International Journal of Medical Science and Clinical Research Studies

ISSN(print): 2767-8326, ISSN(online): 2767-8342

Volume 03 Issue 08 August 2023

Page No: 1595-1599

DOI: https://doi.org/10.47191/ijmscrs/v3-i8-28, Impact Factor: 6.597

Impact of Sao_2/Fio_2 Delta Value on Mortality in Critically Ill Patients with ARDS and COVID-19 in Prone Position

Carlos Jiménez-Correa[1], Carlos Eduardo Rodríguez-Cázares[2], Ma. Natalia Gómez-González[3], Deisy De Jesús-Balcázar[4], Pedro Luis González-Carrillo[5]

[1,2,4,5]Critical Care Medicine and Emergency Medicine Physician. Instituto Mexicano del Seguro Social, Unidad Médica de Alta Especialidad, Hospital de Especialidades No. 1, Centro Médico Nacional del Bajío (IMSS, UMAE HE No. 1 CMN), León, Guanajuato, Mexico. Intensive Care Unit.

[3]Master's degree in clinical research, Critical Care Medicine and Anesthesiologist Physician. IMSS, UMAE HE No. 1 CMN, León, Guanajuato. Mexico. Intensive Care Unit.

ABSTRACT

Introduction: The COVID 19 pandemic generated in December 2019 has come to change paradigms in terms of ventilatory support measures worldwide, continuous clinical monitoring allows timely decision making impacting mortality in patients with ARDS.

Objective: To **i**dentify the relationship between the SO_2/FiO_2 delta and mortality in critically ill patients with ARDS and COVID-19 in prone position.

Material and methods: Retrospective, observational, comparative, analytical study, where all patients who met the inclusion criteria were evaluated: under mechanical ventilation and prone position for acute respiratory failure secondary to SARS-CoV-2 infection, measuring the value of SO_2/FiO_2 before and after the change of position to prone position, also mortality was recorded.

Results: A total of 74 patients were analyzed, 33 corresponding to the survivors and 41 to the non-survivors group. The median age was 53.5 ± 12.77, with a male predominance. The mean days of mechanical ventilation were 10.64 ±5.16. A ROC curve was also performed for Δ SaO_2/FiO_2 and survival (AUC 0.668, p=0.013) for predicting patient survival.

Conclusion: Continuous clinical monitoring is necessary to optimize resources in the different hospital and out-of-hospital areas. Δ SO_2/FiO_2 can be very useful for the continuous monitoring and prognosis in COVID-19 critical patients.

KEYWORDS: SaO_2/FiO_2 delta value, ARDS, COVID-19, prone position, critically ill patient.

ARTICLE DETAILS

Published On:
11 August 2023

Available on:
https://ijmscr.org/

I. INTRODUCTION

The SARS-CoV-2 virus causing Coronavirus Disease 2019 (COVID-19) was declared a pandemic since the World Health Organization (WHO) decree on March 11, 2020, and has infected more than 118,147,420 people and caused 2,621,170 deaths as of March 09, 2021 (1).

The most common initial symptoms of coronavirus 2019 (COVID-19) disease are cough, fever, fatigue, headache, myalgia, and diarrhea (2). It is within the first 7 days after the onset of symptoms that severe disease usually occurs. Dyspnea is the most common symptom of severe disease and is usually accompanied by hypoxemia (3, 4). Most patients with severe COVID-19 develop progressive respiratory failure shortly after the onset of dyspnea and hypoxemia, eventually developing acute respiratory distress syndrome (ARDS), due to the acute onset of bilateral infiltrates, severe hypoxemia and the presence of pulmonary edema without cardiac cause or fluid overload (5). Most patients with severe COVID-19 have lymphopenia (6) and some have thromboembolic complications (7), as well as central or peripheral nervous system disorders (8). Severe COVID-19 can also cause acute cardiac, renal, and hepatic injury, as well as cardiac arrhythmias, rhabdomyolysis, coagulopathy, and shock (9, 10). These organ failures may be associated with clinical and laboratory signs of inflammation, which include fever, thrombocytopenia, increased C-reactive protein, and interleukin-6.

The ARDS that these patients may develop requires adequate monitoring which includes multiple arterial punctures

 Corresponding Author: Ma. Natalia Gómez González

or can be done through a continuous arterial line, which sometimes is not available in all medical units, so delta SaO_2/FiO_2 is proposed as a marker for noninvasive monitoring.

II. MATERIAL AND METHODS

This is an observational, retrospective and comparative study. It was conducted at the Intensive Care Unit of the Hospital de Especialidades Médicas No. 1 (UMAE T1, Bajío), Instituto Mexicano del Seguro Social (IMSS).

All patients admitted to the intensive care unit who met the inclusion criteria (patients with ARDS and COVID19 over 18 years and prone position) in a period from April 1, 2021 to September 30, 2021 were included. The sample was taken on a non-probabilistic convenience basis.

On admission, all patients with a diagnosis of acute respiratory distress syndrome with SARS-CoV-2 infection with positive PCR test who were admitted to the Intensive Care Unit of UMAE HE No.1 Bajío and who required mechanical ventilation and prone position were evaluated according to selection criteria.

Patient demographics were recorded, and the delta value was calculated, according to medical and nursing records, within one hour before and after the prone position. All the patients were followed up until their discharge from the unit to record mortality in intensive care, designating non-survivors as cases and survivors as controls.

The primary objective was to identify the relationship between the SaO_2/FiO_2 delta and mortality in critically ill patients with ARDS and COVID-19 in prone position.

Statistical analysis

The information was processed using the SPSS program. The results are presented in frequency distribution tables and graphs to facilitate their evaluation. Descriptive statistics were used to obtain measures of central tendency (mean, standard deviation and range for discrete variables and frequencies for nominal variables). The Kolmogorov-Smirnov test was performed.

Comparison of groups (survivors vs no-survivors) for qualitative variables was performed using Xi^2 (or Fisher's exact test as appropriate) and for quantitative variables with Student t-test.

The value of $p < 0.05$ is taken for statistical significance. The present study is considered No Research Risk in accordance with the regulations of the general health law on health research. After signing the informed consent, it was explained to them that this is a study that aims to know the attitudes of the workers in their work area, safeguarding their data and without interventions derived from the results of the questionnaire. This work was carried out with the approval of the ethics and institutional research committees with registration number: **R-2020-3609-007.**

III. RESULTS

A total of 74 patients were analyzed, 33 corresponding to the non-survivors and 41 to the survivor group.

The median age was 53.5 ± 12.77, with a male predominance of %. The most frequent comorbidity was arterial hypertension (40%) followed by type 2 diabetes (34%). The mean days of mechanical ventilation were 10.64 ±5.16. The oxygenation variables are explained in Table 1.

In the comparison between groups (survivors vs non-survivors), no significant differences were found between demographic variables such as age, sex and BMI. With respect to comorbidities, although type 2 diabetes mellitus and chronic obstructive pulmonary disease were present in greater numbers in the group of non-survivors, but no significant p values were found.

Table 1. Baseline characteristics

Age (years)	53.5 ± 12.77
Gender n(%)	
Male	47 (63%)
Female	27 (37%)
Weight (Kg)	84.89 ± 15.79
Height (m)	1.65 ± 0.09
MCI (kg/m2)	31 ± 4.71
Comorbidities	
Diabetes mellitus type 2, n (%)	25 (34%)
Arterial hypertension, n (%)	30 (40%)
Asthma	1 (1.5%)
COPD	9 (12%)
Oxygenation parameters	
SO2 before prone position (pre)	87.43 ± 9.20
FiO2 (%) pre	91.8 ±15.12
SO2/FiO2 pre	99.06 ± 25.61
PaO2/FiO2 pre	90.21 ± 30.39
SO2 after prone position (post)	94.39 ± 2.98
FiO2 (%) post	60.47 ± 17.77
SO2/FiO2 post	169.57 ± 49.35
PaO2/FiO2 post	162.93 ± 65.15
Delta SO2/FiO2	70.50 ± 45.19
Mechanical ventilation (days)	10.64 ± 5.16

Values are means ± standard deviation (SD)

When analyzing oxygenation parameters, although the mean peripheral saturation and SO_2/FiO_2 ratio as well as PaO_2/FiO_2 prior to prone position were higher in non-survivors vs. survivors no significant difference was reported. However, after the prone position, the inspired oxygen fraction was lower in the surviving patients (p= 0.03), and a higher value was found in the SO_2/FiO_2 ratio (p= 0.03) and PaO_2/FiO_2 (p= 0.04) in the group of the survivors with respect to the non-survivors.

Surviving patients remained more days under mechanical ventilation ($p = 0.02$) (Table 2).

Table.2 Baseline characteristics according to allocated group

	Non-survivors (n= 33)	Survivors (n= 41)	p- value
Age (years)	56.36 ± 10.95	51.20 ± 13.76	0.07[a]
Gender n(%)			
Male	20 (61%)	27 (66%)	
Female	13 (39%)	14 (35%)	0.8[b]
Weight (Kg)	85.02 ± 13.62	84.79 ± 17.52	0.95[a]
Height (m)	1.65 ± 0.01	1.64 ± 0.09	0.95[a]
MCI (kg/m2)	31.04 ± 4.58	30.98 ± 4.87	0.95[a]
Comorbidities			
Diabetes mellitus type 2, n (%)	15 (45%)	10 (25%)	0.05[b]
Arterial hypertension, n (%)	13 (40%)	17 (42%)	0.85[b]
Asthma	0 (0%)	1 (2%)	0.36[b]
COPD	5 (15%)	4 (9%)	0.72[b]
Oxygenation parameters			
SO_2 before prone position (pre)	88.42 ± 6.65	86.93 ± 10.84	0.4[a]
FiO_2 pre	91.76 ± 14.59	91.83 ± 15.72	0.98[a]
SO_2/FiO_2 pre	99.50 ± 22	98.72 ± 28.46	0.89[a]
PaO_2/FiO_2 pre	91.64 ± 26.57	89.05 ± 33.44	0.71[a]
SO2 after prone position (post)	94.21 ± 3.51	94.54 ± 2.52	0.64[a]
FiO2 post	65.30 ± 18.41	56.59 ± 16.44	0.03[a,c]
SO_2/FiO_2 post	156.13 ±45.92	180.39 ± 49.88	0.03[a,c]
PaO_2/FiO_2 post	149.99 ± 92.18	173.35 ± 45.77	0.04[a,c]
$\Delta SO_2/FiO_2$	56.63 ± 41.84	81.66 ± 41.17	0.01[a,c]
Mechanical ventilation (days)	9.12 ± 4.92	11.90 ± 5	0.02[a,c]

Plus-minus values are means ± standard deviation (SD); [a] t-test ; [b] chi-squared test; [c] significant p-value

A ROC curve was performed for $\Delta SO_2/FiO_2$ and survival, finding an AUC of 0.668 ($p = 0.013$, 95% CI 0.543-0.793) (Fig.1).

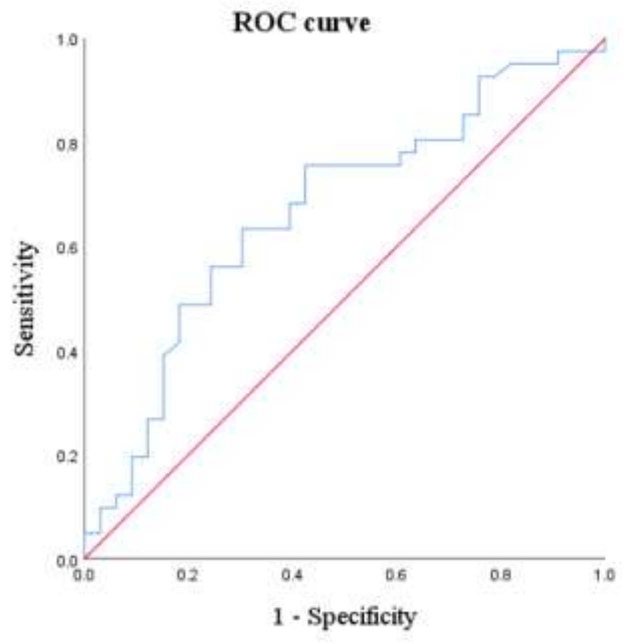

Fig. 1 ROC curve for survival prognosis using $\Delta SO_2/FiO_2$.

For the SO_2/FiO_2 ratio prior to prone position the values found in the ROC analysis were AUC 0.483 ($p = 0.802$ CI95% 0.350-0.616), however for the SO_2/FiO_2 ratio after prone position AUC of 0.647 ($p = 0.030$ CI95% 0.520-0.775) was reported (Fig.2).

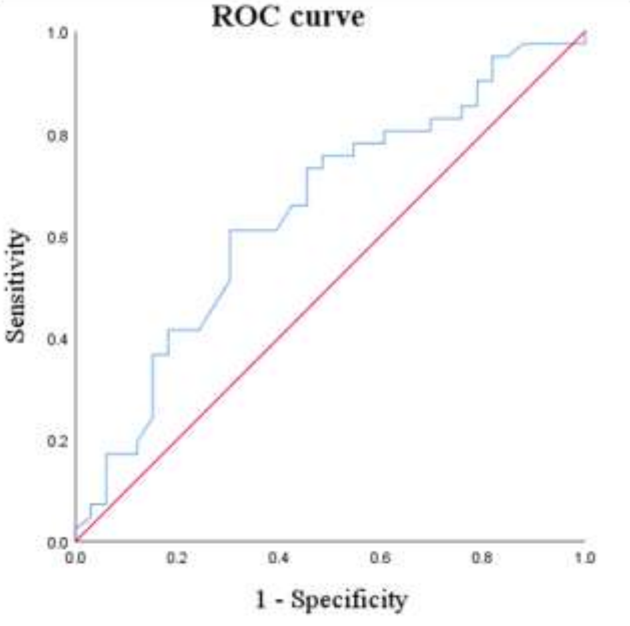

Fig. 2 ROC curve for survival prognosis using SO2/FiO2 after prone position (post).

IV. DISCUSSION

During the pandemic secondary to the SARS-CoV-2 virus disease, more than 118,147,420 was infected [(1)]. The main initial symptoms are cough, fever, fatigue, headache, myalgia and diarrhea[(2)], and the main symptom of severe disease is dyspnea accompanied by hypoxemia [(3, 4)], even developing Acute Respiratory Distress Syndrome (ARDS), which is characterized by the acute appearance of bilateral infiltrates, severe/severe hypoxemia and presence of pulmonary edema without cardiac cause or fluid overload [(5)] , PaO_2/FiO_2 (PF) ratio ≤200. For which arterial puncture is necessary either continuously or by means of continuous invasive monitoring lines, not being available in all services and even with shortage within the critical medicine services during the peaks of the pandemic.

International literature mentions that patients with severe COVID-19 may develop lymphopenia, thromboembolic complications, central or peripheral nervous system involvement, acute cardiac, renal and hepatic lesions, rhabdomyolysis, coagulopathy and shock[(6-10)]; these organ failures may be associated with clinical and laboratory signs of inflammatory response. The development of lung injury leading to respiratory dysfunction and/or failure leading even to the development of acute respiratory distress syndrome [(6-10)].

It has been shown that the pulse oximetry saturation ratio $SatO_2/FiO_2$ (SF) can be a reliable noninvasive alternative to the PF ratio [(11-13)]. In addition, it has been described that patients with COVID-19 reach oxygen levels incompatible with life without the presence of dyspnea, which was called silent hypoxemia, defying basic biology [(14)].

There are several sociodemographic factors that influence the severity of SARS-COV-2 disease, within our study we identified as main ones the history of arterial hypertension, diabetes mellitus, immunosuppression, obesity and male sex, which corresponds with the current international literature, as mentioned by David A. Berlin in his article on Severe COVID published in 2020 in the NEJM journal [15].

The mean age of the patients in the non-survivors was 56.36 ± 10.95 years while the survivor group was 51.20 ± 13.76 years, without statistical significance with a p= 007, which does not coincide with what is mentioned in most of the current literature. The number of days of mechanical ventilation in the non-survivors was 9.12 ± 4.92 vs 11.90 ± 5 in survivors group reaching an important statistical significance (p=0.021), coinciding with the current literature. justified under the precept that those patients who survived required more time under invasive ventilation until weaning.

Due to the critical nature of tissue oxygen consumption in the body, continuous monitoring of SO_2 is essential, having an important accuracy that allows clinical decision making [16-18]. In thus study, most patients had an average SO_2 of 89%, with a range up to 45-100%, with a FiO2 contribution of 100%. Allowing rapid decision making helping to improve the prognosis of our patients with ARDS due to COVID.

Patient oxygenation is initially assessed with a pulse oximeter. Oxygen saturation measured by pulse oximetry (SpO_2) may differ from true SO_2 by up to ± 4% [19].

The ratio of oxygen saturation to fraction of inspired oxygen (SO_2/FiO_2) has been validated as a surrogate marker for the ratio of oxygen partial pressure to fraction of inspired oxygen (PaO_2/FiO_2) in mechanically ventilated patients with ARDS [20]. SO_2/FiO_2 ratios of 235 and 315 correlates with PaO_2/FiO_2 ratios of 200 and 300, respectively [21]. In a prospective study, performed in cardiac revascularization surgery patients, PaO_2/FiO_2 values correlated in the diagnosis of ARDS, a PaO_2/FiO_2 of 300 correlated with a SO_2/FiO_2 of 311 (Sensitivity 90%, Specificity 80%). Allowing with SO_2/FiO_2 an early real-time identification of ARDS, as well as reducing the cost [22].

The SO_2/FiO_2 ratio may be a reliable tool for the detection of hypoxemia among patients admitted to the emergency department, particularly during the SARS-CoV-2 outbreak [23,24]. Within this study in patients the average first PaO_2/FiO_2 was 91.64 ± 26.57 and the average first SO_2/FiO_2 was 99.50 ± 22, demonstrating the close relationship between the two and agreeing with international literature.

In this study, we were able to identify the relationship between the Delta of SO_2/FiO_2 and the change to prone position with respect to the prognosis of patients with ARDS due to COVID 19 in the Intensive Care Unit. Xiaofan Lu, et al. in their article published in Respiratory Research in 2020 demonstrated that SO_2/FiO_2 can be useful as a prognostic marker since it is non-invasive and facilitates immediate treatment adjustment, thus improving overall survival [25-27].

On finding a relationship between the Delta $SatO_2/FiO_2$ value and mortality, a ROC curve was performed for Δ SO_2/FiO_2 and survival, finding an AUC of 0.669 with p=0.013. The importance of the SO_2/FiO_2 index lies in the immediate and continuous identification of the response to interventions and changes in management, allows us to have an overview of the prognosis of the patient with ARDS secondary to SARS-COV-2 pneumonia, and also allows us to save and optimize the available resources.

V. CONCLUSIONS

Continuous clinical monitoring takes on great importance during the pandemic secondary to COVID-19, where it is necessary to optimize resources in the different hospital and out-of-hospital areas. Δ SO_2/FiO_2 can be very useful for the continuous monitoring and prognosis of patients. Post-prone delta SaO_2/FiO_2 may become a predictive assessment of mortality in patients who develop ARDS from COVID-19.

SPONSORSHIP

The authors declare not having received support from any sponsor or resources outside those granted by the medical institution

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

I. World Health Organization Weekly epidemiological update - 9 March 2021.

II. Centers for Disease Control and Prevention. Interim clinical guidance for management of patients with confirmed coronavirus disease (COVID-19). 2020.

III. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020;395:1054-1062.

IV. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323:1061-1069.

V. Ranieri VM, Rubenfeld GD, Thompson BT, et al. Acute respiratory distress syndrome: the Berlin Definition. JAMA 2012;307:2526-2533.

VI. Richardson S, Hirsch JS, Narasimhan M, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID- 19 in the New York City area. JAMA 2020;323:2052-2059.

VII. Helms J, Tacquard C, Severac F, et al. High risk of thrombosis in patients with severe SARS-CoV-2 infection: a multicenter prospective cohort study. Intensive Care Med 2020;46:1089-1098.

VIII. Mao L, Jin H, Wang M, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. JAMA Neurol 2020;77:683-690.

IX. Guo T, Fan Y, Chen M, et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). JAMA Cardiol 2020;5:811-818.

X. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497-506.

XI. Bilan N, Dastranji A, Ghalehgolab Behbahani A. Comparison of the spo2/fio2 ratio and the pao2/fio2 ratio in patients with acute lung injury or acute respiratory distress syndrome. J Cardiovasc Thorac Res. 2015;7(1):28-31.

XII. Li X, Ma X. Acute respiratory failure in COVID-19: is it "typical" ARDS? Crit Care. 2020 May 6;24(1):198.

XIII. Tobin M. J. Does Making a Diagnosis of ARDS in Patients With Coronavirus Disease 2019 Matter? Chest 2020; 158:6, 2275–2277.

XIV. Tobin MJ, Laghi F, Jubran A. Why COVID-19 Silent Hypoxemia Is Baffling to Physicians. Am J Respir Crit Care Med. 2020;202(3):356-360.

XV. Bilan N, Dastranji A, Ghalehgolab Behbahani A. Comparison of the spo2/fio2 ratio and the pao2/fio2 ratio in patients with acute lung injury or acute respiratory distress syndrome. J Cardiovasc Thoracic Rev. 2015;7(1):28-31.

XVI. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72,314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2020;323:1239-1242.

XVII. Hafen BB, Sharma S. Oxygen Saturation. In: StatPearls. Treasure Island (FL): StatPearls 2021.

XVIII. Tobin MJ. Why Physiology Is Critical to the Practice of Medicine: A 40-year Personal Perspective. Clin Chest Med. 2019 Jun; 40(2):243-257.

XIX. Tobin MJ. Basing Respiratory Management of COVID-19 on Physiological Principles. Am J Respir Crit Care Med. 2020;201(11):1319-1320.

XX. Festic, E., Bansal, V., Kor, D. J., & Gajic, O. SpO2/FiO2 Ratio on Hospital Admission Is an Indicator of Early Acute Respiratory Distress Syndrome Development Among Patients at Risk. Journal of Intensive Care Medicine, 2015;30(4), 209–216.

XXI. Rice, TW, Wheeler, AP, Bernard, GR. Comparison of the SpO2/FiO2 ratio and the PaO2/FiO2 ratio in patients with acute lung injury or ARDS. Chest. 2007;132(2):410–417.

XXII. Bashar, F.R., Vahedian-Azimi, A., Farzanegan, B, et al. Comparison of non- invasive to invasive oxygenation ratios for diagnosing acute respiratory distress syndrome following coronary artery bypass graft surgery: a prospective derivation-validation cohort study. J Cardiothorac Surg 13, 2018;123.

XXIII. DesPrez K, McNeil JB, Wang C, et al. Oxygenation Saturation Index Predicts Clinical Outcomes in ARDS. Chest. 2017 Dec;152(6):1151-1158.

XXIV. Catoire P, Tellier E, de la Rivière C, et al. Assessment of the SpO2/FiO2 ratio as a tool for hypoxemia screening in the emergency department [published online ahead of print, 2021 Feb 6]. *Am J Emerg Med*. 2021;44:116-120.

XXV. Guérin C, Reignier J, Richard JC, et al. Prone positioning in severe acute respiratory distress syndrome. N Engl J Med. 2013 6;368(23):2159-68.

XXVI. Weiss TT, Cerda F, Scott JB, et al. Prone positioning for patients intubated for severe acute respiratory distress syndrome (ARDS) secondary to COVID-19: a retrospective observational cohort study.*Br J Anaesth*. 2021;126(1):48-55.

XXVII. Xiaofan Lu, Liyun Jiang, Taige Chen, et al. Continuously available ratio of SpO2/FiO2 serves as a noninvasive prognostic marker for intensive care patients with COVID-19. Respiratory Research. 194 (2020).