

Revisiting the Role of Portable Chest X-Rays in Critically Ill Patients with COVID-19

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Abstract

Portable chest X-ray is a traditional diagnostic and monitoring tool in the intensive care unit (ICU). In this report, chest X-rays of 98 ICU patients (76 males; 46 ± 8.6 years old with partial arterial pressure of oxygen/fractional inspired concentration of oxygen ratio of 155 ± 40.4 , Acute Physiology and Chronic Health Evaluation II score of 19.5 ± 3.5 , ICU length of stay 24 ± 12 days and time on mechanical ventilation 17 ± 9 days) due to severe COVID-19 pneumonia were retrospectively analyzed. Main chest X-ray findings in 97% of cases included bilateral infiltrates (61.2%), variable pulmonary infiltrates/wide patchy consolidations (61.2%) and an interstitial pattern (56.1%). Pulmonary embolism was diagnosed in twenty patients by chest computed tomography (CT) angiography. Chest X-rays of survivors (75.5%) showed gradual improvement 10 ± 2 days post-ICU admission. Although the role of chest CT in the diagnosis of COVID-19 pneumonia is well-established, exploring the putative monitoring role of chest X-rays in the critical care setting, especially in this era of crisis and resource limitations, warrants further attention.

Keywords: COVID-19; Chest X-Ray; Acute Respiratory Distress Syndrome; Intensive Care Unit

Introduction

SARS-CoV-2 disease (COVID-19) emerged in Wuhan city, capital of Hubei province, in China and spread worldwide [1-3]. Most patients are asymptomatic; however, a minority of patients can present with life-threatening disease, which is characterized by acute respiratory distress syndrome (ARDS), sepsis, multi-system organ failure, hyperinflammation and thromboembolic disease [1-3]. The characteristic features of COVID-19 pneumonia were identified and correlated to the severity of the clinical picture by chest computed tomography (CT) scans [4-11]. Although the role of lung ultrasound as a diagnostic and monitoring tool in COVID-19 pneumonia is important [12], the role of traditional radiology cannot be underestimated, especially in the intensive care unit (ICU) [13]. Mechanically ventilated ICU patients with COVID-19 are usually monitored by portable chest X-rays. The advantages are: avoiding transportation to the radiology department, which is time consuming and may facilitate viral shedding, lower radiation risk and greater availability compared to CT scans. However, scarce data exist regarding the monitoring role of traditional radiology in patients with severe COVID-19 pneumonia. Herein, we present a retrospective analysis of the main chest x-ray findings of COVID-19 patients that were admitted to our ICU (King Saud Medical City, Riyadh, Saudi Arabia).

Methods

Retrospective analysis of all critically ill patients that were admitted to the COVID-19 designated 200-bedded ICU of King Saud Medical City, Riyadh, Saudi Arabia, between April 1, 2020 and April 30, 2020 was done. All patients were diagnosed according to the World Health Organization guidelines [14]. COVID-19 was confirmed by Real-Time-Polymerase-Chain-Reaction assays, using QuantiNova Probe RT-PCR kit (Qiagen) in a Light-Cycler 480 real-time PCR system (Roche, Basel, Switzerland), which were performed on nasopharyngeal swabs [15]. Upon ICU admission, the peripheral oxygen saturation to fraction of inspired oxygen ($\text{PaO}_2/\text{FiO}_2$) ratio, and the Acute Physiology and Chronic Health Evaluation II (APACHE II) scores were recorded. Serious COVID-19 was defined as acute respiratory failure: dyspnea, respiratory rate $\geq 30/\text{min}$, blood oxygen saturation $\leq 93\%$, $\text{PaO}_2/\text{FiO}_2$ ratio < 300 and/or development of bilateral pulmonary infiltrates within 24 to 48 hours [16]. All pertinent epidemiologic, demographic and clinical data were retrieved from the patients' electronic medical records by a dedicated research team. Usual outcome measures such as 28-day mortality, days on mechanical ventilation and ICU length of stay were also recorded. The study was approved by our Institutional Review Board Committee (King Saud Medical City, Riyadh, Saudi Arabia). In the statistical analysis, continuous variables were expressed as mean \pm standard deviation (SD) and categorical variables as absolute numbers or percentages.

Results

Ninety eighty critically ill patients with COVID-19 that were admitted in the ICU (King Saud Medical City) during the study period were enrolled in this study. Upon ICU admission, the male/female ratio was 76/22, mean age was 46 ± 8.6 years old, mean $\text{PaO}_2/\text{FiO}_2$ ratio was 155 ± 40.4 and the mean APACHE II score was 19.5 ± 3.5 . Main comorbidities were: history of hypertension (56.1%), diabetes mellitus (50%), end-stage kidney disease (25.5%) and cardiovascular disease (20.5%). Upon ICU admission, 71.5% of patients were receiving ten liters oxygen via nasal cannula, while 28.5% of patients have been already mechanically ventilated. However, after 24 to 48 hours, all patients were mechanically ventilated. ARDS-net/prone positioning ventilation and empiric treatment with ribavirin, interferon beta-1b, antibiotics and ICU supportive care to all patients were administered as per hospital protocol [17]. All patients have received baseline weight- and renal function- adjusted doses of low-molecular-weight heparin thromboprophylaxis unless contraindicated (enoxaparin 20 mg once daily if < 50 kg; enoxaparin 40 mg once daily if 50 - 100 kg; 40 mg twice daily if 101 - 150 kg; 60 mg twice daily if > 150 kg). The main findings on admission chest X-rays (Figure 1 and 2) included bilateral infiltrates (61.2%), variable wide patchy consolidations (61.2%) and an interstitial pattern (56.1%). Either one of the aforementioned patterns (44.9%) or combinations (55.1%) were detected in this cohort of COVID-19 patients. Upon ICU admission, chest X-rays were normal in only 3% of cases. However, these cases had abnormal chest X-rays in follow-up radiology examinations after 3 to 5 days post-ICU admission. Patients with refractory hypoxia ($\text{PaO}_2/\text{FiO}_2$ ratio < 150 for more than 24 hours) and elevated D-dimer levels (> 0.5 mcg/ml) underwent chest CT angiography to exclude pulmonary embolism (PE). PE was found in twenty patients out of the forty nine that were screened. Hence, 22.4% of patients out of the total 98 patients received therapeutic anticoagulation. Four patients with $\text{PaO}_2/\text{FiO}_2$ ratio < 80 received veno-venous extracorporeal membrane oxygenation. Chest X-rays of survivors (75.5%) showed gradual improvement 10 ± 2 days post-ICU admission. The mean ICU length of stay was 24 ± 12 days and time on mechanical ventilation was 17 ± 9 days. Mortality on day-28 post-ICU admission was 24.5%.

Discussion

The vast majority (97%) of the ICU patients with acute respiratory failure due to serious COVID-19 pneumonia had an abnormal chest X-ray, which showed gradual improvement in survivors (75.5%). The main findings included bilateral infiltrates (61.2%), variable wide patchy consolidations (61.2%) and an interstitial pattern (56.1%). Although, the chest imaging patterns in COVID-19 can be extremely heterogeneous and their initial presentation very subtle, the results of the study are in accordance with previous reports [4-11]. Chest CT along with its advancements (i.e. low-dose protocols, portable CT) remains pivotal in detecting promptly typical lung parenchymal changes (i.e. peripheral ground-glass opacities distributed mainly on the lower lung lobes) even when the RT-PCR is negative in patients with COVID-19 [1-11,18]. However, when COVID-19 pneumonia has already progressed and the full-blown clinical picture of ARDS is evi-

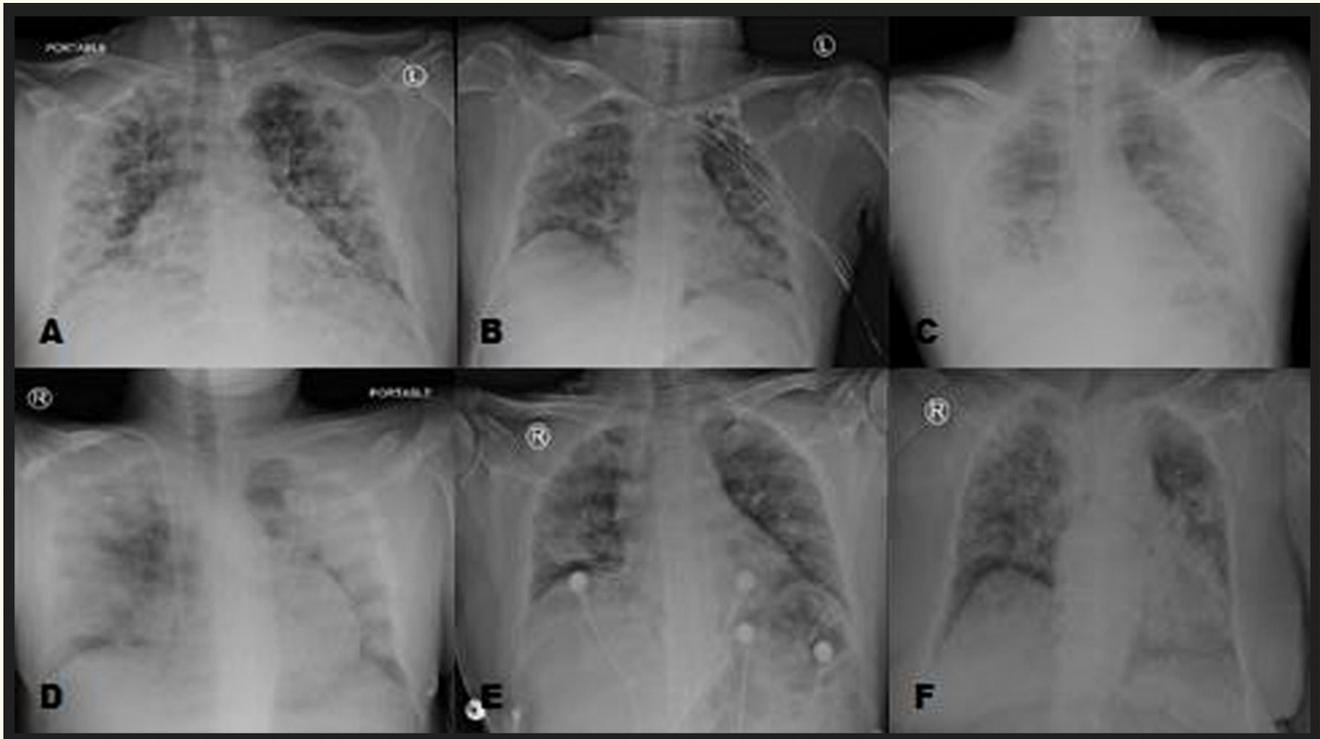


Figure 1: Sample intensive care unit admission chest X-rays in patients with acute respiratory failure due to confirmed serious COVID-19 pneumonia depicting variable infiltrates and consolidation patterns: A. 55 years old male with hypertension, diabetes mellitus and coronary artery disease; B. 40 years old male previously healthy; C. 30 years old male previously healthy; D. 41 years old male with hypertension, end-stage kidney disease on maintenance hemodialysis; E. 50 years old male with hypertension and diabetes mellitus; F. 82 years old female with hypertension, diabetes mellitus and coronary artery disease.

dent, by-the-bed chest X-ray could be useful in terms of continuous monitoring and therapeutic guidance in the ICU setting. Moreover, this monitoring strategy could prevent the transportation of COVID-19 patients to the CT scanner reducing thus the risks of cross-infection amongst health care workers and the viral shedding within the hospital premises. In this study, the recorded 28-day mortality rate, days on mechanical ventilation, and the ICU length of stay were comparable to previous reports [1-3,12]. This retrospective study has many limitations. First, a meaningful subgroup analysis correlating the chest x-ray findings to the outcome measures could not be performed. Also, comparison of chest X-ray to other imaging modalities such as chest CT or lung ultrasound was not pursued as this was not an endpoint of this study. Despite the aforementioned limitations, it is showed that chest x-ray can be a reliable monitoring tool in the ICU for COVID-19 patients with acute respiratory failure due to severe pneumonia. In the COVID-19 era, an adaptation in the clinical workflow and the utilization of staff and resources (budget, healthcare workers, personal protective equipment and imaging devices) may be a prudent strategy. Hence, the monitoring role of traditional radiology, which is a cheap and readily available diagnostic modality, should not be underestimated, especially in the critical care setting. Surely, larger prospective studies evaluating the putative diagnostic and monitoring role of chest X-rays in the evolution of COVID-19 pneumonia are required.

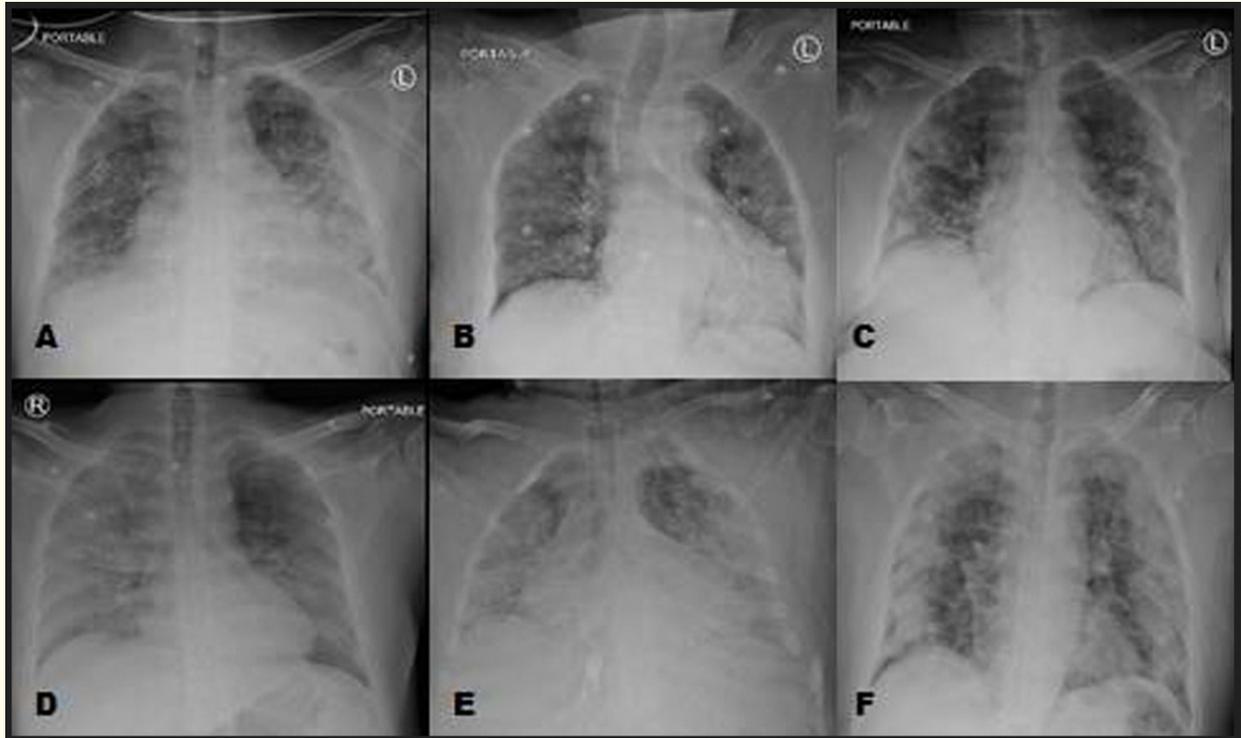


Figure 2: A: Sample intensive care unit admission chest X-rays in patients with acute respiratory failure due to confirmed serious COVID-19 pneumonia depicting variable infiltrates and consolidation patterns: A. 58 years old male with hypertension and diabetes mellitus; B. 46 years old male with hypertension, diabetes mellitus, end-stage kidney disease on maintenance hemodialysis; C. 67 years old female with hypertension; D. 46 years old male previously healthy; E. 42 years old male with hypertension; F. 30 years old male previously healthy.

Conclusion

The role of traditional radiology being a cheap and readily available diagnostic modality in severe COVID-19 pneumonia, especially in this era of crisis and resource limitations, cannot be underestimated. Portable chest X-rays, albeit their inherent limitations, can be useful in the diagnosis and monitoring of severe COVID-19 pneumonia in the critical care setting.

Authors Contributions

All authors equally contributed to drafting the manuscript and approve of its submission to the journal.

Conflicts of Interest

All authors declare no conflicts of interest.

Ethical Approval and Consent to Participate

The study was approved by the Institutional Review Board of King Saud Medical City, Riyadh, Kingdom of Saudi Arabia [H-01-R-053, IORG0010374#, H1RI-7 May-20-00]. All participants or their legal representatives provided informed consent.

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Data Availability

All pertinent data sets included in this study are available by the corresponding author on reasonable request.

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