Tropical Doctor

Article

Tropical Doctor
2025, Vol. 55(3) 217–222

DOI: 10.1177/00494755251349071
journals.sagepub.com/home/tdo
Sage

Utility of peripheral blood oxygen saturation (SpO_2)/fraction of inspired oxygen (FiO_2) ratio and arterial partial oxygen pressure (PaO_2)/FiO_2 ratio in the diagnosis of acute respiratory distress syndrome: A comparative study

Srishti Rathi[1], Rajesh Kakkar[2], Shubhanshu Chawla[3], Sushant Khanduri[4], Rajeev Mohan Kaushik[5] and Reshma Kaushik[6]

Abstract

Our study determined the reliability of using the ratio of peripheral blood oxygen saturation (SpO_2) and the fraction of inspired oxygen (FiO_2) rather than the ratio of arterial partial oxygen pressure (PaO_2) and FiO_2 for diagnosing acute respiratory distress syndrome (ARDS). Pulse oximetry and arterial blood gas analysis were performed to obtain both ratios, respectively, in 70 patients who fulfilled the Berlin definition criteria of ARDS. A detailed history, clinical examination, and relevant evaluation were done. There was a significant correlation between the two ratios. The former had a lower sensitivity and specificity than the latter. Thus, the SpO_2/FiO_2 ratio is a reliable, straightforward, non-invasive, and readily available marker for diagnosing the presence and severity of ARDS, and may be used as an alternative to the PaO_2/FiO_2 ratio in resource-limited settings.

Keywords

Asia, diagnosis, respiratory tract, public health

Introduction

Acute respiratory distress syndrome (ARDS) is a clinical condition that has high morbidity and mortality. It is an acute, diffuse, inflammatory form of injury to the lung of varied aetiology. Prompt recognition and treatment are necessary to curtail its high mortality.[1] It occurs due to injury to the alveoli, causing diffuse damage, and the release of inflammatory cytokines such as tumour necrosis factor and interleukins (ILs) (IL-1, IL-6, and IL-8) that recruit neutrophils to the site of injury, where they are activated and release toxic mediators such as reactive oxygen species and proteases which further damage the capillary endothelium and alveolar epithelium.[2,3]

Defining ARDS requires invasive arterial blood sampling, which demands repeated blood sampling which is time-consuming and expensive equipment. Apart from a delay in the subsequent availability of results to achieve the Berlin definition,[2] it does not allow continuous monitoring. Moreover, the technical skill required to obtain an

[1]Ex-Senior Resident, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India
[2]Ex-Professor, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India
[3]Assistant Professor, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India
[4]Associate Professor, Department of Pulmonary Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India
[5]Professor, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India
[6]Professor and Head, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun, Uttarakhand, India

Corresponding author:
Rajeev Mohan Kaushik, Department of General Medicine, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Swami Ram Nagar, P.O. Jolly Grant – 248016, Dehradun, Uttarakhand, India.
Emails: rmkaushik1@gmail.com; rmkaushik1@rediffmail.com

arterial sample and inadvertent venous sampling are further limiting factors quite apart from its high cost.[4]

The ratio of SpO_2 to FiO_2 is known as the pulse oximetry-based index.[5] Several studies have shown this to be a useful surrogate for the PaO_2/FiO_2 ratio,[6–8] which is practical, especially in settings with limited resources.[8] However, pulse oximeters may not record the true arterial oxygen saturation (SaO_2) in conditions such as severe or rapid desaturation, hypotension, hypothermia, and low perfusion states.[9]

Materials and methods

Our observational cross-sectional study was conducted among 70 patients with ARDS, admitted to the Himalayan Institute Hospital, Dehradun, India, from October 2021 to September 2022, after obtaining approval from the institutional ethics committee. Written informed consent was obtained from all study participants. Consent was obtained from the next of kin if the patient was not in a position to give consent due to the severe illness.

The sample size was estimated to be 62, taking the prevalence of ARDS in the intensive care unit as 20% based on a previous study[6] and a 10% margin of error. It was increased to 70 to adjust for dropouts.

Inclusion criteria were all patients >18 years who fulfilled the Berlin definition criteria for ARDS: onset within seven days of a known clinical insult, or occurrence of new or worsening of symptoms; with chest radiographs showing lung opacities bilaterally, not fully explained by effusions, lobar or lung collapse or lung nodules; respiratory failure not fully explained by heart failure or fluid overload and PaO_2/FiO_2 ratio $\leq$300 mmHg with positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) $\geq$ 5 cm H_2O.[2]

Exclusion criteria comprised patients with concomitant heart failure, chronic obstructive pulmonary disease, hypotension (systolic blood pressure < 90 mmHg), severe anaemia (Hb < 50 g/L), and raised serum total bilirubin > 340 μmol/L.

Patients were assessed for dyspnoea, cough, fever, malaise, and chest pain, along with comorbidity including diabetes mellitus, hypertension, and hypothyroidism. Features of systemic dysfunction, including renal, hepatic, and cardiovascular manifestations, were noted. The mode of ventilation was recorded. Pulse rate, respiratory rate, body temperature, and blood pressure were charted with SpO_2/FiO_2 and PaO_2/FiO_2 ratios. The former was calculated using the pulse oximeter saturation and the FiO_2 that the patient was receiving. The latter was calculated using PaO_2 obtained from an arterial blood gas (ABG) analysis. Laboratory tests included a full blood count, urinalysis, random blood sugar, liver and kidney function tests, prothrombin time (PT)/international normalized ratio (INR), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and any other relevant investigations. A chest radiograph was essential. Electrocardiography and echocardiography were done wherever required. Patients with ARDS were stratified into mild (PaO_2/FiO_2 201–300 mmHg), moderate (101–200 mmHg), and severe ($\leq$100 mmHg), based on the lowest PaO_2/FiO_2 ratio available on the day of ARDS diagnosis according to the Berlin definition.[2]

Data were analysed by SPSS version 23. Continuous data were compared by the Student's *t*-test or one-way analysis of variance test. The linear correlation between two continuous variables was explored using the Pearson

Table 1. Demographic and clinical characteristics of patients with ARDS.

Characteristics	Number of patients ($n = 70$)	Percentage
Age group (years)		
18–39	13	18.6
40–59	26	37.1
≥60	31	44.3
Sex		
Female	23	32.9
Male	47	67.1
Symptoms		
Shortness of breath	70	100.0
Fever	60	85.7
Malaise	50	71.4
Cough	45	64.3
Chest pain	26	37.1
Aetiology of ARDS		
Acute febrile illness	37	52.9
COVID-19	15	21.4
Scrub typhus	5	7.1
Dengue	5	7.1
Enteric fever	1	1.4
Aetiology not identified	11	15.7
Pneumonia	17	24.3
Sepsis	11	15.7
Acute Pancreatitis	2	2.9
Polytrauma	1	1.4
Poisoning	1	1.4
Others	1	1.4
Degree of ARDS (on the basis of PaO_2/FiO_2 ratio)		
Mild	17	24.3
Moderate	40	57.1
Severe	13	18.6
Comorbidity		
Diabetes mellitus	36	51.4
Hypertension	22	31.4
Hypothyroidism	6	8.6
Others	11	15.7

ARDS: acute respiratory distress syndrome; COVID-19: coronavirus disease 2019; PaO_2/FiO_2 ratio, partial pressure of arterial oxygen to fraction of inspired oxygen ratio.

Table 2. Respiratory function-related variables among patients with ARDS as per the severity of ARDS.

Parameters	Overall	Severity of ARDS			p-value
		Mild	Moderate	Severe	
SpO_2 (%)	94.3 ± 3.2	95.5 ± 2.06	94.5 ± 3.05	91.8 ± 3.5	0.003
SaO_2 (%)	92.3 ± 3.5	94.2 ± 2.3	92.4 ± 3.3	89.4 ± 3.7	0.000
PaO_2 (mmHg)	66.5 ± 11.5	75.1 ± 12.9	65.5 ± 8.5	58.5 ± 11.1	0.000
FiO_2 (%)	46.8 ± 17.4	32.2 ± 5.6	43.7 ± 10.3	75.7 ± 10.2	0.000
SpO_2/FiO_2 ratio	225.9 ± 72.7	301.6 ± 39.2	227 ± 50.6	123.5 ± 22.2	0.000
PaO_2/FiO_2 ratio (mm Hg)	159.3 ± 56.9	233.5 ± 21	154.3 ± 29	77.8 ± 15.2	0.000

SpO_2: peripheral blood oxygen saturation; SaO_2: arterial oxygen saturation; PaO_2: arterial partial oxygen pressure; FiO_2: fraction of inspired oxygen; ARDS: acute respiratory distress syndrome.

correlation coefficient. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve (AUC) (equivalent to the concordance (C-) statistic), and a suitable cut-off was calculated using Yuden's index. A linear regression equation was used to describe the relationship between the SpO_2/FiO_2 ratio and the PaO_2/FiO_2 ratio. A p-value < 0.05 was considered statistically significant.

Results

Male predominance was seen (male-to-female ratio of 2.04:1 with 47 males). The age range was 18–82 years. Older individuals aged >60 years were the most affected (44.3%). Dyspnoea and fever were the most common presenting symptoms. Acute febrile illness was the most commonly occurring primary diagnosis. Coronavirus disease 2019 (COVID-19) positivity was the most commonly seen aetiology among 37 patients with acute febrile illness. Most (40) were in the moderate category of ARDS based on the PaO_2/FiO_2 ratio. Diabetes mellitus was the most frequently seen comorbidity (36, 51.4%) (Table 1).

Respiratory function-related variables were significantly different among various grades of disease severity (Table 2). Non-invasive ventilation (NIV) by CPAP was used in 32 (45.7%), and mechanical ventilation in a volume-controlled mode in 22 (31.4%) (Table 3).

Liver and renal function tests were deranged in most. Coagulopathy and an increase in acute phase reactants were seen in most. However, differences in these laboratory parameters among patients with different grades of disease severity were not significant (Table 4).

Table 5 shows differences in ratios in terms of types of ventilation.

The PaO_2/FiO_2 ratio had a significant direct correlation with the SpO_2/FiO_2 ratio among patients with ARDS, with an r-value of 0.903 and a p-value of <0.0001. The PaO_2/FiO_2 ratio proved to be a good predictor of the SpO_2/FiO_2 ratio, which was described using the linear regression equation: $SpO_2/FiO_2 = 42.32 + 1.15\ PaO_2/FiO_2$ (Fig. 1). So a PaO_2/FiO_2 ratio of 300 corresponded to a SpO_2/FiO_2 ratio of 387.32.

Table 3. Modes of ventilation among ARDS patients.

Mode of ventilation	Number of patients ($n = 70$)	Percentage
Artificial ventilator[a]	22	31.4
HFNC	3	4.3
NIV (BIPAP)	13	18.6
NIV (CPAP)	32	45.7

ARDS: acute respiratory distress syndrome; HFNC, high flow nasal cannula; NIV, non-invasive ventilation; CPAP, continuous positive airway pressure; BIPAP, bilevel positive airway pressure.
[a]The mode of ventilation was volume-controlled mode.

ROC curves were plotted for the SpO_2/FiO_2 ratio and PaO_2/FiO_2 ratio, which demonstrated that the AUC of the SpO_2/FiO_2 ratio was 0.908 at a cut-off value of 194 ($p < 0.001$; 95% CI, 0.828–0.989), which was statistically significant (Fig. 2).

The sensitivity of the PaO_2/FiO_2 ratio was 98% as compared to the SpO_2/FiO_2 ratio, at 94.1%. The specificity of the PaO_2/FiO_2 ratio was 92.6%, while that of the SpO_2/FiO_2 ratio was 45.3%. The latter was a good test for detecting true positive cases of ARDS of moderate to severe degree. However, the sensitivity and specificity of the SpO_2/FiO_2 ratio were lower as compared to the PaO_2/FiO_2 ratio.

Discussion

An official recognition and diagnosis of ARDS depends on ABG analysis to date. This is associated with many practical constraints.[10,11]

Thus modified criteria for defining ARDS without requirement for PEEP, using a SpO_2/FiO_2 ratio <315 in conjunction with the presence of bilateral opacities on chest radiographs or lung ultrasound has been proposed in Rwanda. There has been a growing interest in this

Table 4. Laboratory parameters among patients with ARDS as per severity of ARDS.

Parameters	Overall	Severity of ARDS			*p*-value
		Mild	Moderate	Severe	
Serum creatinine (umol/L)	168 ± 168	133 ± 91	165± 179	170 ± 216	0.813
Serum bilirubin (umol/L)	26 ± 12	23 ± 12	26 ± 12	32 ± 15	0.052
Serum ALT (IU/L)	205.4 ± 454.9	90.7 ± 56.2	262.4 ± 585	159 ± 186.7	0.449
Serum AST (IU/L)	151.8 ± 264.2	80.6 ± 43.8	184.2 ± 332.7	130.2 ± 150.2	0.443
Serum ALP (IU/L)	154.4 ± 248.4	95.6 ± 52.2	142 ± 133.7	228.6 ± 459.9	0.314
PT (sec)	17.34 ± 4.86	17.23 ± 2.30	17.45 ± 5.33	17.15 ± 6.03	0.977
INR	1.28 ± 0.56	1.24 ± 0.25	1.33 ± 0.65	1.20 ± 0.58	0.757
CRP (mg/dL)	69.8 ± 32.1	73.2 ± 33.7	62.9 ± 29.9	84.2 ± 32.8	0.098
ESR (mm in the first hour)	66.7 ± 20.5	66.3 ± 23.2	65.6 ± 21.8	70.8 ± 11.9	0.737

ARDS: acute respiratory distress syndrome; ALT: alanine aminotransferase; AST: aspartate aminotransferase; ALP: alkaline phosphatase; PT: prothrombin time; INR: international normalized ratio; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate.

Table 5. Mean (±SD) values of respiratory function-related variables as per age, gender, and mode of ventilation.

Variable	Age group			*p*-value	Sex		*p*-value	Mode of ventilation				p-value
	18–39 years	40–59 years	≥60 years		Male	Female		Artificial ventilator	HFNC	NIV (BIPAP)	NIV (CPAP)	
SpO_2	95.9 ± 3.09	93.5 ± 3.4	94.2 ± 2.6	0.07	94.01 ± 2.8	94.7 ± 3.7	0.45	93.3 ± 4.3	89 ± 1.7	90.8 ± 3.4	92.4 ± 2.8	0.084
PaO_2	67 ± 8.2	64.5 ± 10	68 ± 13.7	0.527	66 ± 13.4	67.7 ± 6.3	0.478	72.6 ± 14.7	61 ± 7.8	60.8 ± 10	65.2 ± 7.8	0.012
FiO_2	40.2 ± 15.8	45.6 ± 16.1	50.7 ± 18.5	0.168	48.4 ± 17.2	43.7 ± 17.7	0.294	54.1 ± 17.1	81 ± 0	46.2 ± 16	38.9 ± 12.5	0.000
SpO_2/FiO_2 Ratio	263 ± 74.9	227 ± 70.7	209.4 ± 69.7	0.081	216.8 ± 69.4	244.4 ± 77.1	0.153	194.7 ± 70.6	109.7 ± 2.9	228.2 ± 75.3	257.2 ± 56.3	0.000
PaO_2/FiO_2 Ratio (mm Hg)	186.8 ± 62.1	156.3 ± 54.6	150.3 ± 54.9	0.143	152.7 ± 56.1	172.9 ± 57.5	0.170	148.7 ± 61.9	75 ± 9.5	148.6 ± 61.1	178.8 ± 44.2	0.007

SpO_2: peripheral blood oxygen saturation; PaO_2: arterial partial oxygen pressure; FiO_2: fraction of inspired oxygen; HFNC: high flow nasal cannula; NIV: non-invasive ventilation; CPAP: continuous positive airway pressure; BIPAP: bilevel positive airway pressure.

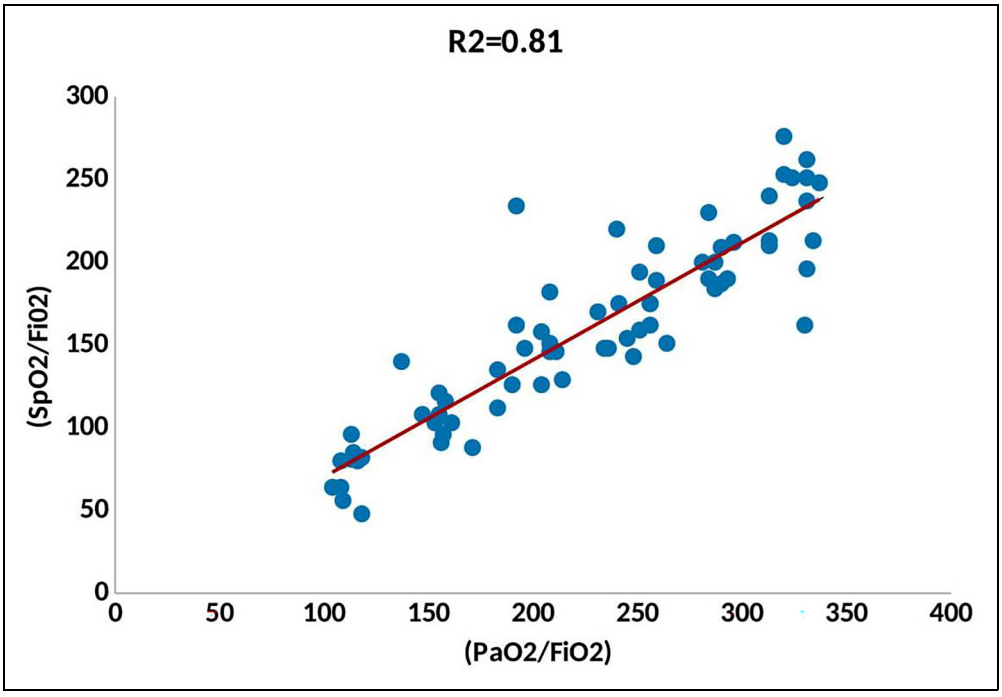
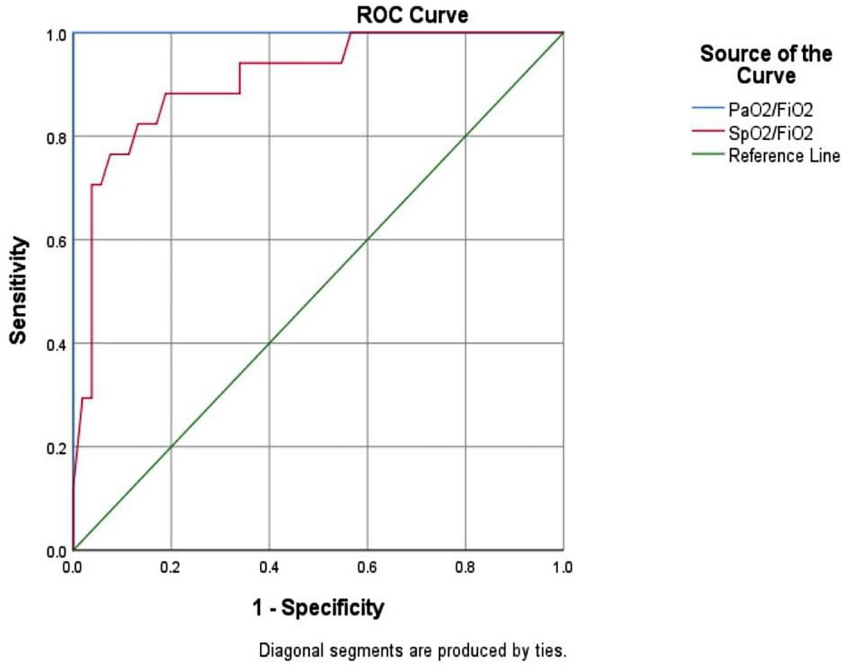


Figure 1. Scatter plot showing the SpO_2/FiO_2 ratio versus the PaO_2/FiO_2 ratio.
SpO_2: peripheral blood oxygen saturation; FiO_2: fraction of inspired oxygen; PaO_2: arterial partial oxygen pressure.



	Sensitivity (%)	Specificity (%)
PaO2/FiO2 ratio	98	92.6
SpO2/FiO2 ratio	94.1	45.3

Figure 2. Receiver operating characteristic curve for the SpO_2/FiO_2 ratio versus the PaO_2/FiO_2 ratio in patients with moderate to severe acute respiratory distress syndrome.
SpO_2: peripheral blood oxygen saturation; FiO_2: fraction of inspired oxygen; PaO_2: arterial partial oxygen pressure.

modification, especially in settings with limited resources. A correlation has been identified between the two ratios, but the degree and reliability of this correlation differ. The universal applicability of the Kigali modification is being assessed at various centres.[12]

Slight variations in the frequency of symptoms may be due to different aetiology, which we found to be pneumonia.

The correlation between the SpO_2/FiO_2 and the PaO_2/FiO_2 ratio is well known.[13–16] A good linear correlation between SpO_2/FiO_2 and PaO_2/FiO_2 ratio ($r = 0.92$, $p < 0.0001$) seems to exist.[17,18] The SpO_2/FiO_2 ratio seems to have excellent discrimination ability for ARDS (AUC = 0.86).[6,7,19]

One limitation in our study that warrants caution is the interpretation of SpO_2. In earlier phases of admission, FiO_2 is often set high which therefore leads to falsely low ratios, leading to errors in detecting the presence and severity of ARDS.[20–22] Even though most of our cases were entered within the first 24 h of hospital admission, the time period was variable. Simultaneous measurements of PaO_2 and SpO_2 could not be taken, but the duration between ABG test and pulse oximetry measurements never exceeded 1 h,[23] though the diagnostic value of the SpO_2/FiO_2 ratio could not be assessed in mild cases of ARDS in our study.

Conclusion

The SpO_2/FiO_2 ratio is a good diagnostic tool for detecting true positive cases of moderate to severe degrees of ARDS. Its sensitivity and specificity are lower than the PaO_2/FiO_2 ratio. However, in resource-limited settings, its use has long been valued although not that commonly realized.

Acknowledgements

We thank Dr Niharika Sethi and Abhinav Bahuguna, Lecturer, Department of Biostatistics, Swami Rama Himalayan University, Dehradun, India for their valuable help in the statistical analysis.

Data availability statement

Data available from the corresponding author on reasonable request.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This study was approved by the institutional ethics committee vide letter no. SRHU/HIMS/ETHICS/2022/308 dated 25 May 2021, and was in accordance with the principles of the Declaration of Helsinki and its later amendments.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by an intramural grant (No. SRHU/Reg/Int/2021-335(24) dated 9 November 2021) from Swami Rama Himalayan University, Dehradun, India.

ORCID iDs

Srishti Rathi https://orcid.org/0009-0000-6233-854X
Rajesh Kakkar https://orcid.org/0000-0002-8489-3648
Shubhanshu Chawla https://orcid.org/0009-0000-2525-7839
Sushant khanduri https://orcid.org/0000-0002-4877-860X
Rajeev Mohan Kaushik https://orcid.org/0000-0003-0217-4269
Reshma Kaushik https://orcid.org/0000-0001-7826-2092

References

1. Siegel MD and Parsons PE. Acute respiratory distress syndrome: clinical features, diagnosis, and complications in adults. In: Finlay G (ed) *UpToDate*. Wolters Kluwer, 2023. https://www.uptodate.com/ (accessed 21 May 2023).
2. ARDS Definition Task Force, Ranieri VM, Rubenfeld GD, et al. Acute respiratory distress syndrome: The Berlin definition. *JAMA* 2012; 307: 2526–2533.
3. Meyer NJ, Gattinoni L and Calfee CS. Acute respiratory distress syndrome. *Lancet* 2021; 398: 622–637.
4. Merlani P, Garnerin P, Diby M, et al. Quality improvement report: linking guideline to regular feedback to increase appropriate requests for clinical tests: blood gas analysis in intensive care. *Br Med J* 2001; 323: 620–624.
5. Wick KD, Matthay MA and Ware LB. Pulse oximetry for the diagnosis and management of acute respiratory distress syndrome. *Lancet Respir Med* 2022; 10: 1086–1098.
6. Bilan N, Dastranji A and Behbahani AG. Comparison of the SpO_2/FiO_2 ratio and the PaO_2/FiO_2 ratio in patients with acute lung injury or acute respiratory distress syndrome. *J Cardiovasc Thorac Res* 2015; 7: 28–31.
7. Khemani RG, Patel NR, Bart RD III, et al. Comparison of the pulse oximetric saturation/fraction of inspired oxygen ratio and the PaO_2/fraction of inspired oxygen ratio in children. *Chest* 2009; 135: 662–668.
8. Pisani L, Roozeman JP, Simonis FD, et al. Risk stratification using SpO_2/FiO_2 and PEEP at initial ARDS diagnosis and after 24h in patients with moderate or severe ARDS. *Ann Intensive Care* 2017; 7: 1–10.
9. Hakemi A and Bender JA. Understanding pulse oximetry, advantages, and limitations. *Home Health Care Manag Pract* 2005; 17: 416–418.
10. Ralston SH, Penman ID, Strachan MWJ, et al. Chapter 10: Acute medicine and critical illness. In: Tallentire VR and MacMohan MJ (eds) *Davidson's principles and practice of medicine*. 23rd ed. Elsevier, 2018, pp.198–199.
11. Zhi M, Ding EL, Theisen-Toupal J, et al. The landscape of inappropriate laboratory testing: a 15-year meta-analysis. *PLoS One* 2013; 8: e78962.
12. 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: 52–59.
13. Rice TW, Wheeler AP, Bernard GR, 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: 410–417.
14. Lohano PD, Baloch SH, Gowa MA, et al. Correlation between the ratio of oxygen saturation to fraction of inspired oxygen and the ratio of partial pressure of oxygen to fraction of inspired oxygen in detection and risk stratification of pediatric acute respiratory distress syndrome. *Cureus* 2021; 13: e18353.
15. Babu S, Abhilash KP, Kandasamy S, et al. 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: 1001–1005.
16. Alur TR, Iyer SS, Shah JN, et al. 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: 251–255.
17. Janipalli VP and Moturi PK. Comparison of SpO_2/FiO_2 ratio and PaO_2/FiO_2 ratio as diagnostic criteria in patients with ALI and ARDS. *J Evid Based Med Healthc* 2020; 7: 2520–2525.
18. Kumar A, Aggarwal R, Khanna P, et al. Correlation of the SpO_2/FiO_2 (S/F) ratio and the PaO_2/FiO_2 (P/F) ratio in patients with COVID-19 pneumonia. *Med Intensiva* 2022; 46: 408–410.
19. Benfield T, Jensen JS and Nordestgaard BG. Influence of diabetes and hyperglycemia on infectious disease hospitalization and outcome. *Diabetologia* 2007; 50: 549–554.
20. Aboab J, Louis B, Jonson B, et al. Relation between PaO_2/FiO_2 ratio and FiO_2: a mathematical description. *Intensive Care Med* 2006; 32: 1494–1497.
21. Lu X, Jiang L, Chen T, et al. Continuously available ratio of SpO_2/FiO_2 serves as a noninvasive prognostic marker for intensive care patients with COVID-19. *Respir Res* 2020; 21: 1–4.
22. Bellani G, Pham T and Laffey JG. Missed or delayed diagnosis of ARDS: a common and serious problem. *Intensive Care Med* 2020; 46: 1180–1183.
23. Wong AI, Charpignon M, Kim H, et al. Analysis of discrepancies between pulse oximetry and arterial oxygen saturation measurements by race and ethnicity and association with organ dysfunction and mortality. *JAMA Netw Open* 2021; 4: e2131674.