E-ISSN 2250-0944

ISSN 2250-1150

doi: 10.48047/ijprt/15.02.153

Correlation Between Arterial Blood Gases and ICU Mortality in Patients with Acute Respiratory Distress Syndrome Undergoing General Anesthesia

Sohail Awan[1], Ahmad Basirat[2], Muhammad Umer[3], Zahid Hussain[4], Muhammad Kashan Siddiqui[5], Muhammad Nadeem Shafique[6]

[1] Internist and Rheumatologist.
[2] Department of Respiratory Medicine, St. Vincent's University Hospital, Elm Park, Dublin 4, Ireland.
[3] Medical Officer, Anesthesia, Ittefaq Hospital Trust.
[4] Senior Registrar, Akhtar Saeed Medical College, Farooq Teaching Hospital.
[5] Senior Registrar, Shalamar Institute of Health Sciences.
[6] Associate Professor of Urology, Head of the Department of Urology and Renal Transplant, Imran Idrees Teaching Hospital, Daska Road, Sialkot Medical College.

Corresponding author: drsaawan@yahoo.co.uk

Abstract

Acute Respiratory Distress Syndrome (ARDS) presents a critical challenge in intensive care, with elevated mortality rates exacerbated by perioperative instability during general anesthesia. This experimental observational study investigates the correlation between perioperative arterial blood gases (ABG) and intensive care unit (ICU) mortality in ARDS patients undergoing surgery under general anesthesia. A total of 200 adult ARDS patients were enrolled and divided based on ICU outcomes: survivors (n=124) and non-survivors (n=76). ABG parameters including PaO_2, $PaCO_2$, pH, and PaO_2/FiO_2 (P/F) ratio were recorded intraoperatively and postoperatively within the first 6 hours. The study revealed significantly lower mean postoperative PaO_2 (68.2 ± 14.3 mmHg vs. 82.5 ± 11.8 mmHg, $p<0.001$) and P/F ratio (148.5 ± 28.4 vs. 191.3 ± 32.1, $p<0.001$) among non-survivors. Elevated $PaCO_2$ (54.7 ± 10.2 mmHg vs. 45.1 ± 9.5 mmHg, $p<0.001$) and acidosis (pH 7.27 ± 0.08 vs. 7.34 ± 0.06, $p<0.001$) were strongly associated with ICU mortality. Multivariate analysis identified postoperative PaO_2 <70 mmHg and $PaCO_2$ >50 mmHg as independent predictors of mortality. These findings highlight the prognostic significance of ABG monitoring in perioperative ARDS management and emphasize the need for targeted ventilation strategies during anesthesia. The study provides a data-driven basis for optimizing perioperative care and reducing mortality in this high-risk group.

Keywords: ARDS, Arterial Blood Gases, ICU Mortality

Introduction

Acute Respiratory Distress Syndrome (ARDS) remains a life-threatening pulmonary condition characterized by rapid onset of widespread inflammation in the lungs, resulting in impaired gas exchange and refractory hypoxemia. Despite advances in critical care and mechanical ventilation, ARDS continues to carry significant morbidity and mortality, particularly in patients requiring surgical intervention under general anesthesia. The pathophysiological complexities of ARDS, including alveolar flooding, surfactant dysfunction, and ventilation-perfusion mismatch, make perioperative management particularly precarious. General anesthesia, with its associated effects on respiratory drive, diaphragmatic tone, and ventilation mechanics, further compounds the risks faced by these patients during and after surgery.1-4

The prognostic utility of arterial blood gas (ABG) parameters in ARDS has long been acknowledged, especially in assessing oxygenation and ventilation adequacy. Parameters such as partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), blood pH, and the PaO_2/FiO_2 (P/F) ratio are routinely used to classify ARDS severity and guide ventilatory support. However, while these metrics are vital in the initial diagnosis and ICU management of ARDS, their role in predicting postoperative outcomes, particularly mortality in ICU settings following general anesthesia, remains insufficiently elucidated. The dynamic shifts in ABG values during and after anesthesia may reflect deeper physiologic stress and could serve as early markers for adverse outcomes.5-8

Recent literature has emphasized the influence of intraoperative ventilation strategies on postoperative pulmonary complications in ARDS patients. Factors such as tidal volume, positive end-expiratory pressure (PEEP), and permissive hypercapnia have been variably associated with either protection or deterioration of lung function. Nevertheless, the correlation between these ventilatory variables and ABG trends in predicting ICU mortality postoperatively has not been thoroughly investigated. The potential for ABG parameters to serve as real-time indicators of surgical tolerance and postoperative trajectory presents a critical gap in perioperative care that deserves further exploration.8-10

Mortality in ARDS patients undergoing surgery is influenced by a combination of pre-existing lung injury, systemic inflammation, and intraoperative insults. In this context, ABG trends can offer insight into the adequacy of perioperative ventilation and tissue oxygenation, both of which are modifiable risk factors. Importantly, deviations in ABG values may precede overt clinical deterioration, providing an opportunity for early intervention. Identifying specific ABG thresholds associated with increased mortality risk may guide intraoperative anesthetic management and postoperative monitoring intensity.

This study aims to explore the correlation between perioperative ABG parameters and ICU mortality in ARDS patients undergoing general anesthesia. By stratifying outcomes based on survivor status and comparing intraoperative and early postoperative ABG results, the study seeks to identify thresholds and trends predictive of poor outcomes. Additionally, it assesses whether early deviations in gas exchange markers can independently predict ICU mortality. This knowledge may allow anesthesiologists and intensivists to personalize ventilation strategies and optimize outcomes in this vulnerable population.

Furthermore, the study contributes to the growing emphasis on precision perioperative medicine by integrating ABG analytics into risk prediction models. While previous studies have explored ABG in the context of ARDS diagnosis and ICU management, this investigation uniquely focuses on the perioperative period—a time often marked by physiologic volatility. The integration of gas exchange data into postoperative mortality prediction tools has the potential to revolutionize risk assessment and therapeutic interventions in ARDS care.

Methodology

This observational, prospective cohort study was conducted Ittefaq Hospital Trust in a tertiary ICU over a 12-month period involving adult patients diagnosed with moderate-to-severe ARDS undergoing elective or emergency surgeries under general anesthesia. Sample size was calculated using Epi Info software, assuming a two-tailed alpha of 0.05, power of 80%, and an expected effect size (Cohen's d) of 0.5 for PaO_2 difference between survivors and non-survivors, with an estimated 35% ICU mortality based on institutional data. The final sample included 200 patients. Inclusion criteria comprised patients aged 18–70 years with Berlin criteria-defined ARDS, requiring mechanical ventilation and undergoing general anesthesia for non-cardiothoracic surgeries. Exclusion criteria included pre-existing severe metabolic acidosis (pH <7.2), chronic obstructive pulmonary disease, pregnancy, or do-not-resuscitate orders. All patients received standardized anesthesia protocols with lung-protective ventilation (tidal volume 6–8 mL/kg ideal body weight). ABG measurements were obtained at induction, end of surgery, and 6 hours postoperatively. Parameters recorded included PaO_2, $PaCO_2$, pH, bicarbonate, base excess, and P/F ratio. Patients were followed until ICU discharge or death. Verbal consent was obtained from patients or legal surrogates. ICU outcomes were recorded, and statistical analysis performed using SPSS v26. Independent t-tests, chi-square tests, and logistic regression identified ABG parameters significantly associated with ICU mortality. A p-value <0.05 was considered statistically significant.

Results

Table 1: Demographic and Clinical Characteristics

Variable	Survivors (n=124)	Non-survivors (n=76)	p-value
Mean Age (years)	51.3 ± 11.4	54.1 ± 10.8	0.07
Male (%)	73 (58.9%)	42 (55.3%)	0.64
APACHE II Score	16.4 ± 4.2	20.8 ± 5.1	<0.001*
Emergency surgery (%)	45 (36.3%)	39 (51.3%)	0.04*
Ventilation duration (days)	6.1 ± 2.3	8.4 ± 3.1	<0.001*

Non-survivors had significantly higher severity scores and longer ventilation.

Table 2: Perioperative Arterial Blood Gas Parameters

ABG Parameter (Post-op)	Survivors (n=124)	Non-survivors (n=76)	p-value
PaO_2 (mmHg)	82.5 ± 11.8	68.2 ± 14.3	<0.001*
$PaCO_2$ (mmHg)	45.1 ± 9.5	54.7 ± 10.2	<0.001*
pH	7.34 ± 0.06	7.27 ± 0.08	<0.001*
P/F ratio	191.3 ± 32.1	148.5 ± 28.4	<0.001*

Significant ABG derangements were observed in non-survivors.

Table 3: Multivariate Predictors of ICU Mortality (Logistic Regression)

Variable	Odds Ratio (95% CI)	p-value
Post-op PaO_2 <70 mmHg	3.12 (1.75–5.57)	<0.001*
Post-op $PaCO_2$ >50 mmHg	2.68 (1.42–4.96)	0.002*
pH <7.30	2.91 (1.60–5.28)	<0.001*
APACHE II >18	3.47 (1.89–6.37)	<0.001*

Postoperative ABG markers were independent predictors of ICU mortality.

Discussion

This study provides compelling evidence linking perioperative arterial blood gas abnormalities with ICU mortality in ARDS patients undergoing general anesthesia. The findings demonstrate that lower PaO_2, elevated $PaCO_2$, and acidosis within the first 6 hours postoperatively are significantly associated with poor outcomes. These results reinforce the importance of vigilant ABG monitoring during the perioperative period as a predictive tool for clinical deterioration.11-13

The observed hypoxemia among non-survivors highlights the inadequacy of oxygenation post-anesthesia in severely injured lungs. PaO_2 <70 mmHg was identified as an independent predictor of mortality, underscoring the limited pulmonary reserve and impaired diffusion capacity in these patients. The P/F ratio, which remained below 150 in non-survivors, confirms persistent severe ARDS and correlates with previously established mortality thresholds.14-16

Hypercapnia was also significantly associated with adverse outcomes. Although permissive hypercapnia is an accepted strategy in lung-protective ventilation, excessive CO_2 levels can exacerbate acidosis and impair cardiac performance. The mean $PaCO_2$ among non-survivors exceeded 54 mmHg, suggesting that uncontrolled hypercapnia may contribute to hemodynamic instability and organ dysfunction postoperatively.18-20

Acidosis emerged as a critical factor, with pH values <7.30 significantly associated with mortality. This metabolic derangement may reflect inadequate ventilation, tissue hypoperfusion, or underlying sepsis. Correction of acidosis through ventilatory adjustments and hemodynamic optimization should be prioritized in high-risk surgical ARDS patients.

The higher APACHE II scores and greater need for emergency surgeries in non-survivors further contextualize the severity of illness. These factors, combined with ABG abnormalities, offer a multidimensional risk profile. Integrating ABG trends into ICU risk models may enhance predictive accuracy and inform therapeutic decisions.

Importantly, this study supports a shift toward individualized ventilation strategies guided by perioperative ABG analysis. Timely identification of deranged gas exchange may prompt changes in ventilator settings, use of adjunctive therapies such as recruitment maneuvers or prone positioning, and escalation of monitoring. Early interventions may reduce the trajectory toward irreversible respiratory failure.

Finally, this study’s implications extend to the design of perioperative protocols. Standardized ABG thresholds could be integrated into anesthesia workflows, triggering alerts for aggressive postoperative support. Such data-driven approaches would refine triage, improve outcomes, and reduce mortality in high-risk surgical ARDS cohorts.

Conclusion

Perioperative arterial blood gas derangements, particularly hypoxemia, hypercapnia, and acidosis, are significantly associated with ICU mortality in ARDS patients under general anesthesia. This study fills a critical knowledge gap by identifying ABG thresholds predictive of poor outcomes and suggests the need for perioperative ABG-guided risk stratification and management. Future research should explore protocol-based interventions driven by early ABG trends.

References

1. Gattinoni L, Marini JJ, Collino F, et al. The pathophysiology of ARDS and the rationale for personalized treatment. Intensive Care Med. 2021;47(5):593–607. https://doi.org/10.1007/s00134-021-06374-3
2. Fan E, Brodie D, Slutsky AS. Acute respiratory distress syndrome: advances in diagnosis and treatment. JAMA. 2023;329(7):566–578. https://doi.org/10.1001/jama.2023.0282
3. Wu C, Ye Z, Tan L, et al. Association between intraoperative arterial blood gas variables and mortality in critically ill surgical patients. Ann Transl Med. 2021;9(8):670. https://doi.org/10.21037/atm-20-7806
4. Roca O, Messika J, Caralt B, et al. Predicting outcome in ARDS: PaO_2/FiO_2 ratio revisited. Crit Care. 2022;26(1):83. https://doi.org/10.1186/s13054-022-03982-6
5. Brochard L, Slutsky A, Pesenti A. Mechanical ventilation to minimize progression of lung injury in acute respiratory failure. Lancet Respir Med. 2021;9(7):728–740. https://doi.org/10.1016/S2213-2600(21)00125-7
6. Xu Y, Li J, Zheng Y, et al. Prognostic value of arterial blood gas analysis in critically ill patients: a retrospective study. BMJ Open. 2022;12(1):e055739. https://doi.org/10.1136/bmjopen-2021-055739
7. Rezoagli E, Fumagalli R, Bellani G. Definition and epidemiology of acute respiratory distress syndrome. Ann Transl Med. 2023;11(2):387. https://doi.org/10.21037/atm-22-3213
8. Meyer NJ, Gattinoni L, Calfee CS. Acute respiratory distress syndrome. Lancet. 2021;398(10300):622–637. https://doi.org/10.1016/S0140-6736(21)00578-6
9. Seeley E, McAuley DF, Eisner MD, et al. Predictors of mortality in ARDS. Respirology. 2022;27(4):292–301. https://doi.org/10.1111/resp.14242
10. He H, Wang X, Wang L, et al. Prognostic value of early changes in $PaCO_2$ in patients with acute hypoxemic respiratory failure. Crit Care Explor. 2023;5(1):e0842. https://doi.org/10.1097/CCE.0000000000000842
11. Nunes Q, Perelló L, Martinez-Simon A, et al. Intraoperative arterial blood gases and mortality in emergency general surgery patients with ARDS. J Crit Care. 2022;67:38–44. https://doi.org/10.1016/j.jcrc.2021.09.003

12. Ghimire S, Rai R, Upadhyay S, et al. Arterial blood gas parameters as predictors of ICU outcomes. Egypt J Intern Med. 2022;34(1):29. https://doi.org/10.1186/s43162-022-00116-8
13. Vaschetto R, Camporota L, Nicola S, et al. Prone position and protective ventilation in ARDS patients: effects on gas exchange. Respir Res. 2021;22(1):140. https://doi.org/10.1186/s12931-021-01718-w
14. Serpa Neto A, Nassar AP Jr, Cardoso SO, et al. Ventilatory strategies and outcomes in patients with ARDS undergoing surgery. Br J Anaesth. 2022;128(4):650–658. https://doi.org/10.1016/j.bja.2021.11.025
15. Dumas G, Demoule A, Fartoukh M, et al. ICU mortality prediction in ARDS using blood gas trends: A multicenter study. Chest. 2023;163(2):408–418. https://doi.org/10.1016/j.chest.2022.10.002
16. Guerin C, Papazian L, Reignier J, et al. ARDS treatment updates and long-term outcomes. Curr Opin Crit Care. 2023;29(1):15–21. https://doi.org/10.1097/MCC.0000000000000901
17. Zimmerman JE, Kramer AA, Knaus WA. Changes in prognosis after ICU admission: Do ABGs tell the whole story? Intensive Care Med. 2022;48(4):473–481. https://doi.org/10.1007/s00134-021-06593-6
18. Hanidziar D, Bittner EA. Perioperative management of ARDS in non-cardiothoracic surgery: a practical approach. Curr Anesthesiol Rep. 2021;11(1):43–52. https://doi.org/10.1007/s40140-020-00427-w
19. Nishikimi M, Jamil M, McCurry M, et al. Prognostic value of PaO_2 and $PaCO_2$ in surgical ICU patients with respiratory failure. J Thorac Dis. 2022;14(3):712–722. https://doi.org/10.21037/jtd-21-1681
20. Blanco-Schweizer P, Arabi YM, Estenssoro E. The future of ARDS care: prevention, prediction, and personalization. Crit Care. 2023;27(1):16. https://doi.org/10.1186/s13054-022-04201-0