International Journal of Advances in Medicine
Munirathnam M et al. Int J Adv Med. 2021 Jan;8(1):98-102
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933

DOI: https://dx.doi.org/10.18203/2349-3933.ijam20205480

Original Research Article

Determining COVID-19 disease severity and outcome using sequential chest radiograph in a new designated COVID-19 hospital

Mahendra Munirathnam[1], Mohan C. N.[1]*, Javeriya Mohammadi[2], Samarth S. Gowda[3], Madhumati Ramaiah[1]

[1]Department of Medicine, [2]Department of Pulmonology, [3]Department of Radiology, Bowring and Lady Curzon Medical College and Research Institute, Bangalore, Karnataka, India

Received: 30 October 2020
Revised: 02 December 2020
Accepted: 03 December 2020

***Correspondence:**
Dr. Mohan C. N.,
E-mail: mohannagchand@gmail.com

ABSTRACT

Background: COVID-19 pandemic to date has recorded around 37 million cases across the world. This study was done to appraise the prognostic importance of portable chest X-ray (CXR) and the Brixia scoring was then used to predict the outcome variables like hypoxia, non-invasive ventilation, intubation, sepsis, multiple organ dysfunction syndrome (MODS), recovery, death and post corona sequalae.
Methods: A 100 reverse transcriptase-polymerase chain reaction (RT-PCR) confirmed COVID-19 infection were included in the study, based on the inclusion and exclusion criteria. A CXR was done on admission and on day 3 following admission. The CXR Brixia score was calculated and was correlated with lab parameters, hypoxia, need for mechanical ventilator and clinical outcome variables. P value of <0.05 was taken as significant.
Results: The mean Brixia score on admission were 2.52±1.505, 6.18±2.969 and 12.05±3.251 in mild, moderate and severe category respectively and the scores that were calculated 3 days after admission were 2.52±1.505, 6.18±2.969 and 12.14±3.306 in mild, moderate and severe category respectively, it was found that mean Brixia scores were higher in patients with moderate and severe category compared to mild category. There was a statistically significant correlation between lymphopenia, lactate dehydrogenase (LDH), d-dimer, C-reactive protein (CRP) and serum ferritin with Brixia score on admission.
Conclusions: The simple and a bedside Brixia CXR score has shown that the higher scores predict a need for monitoring and management to prevent poor clinical outcome and mitigate complications and death. When this score is used along with other easily available biochemical parameters is useful in predicting clinical outcome and prognosis.

Keywords: Brixia score, COVID-19, Corona complications, Prognosis

INTRODUCTION

Coronavirus disease 2019 (COVID-19) caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) began as an outbreak in China in December 2019.[1]

The spread of COVID-19 has resulted in community transmission of the virus in some parts of the world that has led to overwhelming numbers of severe cases. In these regions, health care delivery has been disrupted and compromised by critical resource constraints in diagnostic testing, hospital beds, ventilators, and health care workers. Chest radiography is the imaging modality used for clinical management in majority of the health care setups, since it is portable and easily available. The use of chest radiograph for screening and clinical management was assessed previously in many studies.[2] The routine screening computed tomography (CT) for diagnosis or exclusion of COVID-19 is not recommended by United

States centres for disease control and prevention and also recommendations given by American college of radiology and the society of thoracic radiology, do not suggest the use of CT and chest radiography for large-scale screening and diagnosis.[3] The sensitivity of chest X-ray (CXR) in COVID-19 detection although is low, up to 18% can have a normal chest radiographs or CT when mild or early in the disease course, this decreases to 3% in severe disease and it is shown that serial CXRs done in these patients has accuracy approaching that of chest CT.[4] The pattern that is highly suggestive of COVID-19 infection, in this current pandemic situation, on a CXR is bilateral “patchy” and/or “confluent, band like” ground glass opacity or consolidation in a peripheral and mid-to-lower lung zone, other patterns that are seen on a chest radiograph include parenchymal abnormalities and pleural effusion, although it is a rare finding.[5] In many patients a baseline CXR done at the time of symptom onset maybe normal, some studies have shown that the severity of findings at chest radiography peaked at 10-12 days from the date of symptom onset.[6] A recent Cochrane review of two trials has shown that routine chest radiography for patients with lower respiratory tract infections did not affect clinical outcome, however, the use of chest radiograph in COVID-19 infection to predict clinical outcome still remains debatable.[7] Age ≥50 years, male sex, smoking, presence of comorbidities (e.g., hypertension, diabetes, cardiovascular or cerebrovascular disease, chronic obstructive pulmonary disease (COPD), obesity, malignancy), lymphopenia, thrombocytopenia, liver, kidney impairment, or cardiac injury, elevated inflammatory markers (C-reactive protein, procalcitonin, ferritin), elevated D-dimer, elevated interleukin-6, are associated with increased risk of unfavourable outcome and mortality.

There are many datasets that are available for COVID-19 and non-COVID-19 CXR, few of them are widely used across different parts of the world, they include Cohen/IEEE 8032, Brixia score COVID-19, general block chain COVID-19, agchung RSNA pneunomia Kaggle and chest X-ray-NIH Google.[8] The Brixia score is a dedicated CXR scoring system for reverse transcriptase-polymerase chain reaction (RT-PCR) confirmed SARS-CoV-2 infection. This scoring system includes two steps of image analysis (Figure 1). In the first step, the lungs are divided into six zones on frontal chest projection either anterior-posterior (AP) or posterior-anterior (PA) view, dividing the lung into three equal zone on either side at the bedside, into upper zone, middle zone and lower zone. In the second step, a score (from 0 to 3) is assigned to each zone based on the lung abnormalities detected on frontal chest projection as follows score 0 no lung abnormalities, score 1 interstitial infiltrates, score 2 interstitial and alveolar infiltrates (interstitial predominance) and score 3 interstitial and alveolar infiltrates (alveolar predominance). The scores of the six lung zones are then added to obtain an overall “CXR score” ranging from 0 to 18. Other CXR findings (such as pleural effusion, pulmonary vessel enlargement), not included in the scoring system. This simple, semiquantitative CXR score is useful in predicting mortality in hospitalized patients with SARS CoV-2 infection.[9]

This study was done to assess the utility of simple bedside CXR in predicting prognosis and clinical outcome, in the hospitals which are not equipped with CT scan, with majority of the hospitals being overburdened with increasing number of COVID-19 cases, there is a need for considering simple and easily available bedside tests in predicting clinical severity and outcome.

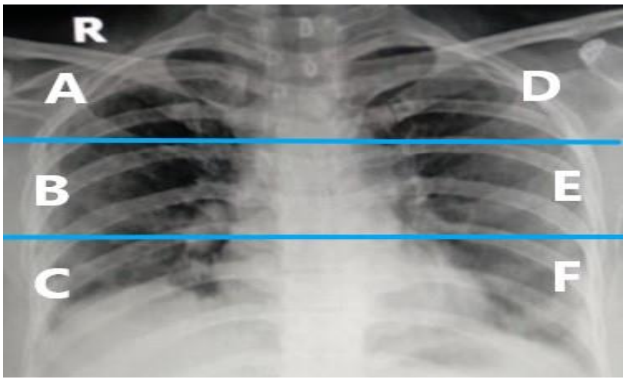

Figure 1: CXR PA view, divided into 6 equal zones and labelled from A to F as shown in the figure, the Brixia score of 10 for this CXR.

METHODS

After obtaining institutional ethical committee clearance, total of 100 RT-PCR confirmed CoVID-19 patients were included in the study, who were admitted to Charaka super speciality hospital, attached to Bowring and Lady Curzon medical college, Bengaluru, considering the inclusion and exclusion criteria. This study was done for a period of two months between September 2020 to October 2020. After obtaining an informed consent, a detailed history was taken, focussed clinical examination was done on admission and the vital parameters were recorded. Patients were grouped into mild, moderate and severe based on ministry of health and family welfare guidelines, Government of India. A CXR was done on admission, on D3 or in case of any clinical worsening. A protocol based management was initiated in all patients. The Brixia CXR score was calculated, which is an 18 point severity scale. The Brixia score was correlated with lab parameters, oxygen requirement, need for mechanical ventilator and clinical outcome variables in the form of sepsis, multiple organ dysfunction syndrome (MODS), recovery and death were studied. Statistical analysis was performed using statistical package for social sciences (SPSS) version 20. [IBM SPASS statistics (IBM corp. Armonk, NY, USA released 2011)] was used to perform the statistical analysis. Descriptive statistics of the outcome variables were calculated by mean, standard deviation for quantitative variables. Inferential statistics like Chi-square test was used for categorical variables. Paired t-test was used for comparison of Brixia score on day of admission and day 3 following admission. Pearson’s correlation was used to compare Brixia score on admission with lab parameters, oxygen requirement and outcome variables. P value of <0.05 was taken as significant.

RESULTS

In this study, 23% of them belonged to mild category, 34% moderate and the rest 43% were included under severe category. The mean age distribution of the study population are 38.13±11.82, 56.44±17.31 and 51.56±11.85 years in the mild, moderate and severe groups respectively. 39.1%, 61.8% and 65.8% were males, while 60.9%, 38.2% and 34.9% were females in the mild, moderate and severe category respectively, there were more females in the mild category. Fever was the most common presenting symptom, seen in all patients admitted to the hospital, this was followed by cough, seen in 81% of them, of which 85% had dry cough the rest had productive cough with mucoid expectoration, 59% had difficulty in breathing (67.8% of them belonged to severe category and 32.2% were included under moderate category), headache and body ache was seen in 47%, 26% of patients had anosmia and ageusia, of which majority, 46.15% belonged to mild category, gastrointestinal symptoms like nausea and vomiting and diarrhoea was seen in 6% and 4% respectively (Figure 2).

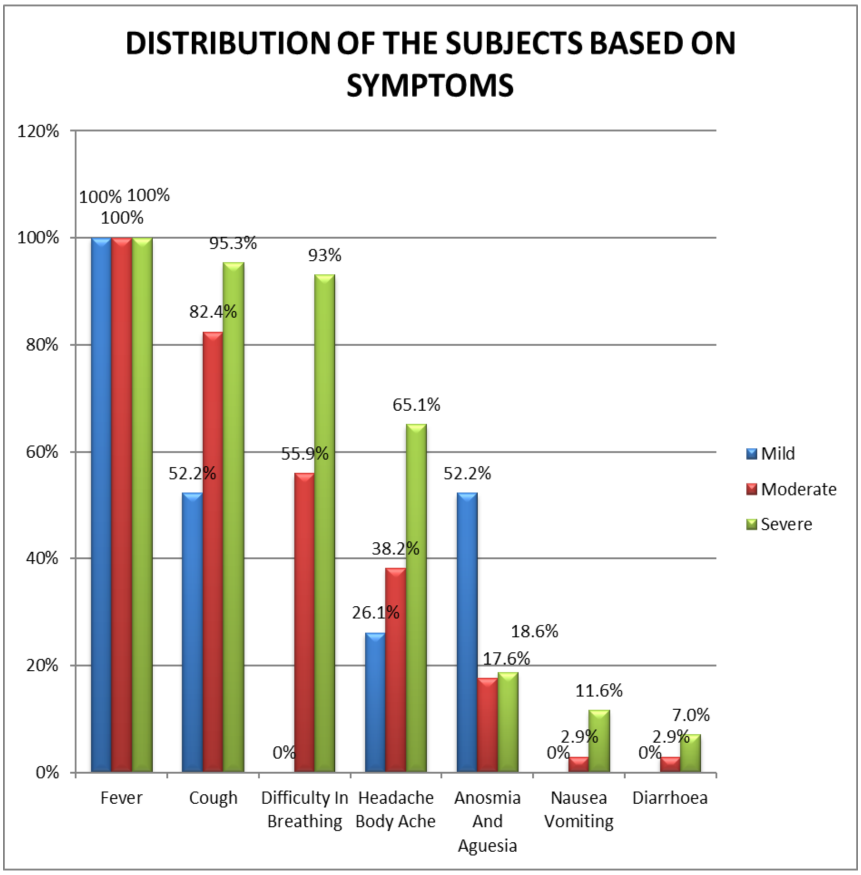

Figure 2: Distribution of study population based on the symptoms.

Among patients admitted to the hospital, 23%, 42%, 8%, 1% and 3% had worsening of symptoms on day 1, day 2, day 3, day 4 and day 5 respectively. 35% of patients had associated comorbidities, 23% were diabetic, 21% hypertensive, 10% obese, 2% chronic obstructive pulmonary disease (COPD), 2% ischemic heart disease (IHD) and 1% obstructive sleep apnea (OSA). 11% of the patients were chronic smokers. The mean Brixia score calculated on admission were 2.52±1.505, 6.18±2.969 and 12.05±3.251 in mild, moderate and severe category respectively and the scores that were calculated 3 days after admission were 2.52±1.505, 6.18±2.969 and 12.14±3.306 in mild, moderate and severe category respectively, the mean Brixia scores calculated using a bedside chest radiograph on admission and 3rd day after admission was found to be higher in patients with severe and moderate category compared to mild category (Figure 3). Laboratory parameters were correlated with Brixia score on admission, there was a statistically significant correlation between lymphocyte count (lymphopenia), lactate dehydrogenase (LDH), d-dimer, C-reactive protein (CRP) and serum ferritin with Brixia score on admission. 23% of admitted patients did not require any oxygen support during the course in the hospital, all these patients were included under mild category, whereas the other 69% of patients required oxygen support either in the form of facemask (45%) or high flow nasal cannula (HFNC) (24%), 6% required non-invasive ventilatory support and 2% required endotracheal intubation with ventilatory support. Among 69 patients who were on oxygen support, 24 of them were shifted to HFNC as they did not maintain adequate saturation on facemask, oxygen requirement in litres were as follows, 24 of them were on 12-15 l/min oxygen, 25 on 10-12 l/min, 10 on 8-10 l/min, 8 on 6-8 l/min and 2 on 5 l/min. CXR findings observed among the study population were, 2% had normal CXR on admission and 3 days after admission, while the most common pattern on the chest x-ray was bilateral, lower zone, peripheral ground glass opacities (42%), followed by bilateral, lower zone consolidation (25%), bilateral diffuse infiltrates (21%), multi-lobar consolidation (9%) and pleural effusion (1%). The mortality rate was 2%, both of them had presented to hospital with symptoms of fever, cough and breathlessness, requiring ventilatory support, both these patients had higher Brixia score of 10 and 14 at admission and 12 and 14 at 3 days post admission respectively, bilateral diffuse infiltrates was seen on chest x-ray, there was an increase in sequential organ failure assessment (SOFA) score from the baseline within next 48 hours, they were initiated on vasopressor support in view of septic shock and multiorgan dysfunction was seen in these two patients. The average number of days of stay in the hospital was 18.61 days, among patients who were discharged from the hospital, 12% required home oxygen following discharge, 8 of them were dependant on oxygen for a month, while, the other 4 required for a period of 2 months, all these patients who were discharged with home oxygen therapy belonged to severe category and they had higher Brixia scores, there by Brixia score was also helpful in predicting post discharge oxygen requirement.

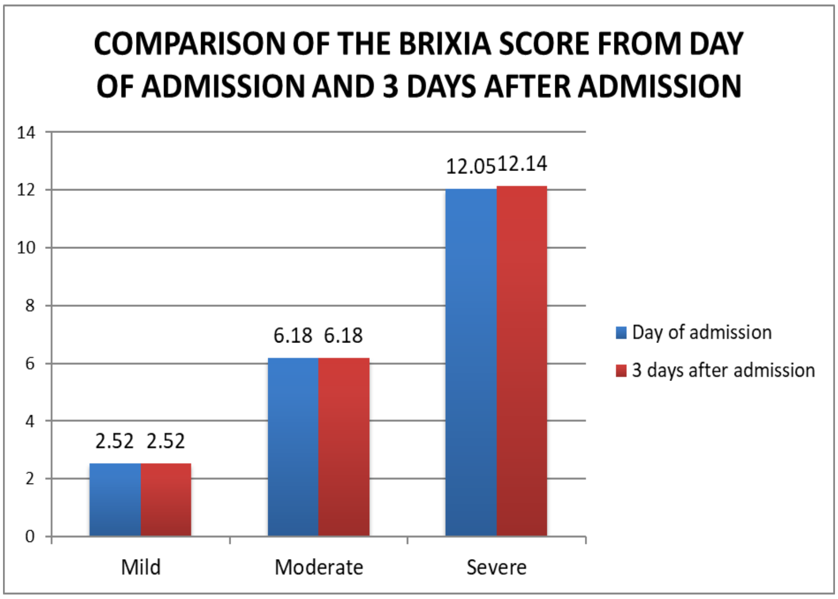

Figure 3: Comparison of mean Brixia score among mild, moderate and severe category.

DISCUSSION

The CXR is routinely used to know the pathology/involvement of the lung, however the scoring is not usually followed and done in clinical practice. Timely sequential CXR are also not followed in sequential manner, for an instance, if scoring is misinterpreted on D1 it can be corrected on D3 or if a CXR is normal on D1, sequential CXR can identify occurrence of new radiological abnormalities, as radiological changes lags severity of CoVID-19 disease and hence sequential CXR has to be done to identify lung involvement.

Majority, 77% belonged to moderate and severe category, since it is a dedicated COVID-19 hospital, there by majority of cases that were allotted belonged to moderate and severe category. Fever, cough and breathlessness were the most common presenting symptoms, it was observed that most of the cases among the moderate and severe category had breathlessness and symptoms like anosmia and ageusia were seen predominantly in mild category patients.

Most common finding on CXR was ground glass opacity (42%) followed by consolidation (25%) predominantly involving peripheral and lower zone, however, a study done by Diletta et al showed that the most common finding on CXR were reticulo-nodular opacities (66.6%), ground glass opacities (62.8%) and consolidation (57.7%), predominantly involving peripheral and lower zone and Frank et al showed consolidation (47%) and ground glass opacity (33%) with predominant basal and lower zone involvement were the most common finding.[6,10]

Brixia score that was calculated on admission and 3rd day after admission, were higher in moderate and severe category compared to mild category patients, no significant difference in score is noted on D1 and D3 in the study probably due to correct score calculated and also the admission Brixia scores correlated well with lymphopenia and other biochemical markers like LDH, CRP, ferritin and d-dimer and higher scores correlated were predictive of oxygen and ventilator requirement, also mortality was seen in patients with higher Brixia scores. A study done by Andrea et al showed that high Brixia score and at least one other predictive factor had the highest risk of in-hospital death.[11]

This study has shown promising results that a simple CXR scoring system can be applied in all patients admitted with COVID-19, although a CT scan was not done in our study, which is relatively more sensitive in identification of COVID-19 pneumonia, since many health care facilities are not equipped with advanced imaging modalities like CT scanning and the shifting of critically ill patients to get CT scan is an arduous job requiring a lot of manpower. The presence of various other findings on a CXR can interfere with interpretation of the results, like presence of pre-existing lung disease or cardiac disease, also, there can be inter-observer variation in interpretation of CXR findings, this needs a lot of training and practise to make careful observations before providing an accurate score. Therefore CXR score must be taken in to account along with other simple, easily available, biochemical predictors of clinical severity and prognosis, so that it will be more helpful in identifying, patients at high risk of requiring high dependency units and intensive care units for early initiation of appropriate treatment for better clinical outcome.

A follow up imaging was not done in patients who had recovered to know the radiological recovery or presence of any sequelae in individuals who required post discharge home oxygen treatment.

CONCLUSION

Majority of the nations have fallen short of health care facilities, therefore it is important to study the use of simple and easily available objective testing modalities that guides appropriate clinical management. Since COVID-19 is a rapidly progressive disease CXR plays an important role in assessing severity and the use of this simple score, Brixia CXR score, that does not require any meticulous skill, if trained appropriately to interpret the results and if used in conjunction with other easily available markers of poor prognosis, will be helpful in identification of patients at high risk, timely shifting of these patients to a health care facility with availability of advanced medical treatment, monitoring disease progression and predict clinical outcome and prognosis.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395(10223):497-506.
2. Bernheim A, Mei X, Huang M, Yang Y, Fayad ZA, Zhang N, et al. Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection. Radiology. 2020;295(3):685-91.
3. American College of Radiology. ACR recommendations for the use of chest radiography and computed tomography (CT) for suspected COVID-19 infection. 2020. Available at: www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection. Accessed on: 30 April 2020.
4. Stephanie S, Shum T, Cleveland H, Challa SR, Herring A, Jacobson FL, et al. Determinants of Chest X-Ray Sensitivity for COVID-19: A Multi-Institutional Study in the United States. Radiol Cardiothorac Imag. 2020;2(5):200337.
5. Smith DL, Grenier JP, Batte C, Spieler B. A Characteristic Chest Radiographic Pattern in the Setting of COVID-19 Pandemic. Radiol Cardiothorac Imag. 2020;2(5):200280.
6. Wong HYF, Lam HYS, Fong AH, Leung ST, Chin TW, Lo CSY, et al. Frequency and Distribution of Chest Radiographic Findings in Patients Positive for COVID-19. Radiology. 2020;296(2):72-8.
7. Cao AMY, Choy JP, Mohanakrishnan LN, Bain RF, van Driel ML. Chest radiographs for acute lower respiratory tract infections. Cochrane Database Syst Rev. 2013;12:CD009119.
8. Garcia-Santa-Cruz B, Sölter J, Bossa MN, Husch A. On the Composition and Limitations of Publicly Available COVID-19 X-Ray Imaging Datasets. Cornell University. 2020.
9. Borghesi A, Maroldi R. COVID-19 outbreak in Italy: experimental chest X-ray scoring system for quantifying and monitoring disease progression. La Radiologia Medica. 2020:1.
10. Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvarà S, et al. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. La Radiologia Medica. 2020:1.
11. Borghesi A, Zigliani A, Golemi S, Carapella N, Maculotti P, Farina D, Maroldi R. Chest X-ray severity index as a predictor of in-hospital mortality in coronavirus disease 2019: A study of 302 patients from Italy. Int J Infect Dis. 2020.

Cite this article as: Munirathnam M, Mohan CN, Mohammadi J, Gowda SS, Ramaiah M. Determining COVID-19 disease severity and outcome using sequential chest radiograph in a new designated COVID-19 hospital. Int J Adv Med 2021;8:98-102.