT

Introduction

Chest Radiography is a primary tool available in the clinical assessment for chest manifestation in a patient with Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection. This study was conducted to determine the utility of chest radiography and characterize the spectrum of chest imaging among COVID-19 patients.

Methods

We retrospectively reviewed chest radiographs of 370 confirmed COVID-19 patients presenting to Nepal Police Hospital, Kathmandu from 5 May to 20 June, 2021. The pattern of chest radiography was interpreted and the radiography findings were analyzed based on Modified Chest X-ray scoring system to enhance clinical understanding and prompt assessment of the COVID-19 patients. Pearson's correlation analysis was used to establish the linear correlation between clinical severity and the Modified Chest X-ray severity score.

Result

Out of 370 confirmed COVID-19 patients, 246 patients (66.49%) were male and 124 patients (33.51%) were female. 185 (50%) patients were admitted from the emergency where 154 (83.24 %) patients among 185 patients were discharged after recovery whereas 31 patients (24 male and 7 female) died. 229 patients in the study showed normal chest X-ray findings. Among 141 patients with abnormal chest radiography, 121 patients (85.81 %) showed bilateral lung involvement with predominantly ground glass opacity and more on peripheral distribution. Lower zone involvement was the most common findings followed by middle zone involvement. On Modified Chest X-ray severity score, 35.46% were mild, 47.51% were moderate and 17.03% were severe. The scoring showed a moderate positive correlation with the clinical severity of the patient.

Conclusions

Chest radiography pattern and scoring system can be used as tools to predict the disease severity in COVID-19 infection. Chest radiography in conjunction with clinical judgment can enhance specific treatment strategies in COVID-19 infection.

Keywords: **Chest Radiographs; COVID- 19; Modified Score; Pandemic.**

Introduction

The tale of Coronavirus disease 2019 (COVID-19) is no more arcane among people these days. The infection by severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) was first reported at the end of 2019 in the Wuhan city of China[1]. The worldwide spread of infection was so rampant and uncontrollable that the World Health Organization (WHO) declared the disease outbreak as a global pandemic on 11 March, 2021[1]. Nepal also witnessed the disastrous second wave of the outbreak in May 2021 with the highest recorded mortality (247 cases in 24 hours) on 19 May 20212. The disease manifests in varying degrees among individuals ranging from fever, fatigue, and dry cough as common symptoms which may progress to acute respiratory distress syndrome (ARDS) resulting in morbidity and mortality in advanced disease[1]. Chest radiography is considered as good monitoring of COVID-19 chest manifestation and severity scoring[3]. Our study was to characterize the pattern of chest radiography and analyze radiography findings based on the Modified Chest X-ray Scoring system to enhance the clinical understanding and prompt assessment of the COVID-19 patients.

Materials and methods

This was a hospital-based retrospective study conducted between 5th May- 20th June 2021, among reverse-transcription polymerase chain reaction (RT-PCR) confirmed COVID-19 patients who presented for chest radiography in the department of radiology at Nepal Police Hospital, Maharajgunj, Kathmandu, Nepal. No personal identifiers were included in data collection, and records were anonymized during analysis. 370 confirmed COVID-19 patients were included in the study whose first chest radiography at the time of presentation was recorded irrespective of the duration of the illness. Repeat and follow-up chest radiography images were not included in the study.

Image acquisition:

All Chest X-rays were acquired as computed radiography (CR) in posterior-anterior (PA) or anterior-posterior (AP) projection using portable chest X-ray unit in the isolation ward/ HDU/ICU and fixed X-ray unit at the Department of Radiology, for emergency and home isolation patients.

Image interpretation and image Analysis:

Image interpretation was done separately by two radiologists with experience of about 5 years under the supervision of a senior radiologist (more than 10-year experience). Chest radiography was interpreted as normal or abnormal. Abnormal findings were classified as lateralization (unilateral/ bilateral), distribution (peripheral/ central/ both), zone predominant (upper/middle/lower), and additional findings as subcutaneous emphysema, pleural effusion, pneumothorax, mediastinal lymphadenopathy. Non-radiological variables like clinical severity, frequency of patient at home isolation, hospital admission, patient with recovery, and death were also recorded.

Chest Radiography scoring[4]:

Severity based on the imaging was calculated using Modified Chest X-ray Scoring System. Posteroanterior (PA) or anterior-posterior (AP) projection X-ray image was divided into 6 regions using two horizontal lines, one at the level of the inferior wall of the aortic arch and the other at the level of the inferior pulmonary vein. A vertical line was drawn in the mid-line results in each lung having 3 regions. Each region was rated 0 to 2 based on lung involvement (consolidation or ground glass opacity); No involvement was scored as 0, while involvement less than 50% was rated as 1 and more than 50% was rated as 2 (Fig. 1). The Sum of all 6 regions was taken as Modified Chest X-ray Severity Score, where the maximum score was 12. The score was further classified as mild (1-4 score), moderate (5-8), and severe (9-12).

Statistical analysis: All statistical analysis was performed using Microsoft Excel (Microsoft Office 2019) and the SPSS version 20.0.0. Pearson's correlation analysis was used to establish the linear correlation between clinical severity and the Modified Chest X-ray severity score. Statistical tests were two-tailed with p 0.01 to indicate statistical significance.

Results

Out of 370 confirmed COVID-19 patients included in the study, 246 patients (66.49%) were male and 124 patients (33.51%) were female (Fig. 2). Patients included in the study came from rmergency, home isolation, and ward/HDU/ICU admission. Clinical grading of most patients who came for chest radiography was mild - 68.91 % (255 patients), followed by severe - 21.09% (78 patients), and

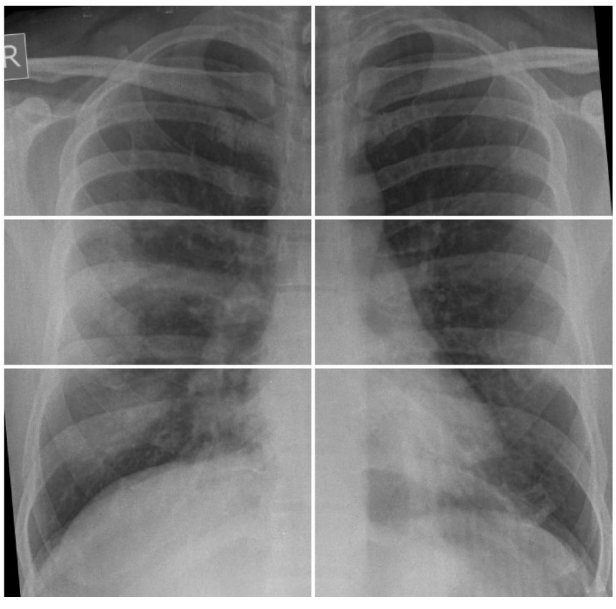

Figure 1: 38 years male with COVID-19 disease shows areas of ground glass opacity in the peripheral region involving the bilateral lungs, predominantly in the middle and lower zones. Modified Chest X-ray severity scoring: (Upper zones R-L; Middle zones R-L; Lower zones R-L): 0-0, 2-1, 2-1 (Total score 6; Moderate severity).

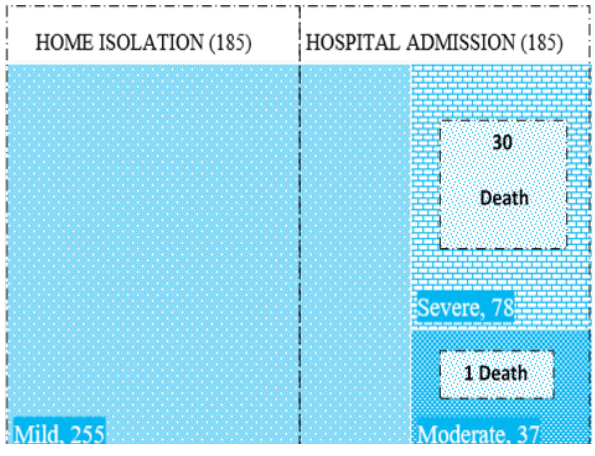

Figure3: Distribution of COVID-19 patients who underwent chest radiography during the second wave according to clinical severity.

Out of 370 patients who underwent chest radiography, on the first imaging 229 patients (61.89%) (male 149 and female 80) had normal findings on chest radiography. Most of the patients with normal chest radiography were

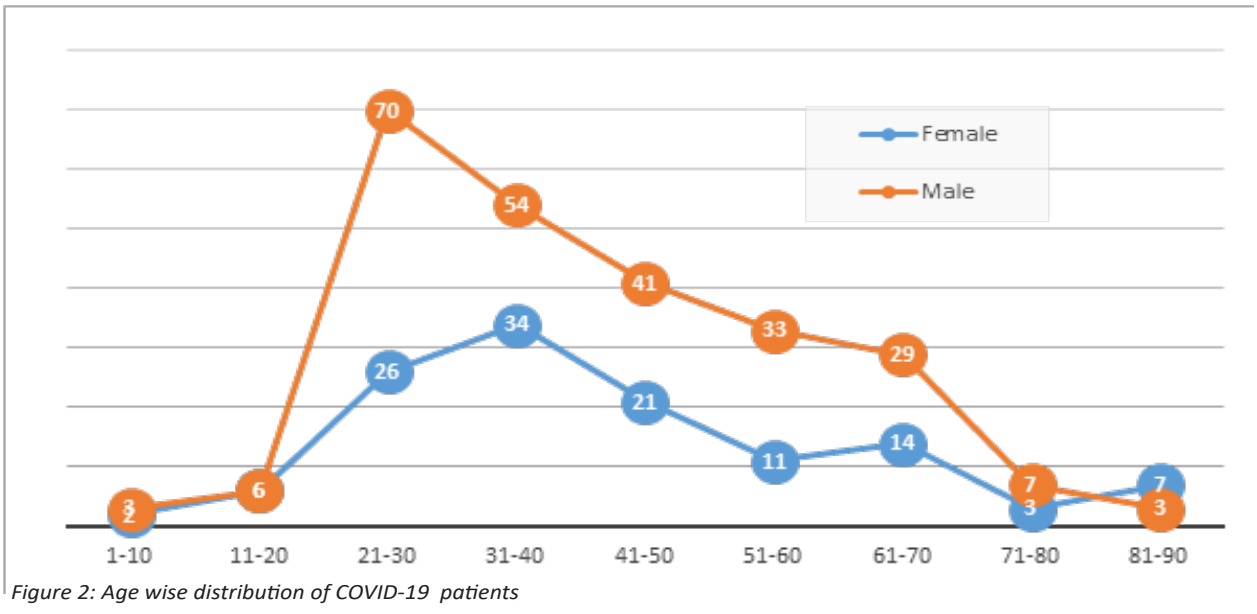

Figure 2: Age wise distribution of COVID-19 patients

moderate - 10% (37 patients).

After clinical assessment, 185 patients (50%) were admitted from the emergency and the rest 185 patients were advised for home isolation as per national guidelines. Among 185 admitted cases, male and female were 135 and 50 respectively. 154 patients (83.24 %) were discharged after recovery whereas 31 patients (24 male and 7 female) died. Of those who died, 1 male patient had moderate symptoms and the rest 30 patient had severe symptoms (Fig. 3).

between 21-50 years age group among both male (117 patients) and female (60 patients). Out of 141 cases positive for chest radiography, there was male predominance (68.79%). Among patients with abnormal chest radiography, 121 patients (85.81%) showed bilateral lung involvement whereas 20 patients had unilateral involvement. All the patients with positive chest radiography had ground glass opacity (GGO) where associated areas of consolidation were seen in 80 patients. (Fig. 4).

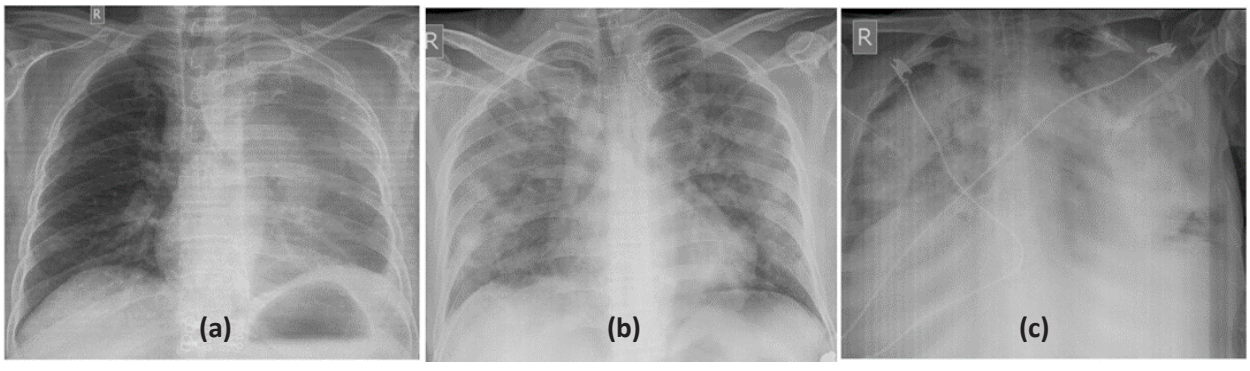

*Figure 4: Chest radiography of three COVID-19 patients with different imaging patterns: **a.** Diffuse ground glass opacity involving the unilateral left lung (0-2, 0-2, 0-2; score 6); **b.** Diffuse ground glass opacity involving the bilateral lungs (2-2, 2-2, 2-2; score 12); **c.** Diffuse bilateral consolidation involving bilateral lungs with air Broncho gram (2-2, 2-2, 2-2; score 12).*

Almost all patients showed peripheral involvement whereas 80 patients among them had both peripheral and central involvement. Lower zone involvement was the most common findings among 81 patients; 58 among them also had middle zone involvement, whereas 41 patients had diffuse involvement (Table 1).

Out of 141 COVID-19 patients with abnormal chest radiography 50, 67 and 24 patients showed mild (1-4), moderate (5-8), and severe (9-12) Modified Chest X-ray Severity Scores. The most common score was 6 among 28 patients. Patients with clinical assessment as mild had less score on Modified X-ray severity compared to those having high score with severe clinical manifestations. The correlation between the clinical severity and the Modified Chest X-ray Severity Score was 0.726 (p 0.01) indicating a moderate positive correlation (Table. 2). Additional findings on chest radiography were subcutaneous emphysema among 3 patients on non-invasive ventilation (NIV) support.

Table 1: Radiological findings at chest radiography

Characteristic	No. of findings
No. of normal baseline chest radiographs	229 (61.89%)
No. of abnormal baseline chest radiographs	141 (38.10%)
Patterns of chest radiographs, among 141 positive cases	
Bilateral	121 (85.81%)
Unilateral	20 (14.19%)
Ground glass opacity only	61 (43.26%)
Ground glass opacity with consolidation	80 (56.73%)
Pattern of distribution	
Periphery only	61 (43.26%)
Both	80 (56.73 %)
Lower zone involvement	R-21; L-24
Middle zone involvement	R-4; L-3
Upper zone involvement	R-8; L-5
Lower and middle zone involvement	R-49; L-68
Diffuse involvement	R-45; L-37
Other features	
Subcutaneous emphysema	3

Table 2: Correlations between clinical severity and Modified X-ray Severity among 141 COVID-19 patients with positive chest radiography.

		Clinical Severity	Modified X-ray severity
Clinical Severity	Pearson Correlation	1	.726**
	Sig. (2-tailed)		.000
	N	141	141
Modified X-ray severity	Pearson Correlation	.726**	1
	Sig. (2-tailed)	.000	
	N	141	141

** Correlation is significant at the 0.01 level (2-tailed).

Limitations:

- ✧ Any chest radiography of RT-PCR positive individual was recorded, irrespective of the duration of illness. Disease progression not taken into account.
- ✧ Only RT-PCR positive cases were included as COVID- 19 infected patients in the study; false-negative or no testing COVID cases patient could not be represented.
- ✧ Chest radiography positioning of a few patients by portable X-ray unit in ICU/HDU was not true AP or PA (depending upon the patient status and position).

Discussion

Out of 370 patients with confirmed COVID-19 disease, there were more males (66.49 %) than females (33.51 %) in this study which was in agreement with most of the published studies[3- 9]. Angiotensin-converting enzyme-2 encoded by ACE 2 gene is postulated as a proven receptor of SARS-CoV-2 and are found to be extremely expressed in Asian male which was discussed as a genetic cause for the male predominance in COVID-19 infection[9]. About 50% of the patient included in this study were advised for home isolation and the rest (185 patients) had hospital admission, where 31 patients (27 male and 7 female) (16.75 %) died during the treatment. This finding was congruent to the study done by Kristoffer et al. (2021)[10] where 17.4 % of the admitted patient died during the treatment.

Every nation is grappling with COVID-19 disease in all possible ways. Standardizing clinical images in COVID-19 pandemic in a resource-constrained environment to avoid non-value-added imaging, minimize exposure risk to radiology technologists, conserve PPE, and reduce radiation dose to patients is a must. Imaging tools including chest radiography and chest computed tomography (CT) have a significant role in the assessment of the patient with COVID-19 infection since the initial discovery of the disease in Wuhan, China[11]. The sensitivity and specificity of chest radiography is 83% and 73% respectively (compared to CT 88% and 77%)[12]. Despite physiological and biological heterogeneity of the COVID-19 disease along with nonspecific imaging pattern when associated with comorbidities or pre-existing disease or added infection, the various reputable society with interobserver agreement claimed the typical imaging pattern of COVID- 19 lung involvement[11]. The typical chest imaging findings of COVID-19 pneumonia include multifocal bilateral peripheral (close to visceral pleural surfaces also including fissures) opacity predominantly involving the lower distribution. Opacities are usually ground glass opacity (GGO) sometimes with areas of consolidation or visible intralobular lines (crazy paving)[11- 18]. Typical imaging pattern of COVID-19 pneumonia was also observed in this study where 85.81% of patients with abnormal chest radiography had bilateral lung involvement with predominantly peripheral distribution, GGO was seen in all the patients where 66.11 % had associated consolidation. The lower zone was the commonest involvement followed by the middle zone.

Radiographic Assessment of Lung Edema (RALE)[18], Brixia[8], and Modified Chest X-ray Severity Score[4] are widely used and currently established tools to monitor the severity and progression

of COVID-19 pneumonia. In the Brixia scoring system, two horizontal lines (at the inferior wall of the aortic arch, and right inferior pulmonary vein level) divides the lung into 6 regions where no involvement; interstitial infiltrates; interstitial and alveolar infiltrates; alveolar dominant is scored as 0; 1; 2; 3 respectively with the total score ranging from 0 to 18[8]. On the other hand, the RALE scoring system divides lungs into 2 regions; right and left with scores 0, 1, 2, 3, and 4 are given depending on the percentage of lung involvement (0%; <25%; 25-50%; 50-75% and >75%) respectively with the maximum score 8 in bilateral lungs[18].

In this study, a Modified Chest X-ray Severity Score was used as a severity measuring tool. This scoring system is relatively fast and had a higher correlation coefficient relative to both Brixa and RALE scoring system[4]. Out of 141 positive chest radiography, the most common score was 6 among 28 patients (13.3%) which was congruent to a study conducted by Setiawati et al. (2021)[4] where 30 patients (13.3 %) had a common score of 6. In our study, out of 141 COVID-19 patients with abnormal chest radiography, 35.46% of patients were mild (1-4 score), 47.51% were moderate (5-8 score), and 17.03% were severe (9-12 score) on Modified Chest X-ray Severity Score. A similar study conducted by Setiawati et al. (2021)[4] among 225 patients showed 19.11% mild, 40% moderate, and 40.8 % severe on Modified Chest X-ray Severity Score. Yasin et al (2020)[3] in their study estimated severity score among 350 COVID-19 patients where baseline chest radiography was studied using RALE scoring system (score 0-8) where mild severity was the most common among 65.71% followed by moderate (23.4%) and severe (10.9%). Similar findings were observed in our study where out of 370 patients, 75.40% (279 patients) were mild (0-4 score), and out of 141 patients with positive chest radiography, 67 patients (47.51%) were moderate (5-8 score), and 24 patients (17.03%) were severe (9-12 score). The Modified Chest X-ray Severity Score in this study showed a moderate positive correlation with the clinical severity of the patient with COVID-19 infection. This agreed with most studies[3,4,11,18], where patients with clinical assessment as mild had less severity score compared to those having high score with severe clinical manifestations.

Conclusions

COVID-19 disease is a global pandemic. Respiratory infection by SARS-CoV-2 may progress to acute respiratory distress syndrome (ARDS) resulting in morbidity and mortality in advanced disease. Chest radiography pattern and scoring system can be used as tools to predict the disease severity in COVID-19 infection. Chest radiography in conjunction with clinical judgment can enhance specific treatment strategies in COVID-19 infection in the resource-constrained environment.

References

1. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. Acta Bio Medica Atenei Parmensis 2020;91(1):157–60.
2. Dashboard. CoVid19. (n.d.). https://covid19.mohp.gov.np/.
3. Yasin R, Gouda W. Chest X-ray findings monitoring COVID-19 disease course and severity. Egypt J Radiol Nucl Med 2020;51(1).
4. Setiawati R, Widyoningroem A, Handarini T, Hayati F, Basja AT, Putri ARDS et al. Modified chest x-ray scoring system in evaluating severity of covid-19 patient in Dr. Soetomo General Hospital Surabaya, Indonesia. IJGM 2021;14:2407–12.
5. Goyal A, Tiwari R, Bagarhatta M, Ashwini B, Rathi B, Bhandari S. Role of portable chest radiography in management of COVID-19: Experience of 422 patients from a tertiary care center in India. Indian J. Radiol. Imaging 2021;31(S 01):S94–S100.
6. Nishtar T, Noor N, Khan SL. X-ray patterns of COVID-19 in patients presenting to Lady Reading Hospital, Peshawar, Pakistan. Pak J Med Sci 2020;37(1). doi:10.12669/pjms.37.1.3435.
7. Rashid N, Dogar IH, Masood M, Ahmed A, Sani U, Nawaz F. Different radiological patterns on plain chest X-Ray in COVID-19 patients. Annals KEMU. 2021;27(1):113-9.
8. Borghesi A, Zigliani A, Masciullo R, Golemi S, Maculotti P, Farina D et al. Radiographic severity index in COVID-19 pneumonia: relationship to age and sex in 783 Italian patients. Radiol med 2020;125(5):461-4.
9. Bwire GM. Coronavirus: Why men are more vulnerable to covid-19 than women? SN Compr. Clin. Med. 2020;2(7):874–76.
10. Strålin K, Wahlström E, Walther S, Bennet-Bark AM, Heurgren M, Lindén T et al. Mortality in hospitalized COVID-19 patients was associated

with the COVID-19 admission rate during the first year of the pandemic in Sweden. Infect Dis (Lond). 2021:1–7.

11. Kanne JP, Bai H, Bernheim A, Chung M, Haramati LB, Kallmes DF et al. COVID-19 Imaging: What We Know Now and What Remains Unknown. Radiology 2021;299(3):E262–E279.

12. Stephanie S, Shum T, Cleveland H, Challa SR, Herring A, Jacobson FL et al. Determinants of chest radiography sensitivity for COVID-19: A multi-institutional study in the United States. Radiology: Cardiothoracic Imaging 2020;2(5)

13. Wong HYF, Lam HYS, Fong AH-T, Leung ST, Chin TW-Y, Lo CSY et al. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. Radiology 2020;296(2):E72–8.

14. Prokop M, van Everdingen W, van Rees Vellinga T, Quarles van Ufford H, Stöger L, Beenen L et al. CO-RADS: a categorical ct assessment scheme for patients suspected of having COVID-19—Definition and evaluation. Radiology 2020;296(2):E97–104.

15. Simpson S, Kay FU, Abbara S, Bhalla S, Chung JH, Chung M et al. Radiological Society of North America Expert Consensus Statement on Reporting chest CT findings related to COVID-19. Endorsed by the Society of Thoracic Radiology, the American College of Radiology, and RSNA - Secondary Publication. Journal of Thoracic Imaging 2020;35(4):219–27.

16. Gezer NS, Ergan B, Baris MM, Appak O, Sayiner AA et al. COVID-19 S: A new proposal for diagnosis and structured reporting of COVID-19 on computed tomography imaging. Diagn Interv Radiol 2020;26(4):315–22.

17. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus disease 2019 (COVID-19) imaging reporting and data system (COVID-RADS) and common lexicon: A proposal based on the imaging data of 37 studies. Eur Radiol 2020;30(9):4930–42.

18. Warren MA, Zhao Z, Koyama T, Bastarache JA, Shaver CM, Semler MW et al. Severity scoring of lung oedema on the chest radiograph is associated with clinical outcomes in ARDS. Thorax 2018;73(9):840–6.