EDITORIAL

A Game Changer for ARDS? Unraveling the Potential of the SF Ratio

Rajavardhan Rangappa

Keywords: Acute respiratory distress syndrome, Kigali modification, PF ratio, SF ratio.
Indian Journal of Critical Care Medicine (2024): 10.5005/jp-journals-10071-24678

Acute respiratory distress syndrome (ARDS) is a critical care condition that, despite medical advancements, still has a high mortality rate of 30–50%. Effective management of ARDS involves continuous monitoring and necessary adjustments to oxygen delivery and ventilator settings. The definition of ARDS has evolved over the last few decades with our understanding of its pathophysiology and management. Acute respiratory distress syndrome was first described in 1967 by Ashbaugh et al.[1] The Berlin definition was a significant step in its evolution in diagnosing ARDS.[2] It used parameters like the positive end-expiratory pressure (PEEP) and PaO_2/FiO_2 (PF) ratios, which are measurements of lung function and oxygenation. However, this method had some limitations. Arterial oxygen pressure measurement requires specialized equipment and trained personnel, and it could be invasive, requiring an arterial line or frequent punctures. Oxygen delivery systems include nasal prongs, face masks, venturi, noninvasive ventilation, high-flow nasal cannula (HFNC) and ventilators which may or may not have PEEP.

In individuals with good health, variations in arterial oxygen pressure (PaO_2) have a strong correlation with alterations in pulse oximetric saturation (SpO_2), specifically when the oxygen saturation is between 80 and 97%. The SpO_2/FiO_2 (SF) ratio can be easily determined at the bedside using pulse oximetry for SpO_2 and the delivered FiO_2. This method eliminates the need for an arterial line and frequent sampling, making it particularly useful in resource-limited settings. Rice et al. conducted the first study in critically ill patients comparing the SF ratio with the PF ratio, finding that the SF ratio correlates with the PF ratio.[3] Dr. Reviello and his team proposed the Kigali modification.[4] This method uses the SF ratio, which is noninvasive and simple to calculate. They proposed defining ARDS using an SF ratio of 315 or less, in conjunction with the presence of bilateral opacities on chest radiographs or lung ultrasound. In recent times, there has been a growing interest in the Kigali modification of ARDS, particularly in settings with limited resources. Research has identified a correlation between the SF and PF ratio, but the degree and reliability of this correlation differ. Additional research is underway to assess the universal applicability of this method in all intensive care units. Since this varies with subgroups of patients, including different races, it is important to validate these definitions in different settings, such as in India, where the population may have darker skin tones.

The study by Rakesh Alur et al. was conducted to validate the role of the SF ratio. The study found a significant positive correlation ($R = 0.622$) between the SF and PF ratio, suggesting that the SF ratio can reliably indicate the oxygenation status, comparable to PF ratio.[5] The study established diagnostic thresholds for the SF ratio of 252 for PF ratio of 200 and 321 for PF 300 respectively. It had a sensitivity and specificity of 68.9 and 95% respectively. This is further supported by the proposed SF ratio thresholds of 252 for PF ratio 200 and 321 for PF ratio 300, which showed promising diagnostic accuracy. The findings were consistent across various settings, including acidosis and alkalosis, and different modes of delivery devices. The positive correlation between the SF and PF ratios ($r > 0.6$, $p < 0.05$) has been confirmed in several studies. Across various studies, SF ratio thresholds for PF ratios of 200 and 300 ranged from 201 to 370 and 263–450, respectively, underscoring the need for further research to define consistent and reliable thresholds for diverse clinical settings (Table 1).[3,6–9]

The continuous monitoring of the SF ratio, beyond just resource-limited settings, allows for early detection of rapid deterioration, potentially leading to quicker interventions. The ease of calculating the SF ratio could also minimize potential errors related to machine calibration. However, this study was conducted at a single center with a small group of patients. Its application to broader healthcare settings with a diverse patient population may be limited. Even though a substantial correlation was found, a perfect ratio between

Department of Critical Care Medicine, Manipal Hospital, Whitefield, Bengaluru, Karnataka, India

Corresponding Author: Rajavardhan Rangappa, Department of Critical Care Medicine, Manipal Hospital, Whitefield, Bengaluru, Karnataka, India, Phone: +91 8589969639, e-mail: rajavardhanr99@gmail.com

How to cite this article: Rangappa R. A Game Changer for ARDS? Unraveling the Potential of the SF Ratio. Indian J Crit Care Med 2024;28(3):191–192.

Source of support: Nil

Conflict of interest: None

Table 1: Summary of studies comparing SF and PF ratios

Author	*Year*	*SF ratio for PF ratio 200*	*SF ratio for PF ratio 300*	*Sensitivity*	*Specificity*
Rice TW et al.[3]	2007	235	315	61%	82%
Sheetal Babu et al.[6]	2010	285	323	74%	93%
Khemani et al.[6]	2013	201	263	72%	85%
Rakesh Alur et al.[5]	2024	252	321	68.90%	95%

the two cannot be assumed based on a single study. It's better to observe the trend rather than a single value.

Clinicians should exercise caution before completely abandoning the PF ratio. The precision of pulse oximetry indices is not only contingent on the device's measurement error but also influenced by various physiological and external factors. These include the presence of carboxyhemoglobin, methemoglobin, and glycohemoglobin, conditions like sickle cell disease, states of poor perfusion, acidemia, the application of nail polish, and motion artifacts.[10]

In the context of critically ill patients, acidemia and poor perfusion states are the most important factors impacting the accuracy of pulse oximetry. The administration of vasopressors was found to influence the accuracy of the relationship between the PF and SF ratios. At saturation of more than 97%, there is no linear correlation between the PaO_2 and SpO_2. Therefore, the S/F ratio's applicability may not extend to all patient populations. Also, there is the possibility of misclassifying ARDS severity and denying some necessary targeted intervention for example PF ratio less than 150 is an indication of prone positioning. In fact, SF ratio is not studied for those interventions.[11]

The role of arterial blood gas extends beyond just assessing oxygenation but also hypercarbia along with evaluation of acid-base balance, electrolyte imbalances, monitoring sepsis, and assessing hemoglobin function. This makes it a valuable diagnostic and monitoring tool for a range of conditions, including ARDS, sepsis, and acute kidney injury.

In view of the change in practices globally there has been increased interest in further refining the definition of ARDS. These changes include expanded use of high-frequency nasal oxygen, and increased utilization of ultrasound in the clinical practice. Matthay's modifications proposed four main recommendations: It Included HFNC with a minimum flow rate of 30 liters a minute. As an alternative to arterial blood gas measurements, use SF ratio, as measured with pulse oximetry, for ARDS diagnosis and assessment of severity if SpO_2 is less than or equal to 97 percent. Retain bilateral lung opacities for imaging criteria but add lung ultrasound as an imaging modality. It can also be used in settings that do not require positive end-expiratory pressure, oxygen flow rate, or specific respiratory support devices.[12]

In conclusion, this study signals a potential shift in the approach to patients with acute hypoxemic failure. The strong correlation between the SF and PF ratios, along with the benefits of noninvasive and simple calculation, makes the SF ratio a compelling alternative, particularly in resource-limited settings. Future research should focus on collaboration between Indian and international researchers, advocating for policy changes to adopt the SF ratio, or encouraging further studies on specific patient populations within India.

Orcid

Rajavardhan Rangappa https://orcid.org/0000-0001-9521-2062

References

1. Bourenne J, Carvelli J, Papazian L. Evolving definition of acute respiratory distress syndrome. J Thorac Dis 2019;11(S3):S390–S393. DOI: 10.21037/jtd.2018.12.24.
2. Fanelli V, Vlachou A, Ghannadian S, Simonetti U, Slutsky AS, Zhang H. Acute respiratory distress syndrome: New definition, current and future therapeutic options. J Thorac Dis 2013;5(3):326–334. DOI: 10.3978/j.issn.2072-1439.2013.04.05.
3. Rice TW, Wheeler AP, Bernard GR, Hayden DL, Schoenfeld DA, Ware LB, et al. Comparison of the SPO_2/FiO_2 ratio and the PAO_2/FiO_2 ratio in patients with acute lung injury or Ards. Chest 2007;132(2):410–417. DOI: 10.1378/chest.07-0617.
4. Riviello ED, Kiviri W, Twagirumugabe T, Mueller A, Banner-Goodspeed VM, Officer L, 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):52–59. DOI: 10.1164/rccm.201503-0584oc.
5. Alur TR, Iyer SS, Shah JN, Kulkarni S, Jedge P, Patil V. A prospective observational study comparing oxygen saturation/fraction of inspired oxygen ratio with partial pressure of oxygen in arterial blood/fraction of inspired oxygen ratio among critically ill patients requiring different modes of oxygen supplementation in intensive care unit. Indian J Crit Care Med 2024;28(3):251–255.
6. Babu S, Abhilash KPP, Kandasamy S, Gowri M. Association between SpO_2/FiO_2 ratio and PaO_2/FiO_2 ratio in different modes of oxygen supplementation. Indian J Crit Care Med 2021;25(9):1001–1005. DOI: 10.5005/jp-journals-10071-23977.
7. Catoire P, Tellier E, de la Rivière C, Beauvieux M-C, Valdenaire G, Galinski M, et al. Assessment of the SPO_2/FiO_2 ratio as a tool for hypoxemia screening in the emergency department. Am J Emerg Med 2021;44:116–120. DOI: 10.1016/j.ajem.2021.01.092.
8. Bilan N, Dastranji A, Ghalehgolab Behbahani A. Comparison of the SPO2/fio2ratio and the PaO_2/FiO_2 ratio in patients with acute lung injury or acute respiratory distress syndrome. J Cardiovasc Thorac Res 2015;7(1):28–31. DOI: 10.15171/jcvtr.2014.06.
9. Tripathi RS, Blum JM, Rosenberg AL, Tremper KK. Pulse oximetry saturation to fraction inspired oxygen ratio as a measure of hypoxia under general anesthesia and the influence of positive end-expiratory pressure. J Crit Care 2010;25(3):542.e9–e13. DOI: 10.1016/j.jcrc.2010.04.009.
10. Chan ED, Chan MM, Chan MM. Pulse oximetry: Understanding its basic principles facilitates appreciation of its limitations. Respir Med 2013;107(6):789–799. DOI: 10.1016/j.rmed.2013.02.004.
11. Wick KD, Matthay MA, Ware LB. Pulse oximetry for the diagnosis and management of acute respiratory distress syndrome. Lancet Respir Med 2022;10(11):1086–1098. DOI: 10.1016/s2213-2600(22)00058-3.
12. Matthay MA, Arabi Y, Arroliga AC, Bernard G, Bersten AD, Brochard LJ, et al. A new global definition of acute respiratory distress syndrome. American Journal of Respiratory and Critical Care Medicine 2024;209(1):37–47. DOI: 10.1164/rccm.202303-0558ws.