Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

European Journal of Internal Medicine 96 (2022) 117–119

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Correlation of non-invasive oxygenation parameters with paO2/FiO2 ratio in patients with COVID-19 associated ARDS

ARTICLE INFO

Keywords
P/F ratio
S/F ratio
ROX index
ARDS
COVID-19

Dear Editor,

COVID-19 associated ARDS (CARDS) is defined as a new-onset respiratory failure with bilateral, non-cardiogenic pulmonary infiltrates, and a paO2/FiO2 ratio (P/F) $\leq$ 300 mmHg is the most severe clinical manifestation of SARS-CoV-2 infection. This condition is characterized by prolonged hospitalization, elevated mortality and a high incidence of thrombotic complications attributed to COVID-19 associated coagulopathy. Arterial blood gas (ABG) analysis, usually obtained through arterial cannulation, is needed to establish the diagnosis and follow the course of ARDS. However, COVID-19 associated coagulopathy may lead to frequent and severe thrombotic complications in the site of arterial catheter with possible detrimental consequences for the patient, such as acute limb ischemia [1]. The assessment of the reliability of non-invasive parameters to follow the course of CARDS, and their potential role in limiting arterial cannulation was the objective of our study.

We conducted a prospective study on consecutive patients admitted to COVID High Care Unit and meeting the criteria of CARDS. When performing ABGs analyses (analyzer ABL90 FLEX; Radiometer, Copenhagen DK) in order to obtain the paO2 values, we concurrently recorded the spO2 (Intellivue MX750; Philips Medical Systems International, Eindhoven NL) and the respiratory rate (RR), analogically or from ventilators (Respironics V60, Philips Medical Systems International, Eindhoven NL; SV300, Mindray Medical, Shenzhen) CN. 100 patients were included, for a total of 1000 measurements of paO2/FiO2 ratio, spo2/FiO2 (S/F) ratio and the ROX index, which is the result of S/F*1/RR. We performed a linear correlation test and a linear regression analysis between S/F and P/F ratio and between ROX index and P/F ratio (Fig. 1, Panel a).

We then divided the total measurements of P/F ratio in 3 groups, according to the Berlin definition of ARDS criteria [2]: Group 1, mild ARDS ($200 < P/F \leq 300$; 49/1000 measurements); Group 2, moderate ARDS ($100 < P/F \leq 200$; 522/1000 measurements); Group 3, severe ARDS ($P/F \leq 100$; 429/1000 measurements). At this point, we performed linear correlation test and linear regression analysis between the aforementioned non-invasive variables and P/F ratio for each of those 3 groups. For the Group 1 (mild ARDS), neither the S/F ratio nor the ROX index significantly correlated with the P/F ratio ($p = 0.206$ and $p = 0.217$, respectively). This is likely due to the flattening of the oxygen-hemoglobin dissociation curve in its right-upper part, with non-linear increase of spO2 following a rise of the paO2 values). However, in the Group 2 (moderate ARDS) and 3 (severe ARDS) the correlation of both non invasive variables with P/F ratio was moderate/strong, and remarkably significant (Fig. 1, Panels b and c).

Our study has found a strong linear correlation of S/F ratio and ROX index with P/F ratio in patients with CARDS, statistically significant analyzing both the total of 1000 measurements and the group of measurements indicative of moderate and severe CARDS.

To the best of our knowledge, only a few papers exploring the correlation between S/F and P/F ratio have been published, and none of them covering COVID-19 patients [3–5]. A recently published study has investigated the correlation between ROX index and P/F ratio in patients with SARS-CoV-2 infection, and the pooled results are consistent with our ones ($R = 0.650$, $p < 0.001$) [6]. In all the tests we performed, S/F ratio showed a better correlation than ROX index with P/F ratio; this seems likely related to a wide dispersion of RR values because of the phenomenon of silent hypoxemia, well described in CARDS [7].

The possibility to take into account the increased minute ventilation, which is a feature of COVID-19 associated respiratory failure, could represent an important perspective, as suggested by a recently published paper on the better performance of standardized paO2/FiO2 ratio versus traditional P/F in predicting in-hospital mortality [8]. However, the aim of that study was to compare the ability of these two parameters to predict the outcome, and not to evaluate the correlation of those parameters with S/F or ROX. Moreover, in the advanced stages of the disease, the progressively worsening ventilation-perfusion mismatch with increasing airway deadspace and shunt fraction, frequently causes a shift from hypocapnia to hypercapnia and a paradoxical improvement in standard paO2 with a potentially misleading overestimation of STP/F ratio [9].

In conclusion, S/F ratio is a reliable, non-invasive, and easy to track parameter for monitoring COVID patients with moderate and severe ARDS, potentially useful in reducing the need for positioning arterial catheters and the possible consequent thrombotic complications related to COVID associated coagulopathy.

https://doi.org/10.1016/j.ejim.2021.12.015
Received 2 December 2021; Received in revised form 10 December 2021; Accepted 15 December 2021
Available online 21 December 2021

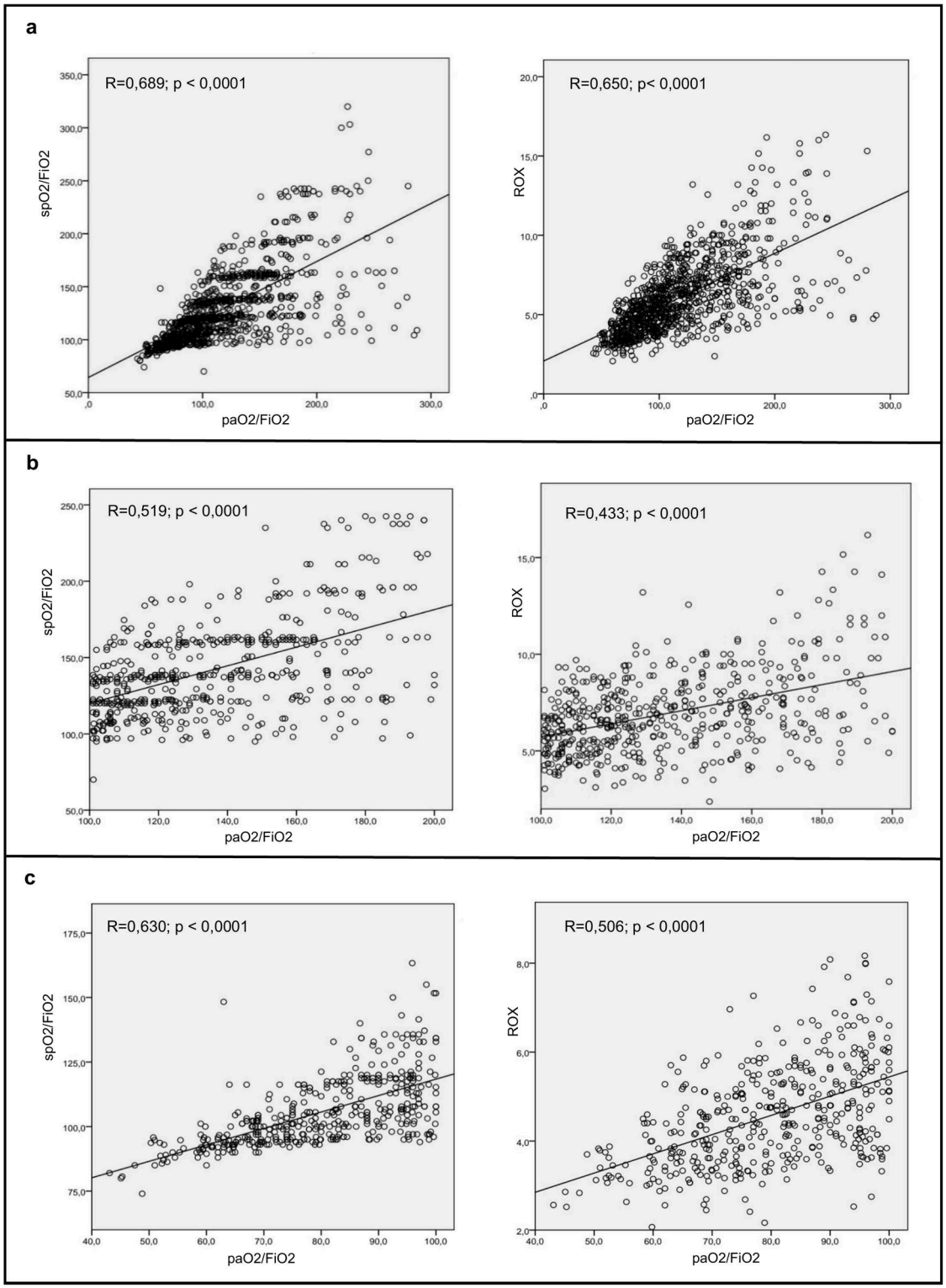

Fig. 1. Linear correlation between spO2/FiO2 ratio and pao2/FiO2 ratio and between ROX and paO2/FiO2 ratio.

CRediT authorship contribution statement

Giacomo Zaccagnini: Conceptualization, Data curation, Formal analysis, Writing – original draft. **Andrea Berni:** Formal analysis, Writing – review & editing. **Filippo Pieralli:** Conceptualization, Data curation, Formal analysis, Writing – original draft.

Declaration of Competing Interest

The authors declare they have no conflict of interest.

References

[1] Dorigo W, Fargion A, Paperetti L, et al. Increased rates of hand ischemia following arterial cannulation in patients with severe COVID19-related pneumonia. Thromb 2020;194:33–5. https://doi.org/10.1016/j.thromres.2020.06.023.

[2] ARDS Definition Task Force, Ranieri VM, Rubenfeld GD, et al. Acute respiratory distress syndrome: the Berlin definition. JAMA 2012;307(23). https://doi.org/10.1001/jama.2012.5669. 2526–33.
[3] Riviello ED, Kiviri W, Twagirumugabe T, et al. Hospital incidence and outcomes of the acute respiratory distress syndrome using the kigali modification of the Berlin definition. Am J Respir Crit Care Med 2016;193(1). https://doi.org/10.1164/rccm.201503-0584OC. 52–9.
[4] Rice TW, Wheeler AP, Bernard GR, et al. Comparison of the SpO2/FIO2 ratio and the PaO2/FIO2 ratio in patients with acute lung injury or ARDS. Chest 2007;132(2):410–7. https://doi.org/10.1378/chest.07-0617.
[5] Pisani L, Roozeman JP, Simonis FD, et al. Risk stratification using SpO2/FiO2 and PEEP at initial ARDS diagnosis and after 24 h in patients with moderate or severe ARDS. Ann Intensive Care 2017;7(1):108. https://doi.org/10.1186/s13613-017-0327-9. Published 2017 Oct 25.
[6] Zaboli A, Ausserhofer D, Pfeifer N, et al. The ROX index can be a useful tool for the triage evaluation of COVID-19 patients with dyspnoea. J Adv Nurs 2021;77(8).3361–9.
[7] Dhont S, Derom E, Van Braeckel E, Depuydt P, Lambrecht BN. The pathophysiology of 'happy' hypoxemia in COVID-19. Respir Res 2020;21(1):198. https://doi.org/10.1186/s12931-020-01462-5. Published 2020 Jul 28.
[8] Prediletto I, D'Antoni L, Carbonara P, et al. Standardizing PaO2 for PaCO2 in P/F ratio predicts in-hospital mortality in acute respiratory failure due to COVID-19: a pilot prospective study. EJIM 2021;92:48–54. https://doi.org/10.1016/j.ejim.2021.06.002.
[9] Gattinoni L, Busana M, Camporota L. Standardised PaO2/FiO2 ratio in COVID-19: added value or risky assumptions? EJIM 2021;92:31–3. https://doi.org/10.1016/j.ejim.2021.09.004.

Giacomo Zaccagnini[a,*], Andrea Berni[b], Filippo Pieralli[a]
[a] *COVID-19 High Care Unit, University Hospital Careggi, Largo Brambilla 3, Firenze 50139, Italy*
[b] *Medicina Interna 3, University Hospital Careggi, Largo Brambilla 3, Firenze 50139, Italy*

[*] Corresponding author.
E-mail address: zacgia@msn.com (G. Zaccagnini).