Acta Scientific CANCER BIOLOGY (ISSN: 2582-4473)

Volume 5 Issue 1 January 2021

Research Article

Utility of Chest Radiographs in Hospitalised COVID-19 Pneumonia Patients

Saarah Khan*, Richa D Jain, Sudhir Kumar Kale

Consultant, Department of Radiodiagnosis, Aster CMI Hospital, Bengaluru, India

***Corresponding Author:** Saarah Khan, Radiologist, Department of Radiodiagnosis, Aster CMI Hospital, Bengaluru, India.

Received: December 24, 2020

Published: January 21, 2021

Abstract

Background: Imaging has played an important role in the current global pandemic of SARS CoV2 pneumonia. The role of chest X-Rays and CT has been proved time and again. COVID -19 pneumonia spectrum ranges from asymptomatic patients to severe ARDS.

Purpose: We aimed to determine the sensitivity and specificity of chest radiographs with respect to RT PCR and Prognostication based on chest X-Ray severity index.

Material and Methods: 300 prospective patients coming to the ED and admitted as COVID 19 suspects were included in our study. Chest x ray performed on the day of admission and RT PCR results were collated. Subsequently two independent radiologists with 3years and 8years experience evaluated about 1200 serial radiographs for COVID 19 features and Severity index was calculated. Further clinical details of number of days of admission and treatment given were collected and correlated to the severity index calculated.

Results: 189 males and 111 females were included in our study. The sensitivity of Chest radiographs was 59% with a specificity of 20%. Calculated diagnostic accuracy was 55%.

We also found correlation with the severity index and prognosis of the patient in terms of oxygen requirement, ventilatory support and final outcome which had a sensitivity of 90%,83% and 100% respectively with an accuracy of 70%, 70% and 96% respectively.

Conclusion: The wide availability and feasibility of portable chest radiography with a reasonable sensitivity has made it a quick diagnostic tool in evaluating the process of evolution and assessment of severity of lung involvement. Chest radiographs have been validated as an independent prognostic indicator for decision making with regards to hospital admission/Intubation.

Keywords: COVID 19; Radiographs; Hospital

Abbreviations

COVID 19: Corona Virus Disease 19; RT PCR: Reverse Transcriptase Polymerase Chain Reaction; CXR: Chest X Ray/Radiograph; CT: Computed Tomography; ED: Emergency Department.

Introduction

The devastating effects of the novel coronavirus (COVID 19) are being revealed on a day to day basis. The pandemic has brought the world to a standstill.

We are not able to comprehend why this disease has different outcomes in different individuals irrespective of age, race and regional constraints. Spectrum of COVID 19 positive patients varies from asymptomatic to patient on ventilators [1].

The cases are continuing to increase worldwide. First reported in December 2019 in Wuhan, China, WHO reported 78,811 laboratory confirmed cases as on 24th February, 2020 with more than 2200 cases being reported outside China. Currently the total number of cases reported worldwide is 38,802,545.

It is a highly contagious disease spreading through respiratory droplets. The symptoms caused by COVID-19 are usually those of the lower respiratory tract and include fever, cough and dyspnoea. Few patients presented with myalgia and some other non-specific symptoms such as loss of smell and taste, headache, etc. Acute respiratory distress syndrome is present in 17%–29% of patients [3]. The fatality rate is estimated to be approximately 2.3% [3]. Genetic sequencing of SARS-CoV-2 has permitted the rapid development of real-time reverse transcription polymerase chain reaction (RT-PCR) of viral nucleic acid and is the diagnostic gold standard. However RT PCR test has several limitations due to the high number of false-negative tests and the delay in results [4]. Thus radiological evaluation with CXR has a pivotal role to play in the rapid assessment of patients as well as in the emergency department (ED) while waiting for the RT-PCR results for risk stratification and triage. Since the prevalence of COVID is increasing, it becomes imperative for all clinicians of different specialities to be able to recognise the CXR findings that may be performed for other purposes further highlighting that CXR is of paramount importance.

Portable chest X-rays play a pivotal role in the disease process as they mirror the CT findings. The Fleischner Society issued a consensus statement exploring the application of imaging, primarily computed tomography (CT), in the evaluation, diagnosis, and risk stratification of patients [2].

Thus Portable X-ray has become a primary imaging modality in the management of COVID-19.

Despite having a lower sensitivity than RT-PCR the utility of initial CXR in predicting clinical outcomes is an unmet need. Portable CXRs are being used as the preliminary method reducing the movement of patients and thereby minimizing the risk of cross infection. Progression and regression can be easily assessed on X rays; Since it is not possible to repeat CT studies as frequently due to radiation risk and difficulties in patient transfer. Follow up X-rays can be carried out with ease. It is suggested that positive CXR findings in patients with high suspicion of COVID-19 can negate the need for a Computed Tomography (CT) scan [5]. Furthermore it is cheaper, easily available and patient-friendly. With this brief background a study of the different patterns of lung involvement using CXR as a tool will help the medical community in its efforts to combat this pandemic to a great extent.

Materials and Methods

Patient selection and inclusion criteria

A prospective study was conducted on 300 (189 males and 111females)suspected COVID as well as RT-PCR proven cases visiting the ED and fever/flu clinic at Aster CMI hospital, Hebbal during a time period of 45 days. The age group ranged between 12years to 83 years with an average age group of 50 years. Written and informed consent was waived off. RT-PCR nasopharyngeal and throat swab was performed on all clinically suspected cases by an experienced lab professional.

Image acquisition and analysis

All patients were subjected to baseline CXR as a standard of care using local protocols. They were acquired as either computed or digital radiographs.

The initial X-rays included a PA (Postero-anterior) or AP(Antero-posterior) view. Subsequent follow up X-rays were AP views in the isolation rooms/ICU/Suspected wards.

Siemens 60 MA portable X-ray machine was used for all portable CXRs with the X-ray acquired with Kvp 65-75 AND 8-10 mAs.

A total of 1200 CXRs were interpreted and reported and in a structured format by two independent radiologists with 3 years and 8 years of experience respectively. The CXR and RT-PCR findings were tabulated along with other predictors of clinical outcome such as progression/regression, number of days to stabilise, associated comorbidities, oxygen requirement, ventilator support. The final outcome was expressed as discharged healthy or deceased.

Radiographic scoring

Each lung was divided into three zones

- Upper zone-from the apices to the superior hilar markings.
- Mid zone-from the superior to inferior hilar markings.
- Lower zone-from the inferior hilar markings to the costophrenic sulcus.

Each zone was given a binary score as 0 if the opacity was (absent) and 1 if the opacity was (present).

RT-PCR

The virological monitoring was performed after collecting nasopharygeal swabs by expertised laboratory personnel and targeted for RNA dependent RNA polymerase B -gene of SARS-CoV-2.

Statistical analysis

The statistical analysis was performed by STATA11.2(College Station Texas USA). Age distribution, gender distribution, distribution of positive and negative baseline chest X-ray, distribution of positive and negative RT-PCR, progression/regression of serial CXRs, Radiographic scoring, pattern of involvement, CT correlation (wherever relevant), comorbidities, Oxygen requirement, need of ventilatory support and final outcome (Discharged/refereed/death) were described as frequency and percentage.

Results

Our study included 300 patients and was male dominated (63%). Age group ranged between 12 to 83 years with an average age of 50 years. Majority of the patients were aged between 51 to 60 years.186 out of 300 patients had a positive baseline CXR at admission and the remaining were found to have negative baseline CXR. RT-PCR was positive in 90% of the patients with a positive baseline CXR. The rest of the 10% of cases had an abnormal baseline CXR but RT-PCR was found to be negative. Disease progression was reported in 66% of the cases. Radiographic score of 6 was reported in 28% of the cases and a score of 0 in 34%. The rest of them had scores ranging between 1 and 4.

Typical findings were observed in 216 out of 300 patients and the remainder demonstrated atypical or indeterminate findings.

Hypertension and diabetes were the predominant comorbidities among our patient population. However less frequent ones included Hypothyroidism, CVA, IHD/CAD etc.

Correlation between X-ray and RT-PCR yielded a sensitivity of 59% and a specificity of 29% with a diagnostic accuracy of 55%. Concurrency between radiographic scoring and oxygen requirement was also estimated which showed excellent collation having sensitivity of 90% and 83% respectively. Collation between ventilator and final outcome was extra-ordinary with a sensitivity of 100% and an accuracy of 96%.

Discussion

Our study included 300 patients, 63% males and 37% females aged between 12-83 years.

Studies conducted by D.Toussie, B.J Stevens, D.Cozzi, M.Durrani, S.G Vancheri, G.Wu, had similar results of higher incidence of the disease in males in comparison to females. However the study conducted by H.Y.F Wong had lesser incidence of the disease in the former.

31% of the patients were diabetics and 30% hypertensives. Less common comorbidities included Ischemic heart disease, CVA, Hypothyroidism etc.

The CXR is the initial imaging investigation for all patients in which COVID-19 is suspected [17], or patients with mild features of COVID-19 at risk for disease progression and patients with worsening respiratory status [16]. The CXR reportedly has lower sensitivity in early or mild cases when compared with the RT-PCR [18], with one study reporting 69% sensitivity. Our study had similar outcome with baseline CXRs having a sensitivity of 59% and a specificity of 20%. The study conducted by D. Cozzi as well had a similar sensitivity of 67%.

The CXR report may be available to clinicians before the RT-PCR result. Therefore, an accurate chest x-ray interpretation is paramount in helping to guide the early diagnosis and treatment plan. It is suggested that positive CXR findings in patients with high suspicion of COVID-19 can negate the need for a Computed Tomography (CT) scan [14].

In our study initial X-rays were abnormal in 62% of the patients with 38% patients having normal CXR. However the 27 out of 114 patients who had normal baseline CXRs showed serial progression of the disease.

Typical or indeterminate findings were observed in 159 out of 186 abnormal X-rays. Findings not consistent with COVID-19 were seen in 27 out of 186 abnormal CXRs and included minimal bilateral pleural effusion and inhomogeneous opacities with peri-hilar distribution giving a bat wing appearance.

Most commonly observed chest X-ray findings were Peripheral and subpleural inhomogeneous/ground glass opacities with or without consolidations in both the mid and lower zones or Diffuse ground glass haziness in both the mid and lower zones. Occasional (12/300 cases)unilateral involvement was also observed.

Chest X-ray interpretation

Every X-ray was interpreted based on the below mentioned table [20].

COVID imaging classification	CXR appearance
Typical	Multi-focal peripheral consolidation. Multi-focal rounded opacities and nodules.
Indeterminate	Multi-focal non peripheral consolidation.
Atypical (May be due to COVID-19 but must consider other causes)	Focal lobar consolidation. Pleural effusion Peri-hilar interstitial opacities. Bronchial wall thickening. Atelectasis. Lymphadenopathy.
Negative (Does not exclude COVID-19)	No CXR findings of pneumonia. Edema.

Table a

62% of the patients had a positive baseline CXR at admission where as 32% were found to have negative baseline CXR despite RT-PCR being positive. RT-PCR was positive in 90% of the patients with a positive baseline CXR. The rest of the 10% of cases had an abnormal baseline CXR but RT-PCR was found to be negative.

28% of the patients had a radiographic score of 6 and 34% had a radiographic score of 0.The rest of them had scores ranging between 1-4.

Chest x-ray severity score was found in a previous report to be a predictive index of risk for hospital admission and intubation in patients with COVID-19 pneumonia [2], and mobile chest x-rays were found to be beneficial in the follow up of critically ill COVID-19 patients in another study [19]. Concurrency was estimated between the Radiographic score and need of oxygen and ventilator requirement. The radiographic score had a sensitivity of 90% as compared to Oxygen requirement which had a specificity of 52% and a sensitivity of 83% as compared to ventilator requirement which had a specificity of 59%.

Collation between ventilator need and outcome showed excellent correlation with a sensitivity of 100% and a specificity of 98% with an accuracy of 96%.

RT-PCR was the first line of diagnosis in patients with COVID-19 in Jordan [6]. However in our study CXRs were considered as the primary investigation of choice due to the delayed results of RT-PCR swab in order to decide the need for admission, assessing the disease severity and need for oxygen/ventilatory requirement. Moreover RT-PCR could only provide qualitative data, unlike CXR which could quantitate the severity of the disease process.

In previous reports, chest CT scan was found to be a more sensitive diagnostic tool than RT-PCR even in asymptomatic patients reaching 98% [7-9]. However, many researchers found that patients with a positive RT-PCR may have a negative chest CT scan, and patients with a negative RT-PCR may have positive chest CT scan [8,10,11]. Chest x-ray was regarded an insensitive tool reaching 69% [9,12-14]. The American College of Radiologists (ACR) and the Fleischner Society have suggested that imaging is not advised for patients who tested positive by RT-PCR who were asymptomatic or have mild symptoms, and CT scan should be reserved for patients with a progressive disease course [15,16]. Due to the high infectious rate of COVID-19 virus; infection control in radiology

departments becomes a challenge in the CT scan suite, therefore, the ACR has also recommended that portable chest x-ray may be considered to minimize the risk of cross infection [13,15].

Chart 1: Age Distribution Of Patients In The Study.

Interpretation: The majority of the patients were aged between 51-60 years.

Chart 2: Distribution Of Males And Females In The Study.

Interpretation: The study was male dominated with 63% being males.

Chart 3: Frequency Of Positive And Negative Baseline Chest X-Rays.

Interpretation: Positive baseline CXRs were seen in 62% of the patients.

Chart 4: Frequency Of Progression And Regression Of The Disease.

Interpretation: Disease progression was seen in 66% of the patients.

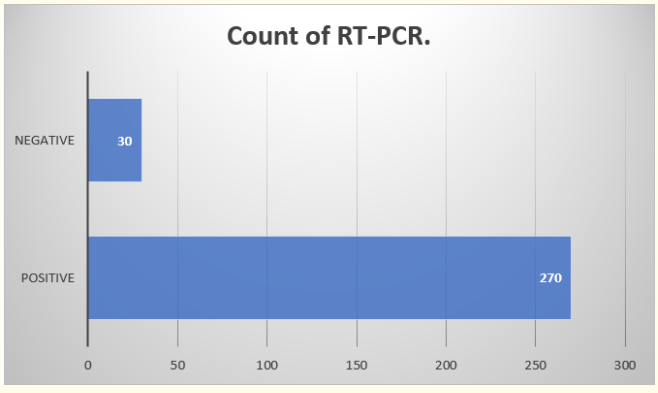

Chart 5: Count Of RT-PCR.

Interpretation: Only 30 among 300 patients had a negative RT-PCR..

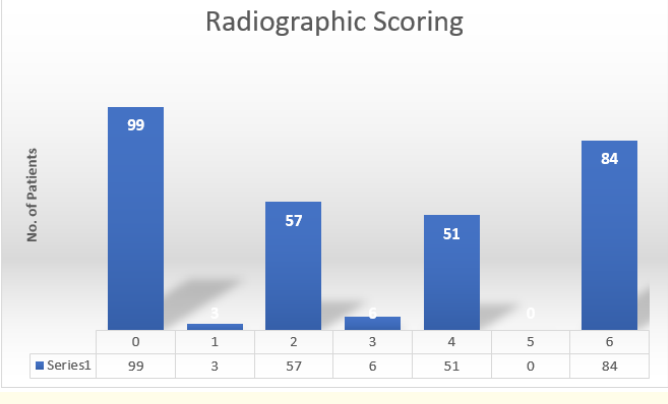

Chart 6: Radiographic Scoring.

Interpretation: 34% had a score of 0 and 28% had a score of 6.

Chart 7: Pattern Of Involvement.

Interpretation: 216 out of 300 patients showed typical pattern of presentation.

Chart 8: Distribution Of Co-Morbidities.

Interpretation: Diabetes and hypertension were the dominant comorbidities.

X-Ray		RT-PCR		
		Positive	**Negative**	**Total**
	Positive	159	24	183
	Negative	111	6	117
	Total	270	30	300
Sensitivity	59%			
Specificity	20%			
Positive Predictive Value	87%			
Negative Predictive Value	5.00%			
Accuracy	55%			

Table 1: Correlation Between X-Ray and RT-PCR.

		Oxygen		
Radiographic Scoring		**Positive**	**Negative**	**Total**
	Positive	129	75	204
	Negative	15	81	96
	Total	144	156	300
Sensitivity	90%			
Specificity	52%			
Positive Predictive Value	63%			
Negative Predictive Value	84%			
Accuracy	70%			

Table 2: Concurrency Between Radiographic Scoring and Oxygen Requirement.

		Ventilator		
Radiographic Scoring		**Positive**	**Negative**	**Total**
	Positive	114	66	180
	Negative	24	96	120
	Total	138	162	300
Sensitivity	83%			
Specificity	59%			
Positive Predictive Value	63%			
Negative Predictive Value	80.00%			
Accuracy	70%			

Table 3: Concurrency Between Radiographic Scoring and Ventilator Requirement.

		OUTCOME		
Ventilator		**Positive**	**Negative**	**Total**
	Positive	30	12	42
	Negative	0	258	258
	Total	30	270	300
Sensitivity	100%			
Specificity	98%			
Positive Predictive Value	71%			
Negative Predictive Value	100.00%			
Accuracy	96%			

Table 4: Concurrency Between Ventilator And Final Outcome.

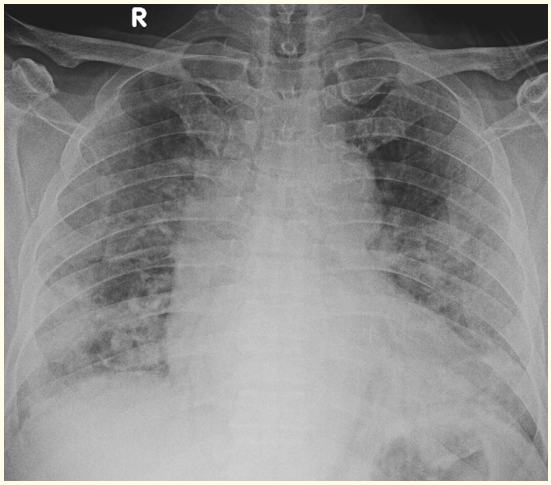

Figure 1: Typical Involvement-Peripheral Subpleural Consolidations and Ground Glass Opacities In Bilateral Lung Fields.

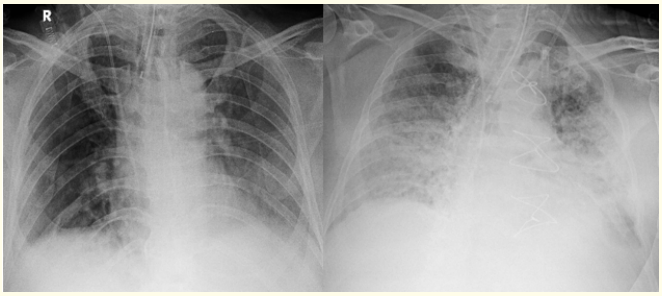

Figure 2: A and B: COVID X-Ray Showing Interval Progression of The Disease Within 2 Days.

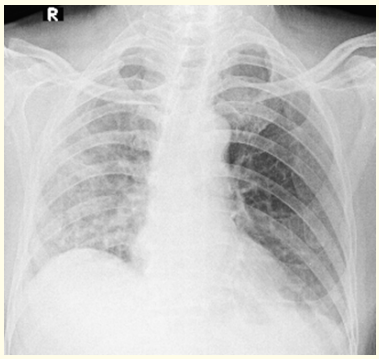

Figure 3: Unilateral Involvement .

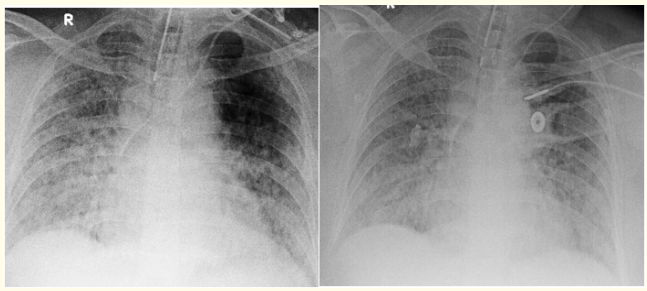

Figure 4: A and B: Ventilator Associated Pneumonia (Left Upper Zone) As A Complication In A COVID Intubated Patient within 5 Days.

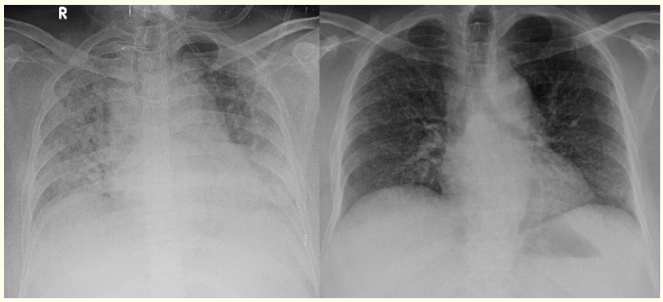

Figure 5: A and B: X-Ray Showing Interval Regression of the Disease Over A Period of 21 Days.

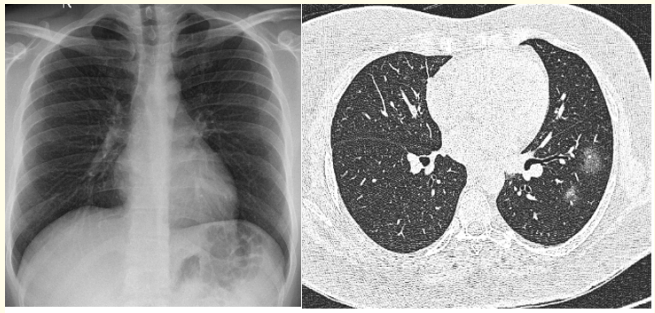

Figure 6: A and B: Pitfall Of X-Ray As Compared To HRCT Chest Where X-Ray Was Normal But HRCT Showed A Ground Glass Densities In The Left Lower Lobe.

Limitations

CXR interpretation can be confounded by several underlying co-morbid conditions such as chronic lung disease or cardiac failure. Thus its accuracy is more in the younger population. The correlations with the disease was truncated for a few patients as not all patients could be followed up to their final outcomes due to referral, reasons being shortage of beds/patient affordability etc. The interval between the RT-PCR testing and serial CXRs were governed by the clinical need. Due to lack of uniformity the accuracy of the interpretation was adversely affected. The X-rays were available to ED physicians which influenced the decision regarding need of admission.

Conclusion

With no respite in the current pandemic and increasing numbers every day our study concludes X ray can be used as a screening tool to diagnose, assess severity and follow up of patients with COVID-19 pneumonia.

Bibliography

1. Durrani M., *et al*. "Chest X-rays findings in COVID 19 patients at a University Teaching Hospital - A descriptive study". *Pakistan Journal of Medical Sciences* 36 (2020): S22-26.

2. Toussie D., *et al*. "Clinical and Chest Radiography Features Determine Patient Outcomes In Young and Middle Age Adults with COVID-19". *Radiology* 14 (2020): 201754.

3. Kanne JP., *et al*. "Essentials for Radiologists on COVID-19: An Update—Radiology Scientific Expert Panel". *Radiology* 27 (2020): 200527.

4. Cozzi D., *et al*. "Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome". *Radiology Medicine* 125.8 (2020): 730-737.

5. Stevens BJ. "Reporting radiographers' interpretation and use of the British Society of Thoracic Imaging's coding system when reporting COVID-19 chest x-rays". *Radiography (London, Engl1995)* (2020): S1078-8174 (20)30098-5.

6. Rousing LA., *et al*. "Chest x-ray findings and temporal lung changes in patients with COVID-19 pneumonia". *BMC Pulmonary Medicine* 20 (2020): 245.

7. Salehi S., *et al*. "Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients". *AJR* 215 (2020): 1-7.

8. Ai T., *et al*. "Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases". *Radiology* 26 (2020): 200642.

9. Fang Y., *et al*. "Sensitivity of chest CT for COVID-19: comparison RT-PCR". *Radiology* 19 (2020): 200432.

10. Chung M., *et al*. "CT imaging features of 2019 novel coronavirus (2019-NCoV)". *Radiology* 295 (2020): 202-207.

11. Bernheim A., *et al*. "Chest CT findings in coronavirus Disease-19 (COVID-19): relationship to duration of infection". *Radiology* 295 (2020): 200463.

12. Lei Y., *et al*. "COVID-19 Infection: Early Lessons". *Canadian Association of Radiologists Journal* (2020).

13. Wong HYF., *et al*. "Frequency and distribution of chest radiographic findings in COVID-19 positive patients". *Radiology* 27 (2019): 201160.

14. Jacobi A., *et al*. "Portable chest X-ray in coronavirus disease-19 (COVID-19): a pictorial review". *Clinical Imaging* 64 (2020): 35-42.

15. "ACR recommendations for the use of chest radiography and computed tomography (CT) for suspected COVID-19 infection". *American College of Radiology* (2020).

16. Rubin GD., *et al*. "The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society". *Radiology* (2020).

17. British Society of Thoracic Imaging Radiology decision tool for suspected COVID-19 (2020).

18. H Choi., *et al*. "Chest CT and implications for chest radiograph interpretation". *Radiology Imaging*.

19. Wu G and Li X. "Mobile x-rays are highly valuable for critically ill COVID patients". *European Radiology* 13 (2020): 1-3.

20. Simpson S., *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". *Radiology Cardiothoracic Imaging* 2.2 (2020): e200152.