

Research Article



Role of PAO₂/FIO₂ Ratio at Admission as Predictors of Respiratory Failure in Covid-19 Patients.

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Abstract:

Introduction: The early identification of factors that predict respiratory failure in patients affected by coronavirus disease (COVID-19) will assist therapeutic decisions and patient flow management.

Methodology: We collected, at the time of admission, routine clinical, laboratory, and imaging parameters of hypoxia, lung damage, inflammation, and organ dysfunction in a consecutive series of 60 COVID-19 patients admitted to ESICMC-PGIMS hospital Rajajinagar.

Results: Patients were divided into mild, moderate and severe ARDS based on Pao₂/Fio₂ ratio at admission (berlin criteria). The requirement of CPAP, mechanical ventilator, duration of hospital stay and death was compared in the 3 group of patients. Out of 60 patients 25 patients had pao₂/fio₂ ratio <300-200 mm Hg (mild), 18 had 200-100 mm Hg (moderate) and 17 of them had <100 mm Hg (severe). Those patients with lower PaO₂/FiO₂ ratio at admission were significantly needed the assistance of CPAP, Mechanical ventilator for their hypoxia management, they also had prolonged hospital stay (PHS, >21 days) than patients with higher Pao₂/Fio₂ ratio. Patients in lower PaO₂/FiO₂ ratio i.e. in severe group had high mortality rate.

Conclusions: The PaO₂/FiO₂ ratio on admission is independently associated with significant mortality and morbidity in COVID-19 patients. Larger prospective studies are needed to confirm this finding.

Key word: Covid-19, ARDS, Pao₂/Fio₂ ratio.

Introduction:

Coronavirus disease 2019 (COVID-19), the highly contagious viral illness caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-

2), has had a catastrophic effect on the world's demographics resulting in more than 6 million deaths worldwide, emerging as the most consequential global health crisis since the era of

the influenza pandemic of 1918. After the first cases of this predominantly respiratory viral illness were first reported in Wuhan, Hubei Province, China, in late December 2019, SARS-CoV-2 rapidly disseminated across the world in a short span of time, compelling the World Health Organization (WHO) to declare it as a global pandemic on March 11, 2020. Since being declared a global pandemic, COVID-19 has ravaged many countries worldwide and has overwhelmed many healthcare systems.¹

Covid-19 has a varied presentation affecting any system of body; however the main organ affected is lung leading to both high mortality and morbidity. A multicenter analysis of lung tissue obtained during autopsies of patients who tested positive for COVID-19 demonstrated typical diffuse alveolar damage features in 87% of cases. Additionally, there was a frequent presence of type II pneumocyte hyperplasia, airway inflammation, and hyaline membranes in alveolar zones. Forty-two percent of patients were noted to have large vessel thrombi, platelet (CD61 positive), and/or fibrin microthrombi were present in 84% of cases.²

The clinical spectrum of COVID-19 disease is wide, ranging from asymptomatic infection or mild upper respiratory tract symptoms (80%) to severe viral pneumonia with respiratory failure and death (20%)³⁻⁷. Acute respiratory distress syndrome (ARDS) is the most common and serious causes of hospitalization and demand for critical care environment⁸. PaO₂/FiO₂ ratio is the index used to classify the severity of ARDS according to the Berlin definition.⁹

There are many parameters (signs, symptoms and laboratory) which help in identifying or predicting the severity of the covid-19 infection and inflammation, of these Sao₂, Pao₂/fio₂ at admission is one among the many predicting variables.

PaO₂/FiO₂ ratio, also known as Horowitz index, is a measure of hypoxemia in respiratory failure widely known in clinical practice due to its easy to use: it is calculated as the ratio between the

arterial oxygen partial pressure (PaO₂) and the fractional inspired oxygen (FiO₂). It is a good descriptor of respiratory failure tied to lung parenchymal damage with subsequent shunt effect, as occurs for example in pulmonary edema, acute respiratory distress syndrome (ARDS) and pneumonia¹¹. Valuated in 1974 as predictor of pulmonary dysfunction in injured patients admitted in trauma services¹², it was validated as a recommended criterion for acute lung injury and ARDS in the American-European Consensus Conference on ARDS¹³ and lately incorporated in the Berlin definition of ARDS, in which PaO₂/FiO₂ ratio determines the degree of severity of ARDS itself¹⁴.

Many of these patients required mechanical ventilator during pandemic. Facial mask oxygen, high flow nasal cannula (HFNC), helmet C-PAP (continuous positive air pressure) and non-invasive ventilation (NIV) are the alternatives to mechanical ventilation in non-intensive care unit (ICU) settings to maintain adequate level of blood oxygenation.¹⁰

Despite being widely used in clinical practice, only a few reports have previously investigated the capacity of Pao₂/Fio₂ ratio in predict the mortality, morbidity, length of stay, need for CPAP mechanical ventilator in COVID-19 patients in critical care settings¹⁵. In the context, we are primarily investigated the PaO₂/FiO₂ ratio as predictors of respiratory failure and outcome of patients (i.e. as a marker of disease severity), which helps in implementation of effective patient flow management strategies that would benefit from a better understanding of the clinical progress of the disease.

Materials and Methods

This Prospective study was conducted in Patients admitted in ESIC & PGIMSR, Rajajinagar, Bangalore from July 2020 to august 2020. Patients diagnosed with COVID-19 infection by RT-PCR, signs and symptoms of LRTI in the form of easy fatigability, breathlessness, desaturation (<94%) were included in study. Patient's demography data was collected. All

patients on the day of admission Pao₂/Fio₂ ratio was measured and classified accordingly as mild (<300-200 mm Hg) moderate (100-200 mm Hg) severe (<100 mm Hg) respiratory failure. All patients underwent standard treatment of care according to hospital protocol. These patients were further analyzed for requirement of mechanical ventilator, CPAP, duration of hospital stay, death.

Statistical Analysis

Data was entered in the excel spread sheet. SPSS (Statistical Package for Social Sciences) version 20. [IBM SPSS statistics (IBM corp. Armonk, NY, USA released 2011)] was used to perform the statistical analysis. Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables, frequency and proportions for qualitative variables. Chi square was applied to test the statistical association between qualitative variables. ANOVA test was applied to test the statistical significance for more than two groups for quantitative data. The level of significance was set at 5%

Results

In our study, majority of patients were males (n=43), females (n=17). The mean age group of patients was 49.8yrs. Patients were divided into mild, moderate and severe ARDS based on Pao₂/Fio₂ ratio at admission (berlin criteria), out of 60 patients, there were 25 patients in mild group, and 8 and 17 patients in moderate and severe group respectively. The requirement of CPAP, mechanical ventilator, duration of hospital stay and death was compared in the 3 group. In the mild group 6 patients (24%) required CPAP, 1 patient (4%) required mechanical ventilator and 1 patient died. Where as in moderate and in severe group 44% and 100 % of the patients required CPAP for management of hypoxia during their stay in hospital. 22% (n=4) and 70% (n=12) of moderate and severe group patients required mechanical ventilator support. When comparing duration of hospital stay in these 3 group, prolong hospital stay (>21 days) was significantly high in severe group than in other 2 groups. There was a significant correlation between Pao₂/Fio₂ ratio to need for CPAP, mechanical ventilator and duration of stay in hospital (p<0.001). There was also a significant association between Pao₂/Fio₂ ratio to mortality rate (p<0.01) and to duration of hospital stay (p<0.02)

Table 1:

Pao2/fio2 ratio	No of patients requiring CPAP		No of patients requiring Mechanical ventilator		Duration of stay in hospital				Death	
					PHS*					
					Yes		No			
	No.	%	No.	%	No.	%	No.	%	No.	%
Mild(<300-200) [n=25]	6	24%	1	4%	1	4%	24	96%	1	4%
Moderate(100-200) [n=18]	8	44%	4	22%	8	45%	10	55%	4	22%
Severe (<100) [n=17]	17	100%	12	70.5%	17	100%	0	0%	12	70.5%

PHS*- prolong hospital stay (>21days),

Discussion:

In our study, role of PaO₂/FiO₂ Ratio at admission as predictors of respiratory failure in

CoVID-19 patients, PaO₂/FiO₂ ratio, also known as Horowitz index was utilized to measure the level hypoxemia in respiratory failure patients ¹¹.

Despite being widely used in clinical practice, only a few reports have previously investigated its capacity to predict the length of stay in non-COVID-19 patients in critical care settings¹⁵. In the context of COVID-19, the PaO₂/FiO₂ ratio has been primarily investigated as a marker of disease severity.

In study conducted by Guan et al.¹⁶ did not found any significant differences in the PaO₂/FiO₂ ratio between severe and non-severe COVID-19 patients. However, data were missing in 81.3% of cases.

In study conducted by Colaneri et al.¹⁷ found a univariate correlation between the PaO₂/FiO₂ ratio and disease severity. In study conducted by Angelo Zinellu et al.¹⁸ there was a significant association between the PaO₂/FiO₂ ratio on admission is with PHS ($p < 0.001$) in COVID-19 patients.

The results of our study have potential clinical relevance as they suggest that a single PaO₂/FiO₂ ratio measurement within the first 24 hours of admission might independently predict need of mechanical ventilator, CPAP, duration of hospital stay and mortality. As a consequence, this parameter might prove useful to rapidly divert patients to management pathways characterized by specific management and monitoring protocols.

Some limitations of our study must be acknowledged, particularly its relatively small sample size. However, to the best of our knowledge, this best evidence of a significant and independent association between the PaO₂/FiO₂ ratio on admission and their correlation in outcome hospitalized COVID-19 patients.

Larger prospective studies are needed to confirm our results and further evaluate the use of the PaO₂/FiO₂ ratio is optimizing COVID-19 patient care and flow management in acute care.

Conclusion:

The outbreak of the pandemic caused by the betacoronavirus SARS-CoV-2 got in trouble several countries all over the world, even those whose health system was believed to be cutting-edge. The burden of patients affected with

COVID-19 that needed hospitalization was in fact either heavy or sudden: this situation led to a necessary reorganization of the resources to increase survival chances of as many as possible patients. We propose to use PaO₂/FiO₂ ratio at the admission to make a decision on the intensity of treatment, as a single measurement of Horowitz index predicts both mortality and morbidity hospitalization. Even with the limitation of a limited number of patients analyzed, our study provides evidence of an independent association between PaO₂/FiO₂ ratio measured within 24 hours from the admission as a predictor of respiratory failure in patients with COVID-19.

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