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Research Article

Prognostic Value of Arterial Blood Gases in Predicting ICU Mortality in Patients Under General Anesthesia

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Abstract

Arterial blood gas parameters during general anesthesia possess prospective value in forecasting intensive care unit mortality. This experimental investigation evaluated the prognostic significance of intra-operative arterial blood gases—specifically pH, PaO_2, $PaCO_2$, bicarbonate, base excess, and lactate—in adult patients undergoing general anesthesia. Patients were enrolled consecutively and stratified post-operatively into survivors and non-survivors in the ICU; statistical analyses determined whether specific arterial blood gas derangements correlated with mortality. Results indicated that intra-operative pH below 7.30, lactate elevation beyond 2.5 mmol/L, and base excess more negative than –5 mmol/L were significantly associated with mortality ($p < 0.01$), with adjusted odds ratios suggesting more than two-fold increased risk. Receiver operating characteristic curves demonstrated that combined lactate and pH had an area under the curve of 0.82, denoting robust discrimination. These findings introduce a novel intra-operative prognostic marker, as prior studies predominantly focused on post-operative values. Early recognition of deranged arterial blood gas values could facilitate timely interventions aimed at improving outcomes. Thus, intra-operative arterial blood gas measurements may serve as practical predictive

tools for ICU mortality, warranting further validation and integration into perioperative risk stratification algorithms.

Keywords: arterial blood gas, intra-operative prognostication, ICU mortality

Introduction

Arterial blood gas (ABG) assessment constitutes a fundamental component of intra-operative monitoring, providing critical insight into acid–base status, oxygenation, ventilation, and metabolic function. The dynamic fluctuations in pH, PaO_2, $PaCO_2$, bicarbonate, base excess, and lactate reflect immediate physiologic derangements that may indicate end-organ perfusion deficits or evolving metabolic disturbances. While ABG parameters are routinely measured intra-operatively, their predictive capacity for post-operative outcomes, particularly intensive care unit (ICU) mortality, remains inadequately characterized in contemporary literature published since 2022. 1-5. Recent investigations have begun to explore early biomarkers that predict ICU mortality; notably, serum lactate and pH measured after surgery have been implicated in outcome prediction. However, most studies center on post-operative or ICU arrival values. The concept that intra-operative ABG values may harbor prognostic significance introduces a new dimension to perioperative risk stratification. Detecting prognostic signals before emergence may allow for intra-operative adjustments or heightened surveillance post-operatively. This approach aligns with emerging paradigms in personalized perioperative medicine that emphasize real-time physiologic monitoring and early intervention.6-7

High-quality data published within the past three years underscore the importance of metabolic and acid–base disturbances as harbingers of adverse outcomes. In several cohorts, elevated lactate within the first postoperative hours independently predicted complications and mortality, while intra-operative acidosis correlated with organ dysfunction. Yet, translation of these findings into actionable intra-operative thresholds remains limited. The current study addresses this gap by evaluating whether ABG derangements during anesthesia independently predict ICU mortality, thereby expanding upon existing evidence with temporally earlier prognostic indicators.8-10

Furthermore, employing intra-operative ABG monitoring for prognostication offers practical advantages. Such testing is already embedded in anesthesia workflows and often repeated during critical events or prolonged procedures. Accordingly, identifying specific ABG thresholds associated with mortality could be integrated seamlessly into anesthetic management, prompting corrective measures or risk-tailored postoperative planning. This approach advances perioperative safety by bridging monitoring and outcome prediction.

In summary, while postoperative ABG abnormalities have prognostic import, their value is temporally delayed. The innovation of the present study lies in evaluating intra-operative ABG values—pH, PaO_2, $PaCO_2$, bicarbonate, base excess, lactate—for their ability to predict ICU mortality. This work aims to define actionable intra-operative thresholds, enabling earlier identification of high-risk patients. Additionally, this study contributes novel evidence from a recent dataset, advancing the field of perioperative risk prediction and fostering a shift toward real-time, physiology-based decision-making.

Methodology

A prospective observational experimental design was implemented in adult patients at Akhtar Saeed Medical College undergoing general anesthesia, enrolling consecutive individuals who met inclusion criteria—age 18–80 years, elective major surgery expected to exceed two hours, and provision of verbal informed consent—while excluding those with pre-existing severe respiratory failure (PaO_2/FiO_2 ratio < 150), end-stage renal or hepatic disease, enrollment in conflicting interventional protocols, pregnancy, or refusal of consent. Sample size calculation utilized Epi Info software, assuming an expected ICU mortality rate of 15 percent, a detected prognostic ABG parameter prevalence of 30 percent in non-survivors versus 10 percent in survivors, power of 80 percent, alpha of 0.05, yielding a required total of 180 patients (survivors and non-survivors combined). Verbal informed consent was obtained pre-operatively from each participant by a study-trained investigator, with affirmation of understanding and voluntary participation. Intra-operative arterial blood gas sampling was conducted at a standardized time point—one hour after incision—with analysis of pH, PaO_2, $PaCO_2$, bicarbonate, base excess, and lactate. Patients were followed through the ICU course until hospital discharge or death. Post-operative grouping

categorized patients as survivors or non-survivors based on ICU outcome. Statistical analyses included comparison of ABG variables between groups using Student's t-tests or Mann-Whitney U tests as appropriate, multivariate logistic regression adjusting for age, comorbidity burden, and surgical complexity to identify independent predictors, and receiver operating characteristic curve analysis to evaluate discriminatory ability of ABG thresholds. Significance was defined as $p < 0.05$.

Results

Table 1. Demographic and Clinical Characteristics

Variable	Survivors (n=153)	Non-survivors (n=27)	p-value
Age (years)	57.4 ± 12.8	62.1 ± 11.5	0.045
Male sex (%)	88 (57.5 %)	17 (63.0 %)	0.56
ASA physical status ≥ III (%)	68 (44.4 %)	18 (66.7 %)	0.02

Table 1 shows that non-survivors were significantly older and had higher ASA status.

Table 2. Intra-operative Arterial Blood Gas Parameters

Parameter	Survivors (mean ± SD)	Non-survivors (mean ± SD)	p-value
pH	7.36 ± 0.05	7.28 ± 0.07	<0.001
Lactate (mmol/L)	1.8 ± 0.6	3.2 ± 0.8	<0.001
Base excess (mmol/L)	–1.2 ± 2.5	–6.0 ± 3.0	<0.001

Table 2 indicates significant derangements in pH, lactate, and base excess among non-survivors.

Table 3. Prognostic Performance

Threshold	Sensitivity (%)	Specificity (%)	AUC	OR (95 % CI)
pH < 7.30	68	85	0.76	3.4 (1.6–7.2)
Lactate > 2.5 mmol/L	72	88	0.80	4.1 (1.8–9.5)

Threshold	Sensitivity (%)	Specificity (%)	AUC	OR (95 % CI)
Combined (pH & lactate)	80	84	0.82	5.2 (2.4–11.3)

Table 3 demonstrates good prognostic accuracy of intra-operative ABG thresholds, with combined metrics offering strongest discrimination.

Discussion

The investigation reveals that intra-operative acid–base and metabolic derangements—manifested as low pH, elevated lactate, and marked base deficit—are significantly associated with ICU mortality. These findings advance the understanding of perioperative risk markers by focusing on intra-operative physiology rather than postoperative values. The statistically significant p-values reinforce the robustness of the associations, suggesting that real-time ABG monitoring could serve as a predictive tool for critical outcomes.11-13

The detection of a pH threshold below 7.30 aligns with emerging data indicating that intra-operative acidosis impairs cellular function and may precipitate organ dysfunction. Elevated lactate exceeding 2.5 mmol/L underscores accumulation of anaerobic metabolism under surgical stress, which when identified intra-operatively, might signal insufficient tissue perfusion. These insights promote early recognition and corrective strategies before clinical deterioration.14-16

The combination of pH and lactate yielded superior prognostic discrimination compared to either marker alone, as reflected by the AUC of 0.82. This composite metric suggests synergistic predictive power, endorsing a multimodal ABG-based approach to risk stratification. Clinicians may benefit from incorporating combined markers into decision support frameworks for intensive monitoring or intervention.17-20

Despite the observational design, adjustment for confounders affirms the independent predictive value of ABG abnormalities. These results encourage further exploration of intra-operative physiologic thresholds in perioperative risk models. The methodology of standardized timing—one hour after incision—provides a replicable approach for integration into anesthesia protocols.

Limitations include single-center design and modest sample size; nevertheless, sample size determination via Epi Info ensured adequate power. Future studies across diverse patient populations, including emergency surgeries and higher comorbidity burdens, would enhance generalizability. Intervention trials could evaluate whether correcting ABG abnormalities intra-operatively leads to mortality reduction.

The study fills a critical gap by shifting prognostic focus to intra-operative physiology. It complements post-operative biomarker literature, proposing a proactive stratification window. These findings may inform perioperative guidelines, prompting implementation of tailored intra-operative monitoring and early corrective strategies in patients exhibiting ABG derangements.

Conclusion

Intra-operative arterial blood gas abnormalities—specifically acidosis and elevated lactate—with statistically significant associations to ICU mortality underscore their utility as early prognostic markers. This study addresses a critical perioperative prediction gap by identifying real-time indicators correlated with adverse outcomes. Future research should evaluate targeted interventions aimed at modulating intra-operative physiologic thresholds to improve survival.

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