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Original Research Article

Clinical Significance of Arterial Blood Gas Analysis in Critical Care

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Abstract:

Background: Critically ill patients frequently develop disturbances in acid–base balance, oxygenation, and ventilation due to underlying respiratory, metabolic, and systemic illnesses. Arterial blood gas (ABG) analysis provides rapid and comprehensive assessment of these disturbances and plays a crucial role in diagnosis, monitoring, and management in critical care settings.

Objectives: To evaluate the clinical significance of arterial blood gas analysis in critically ill patients by assessing patterns of acid–base disorders and abnormalities in oxygenation and ventilation.

Methods: An observational analytical study was conducted in the Central Laboratory of the Biochemistry Department, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India, over a one-year period from January 2025 to December 2025. A total of 70 critically ill patients requiring ABG analysis as part of routine clinical care were included. Arterial blood samples were collected using standard aseptic techniques and analyzed for pH, PaO_2, $PaCO_2$, bicarbonate, base excess, and oxygen saturation. Acid–base and respiratory abnormalities were interpreted using standard criteria. Data were analyzed descriptively.

Results: The majority of patients demonstrated abnormal ABG findings. Metabolic acidosis was the most common acid–base disturbance, followed by respiratory acidosis and mixed acid–base disorders. Hypoxemia was frequently observed, indicating impaired oxygenation in a significant proportion of patients. Ventilatory abnormalities, including hypercapnia and hypocapnia, were also noted. ABG analysis provided clinically relevant information that supported diagnosis, guided therapeutic interventions, and aided in monitoring response to treatment in critically ill patients.

Conclusion: Arterial blood gas analysis is an essential investigative tool in critical care, offering valuable insights into acid–base balance, oxygenation, and ventilation. Its routine use facilitates early detection of physiological derangements and supports effective clinical management. Integration of ABG analysis into standard critical care protocols can enhance diagnostic accuracy and improve patient care.

Keywords: Arterial blood gas; Critical care; Acid–base disorders; Hypoxemia; Respiratory failure; Clinical significance.

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Introduction

Critical care medicine deals with patients who have life-threatening conditions requiring continuous monitoring, rapid diagnosis, and timely therapeutic interventions. Such patients often present with disturbances in respiration, circulation, metabolism, and acid–base balance, which can rapidly progress to organ failure if not promptly recognized and managed. In this context, laboratory investigations play a crucial role in guiding clinical decision-making. Among these investigations, arterial blood gas (ABG) analysis is regarded as one of the most essential tools for evaluating the physiological status of critically ill patients [1]. Arterial blood gas analysis provides immediate and objective information regarding oxygenation, ventilation, and acid–base status. Parameters such as pH, partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), bicarbonate (HCO_3^-), and oxygen saturation reflect the integrated functioning of the respiratory, cardiovascular, and metabolic

systems. Even subtle alterations in these values can signal early deterioration in a patient's clinical condition, making ABG analysis indispensable in intensive care units (ICUs) and emergency settings [2].

Acid–base homeostasis is vital for normal cellular function, enzymatic activity, and metabolic processes. Disturbances in acid–base balance commonly occur in critically ill patients due to conditions such as sepsis, shock, respiratory failure, renal dysfunction, and diabetic emergencies. These disturbances may present as metabolic or respiratory acidosis or alkalosis, often in mixed forms. ABG analysis remains the gold standard for identifying these disorders and differentiating their underlying mechanisms, thereby enabling targeted therapeutic interventions [3]. Respiratory failure is one of the most frequent indications for ABG analysis in critical care. Patients with acute or chronic lung diseases, neurological impairment, trauma, or sepsis may develop hypoxemia, hypercapnia, or both. Clinical assessment alone is often insufficient to accurately evaluate the severity of respiratory compromise. ABG parameters allow clinicians to assess the adequacy of ventilation and oxygenation, monitor response to oxygen therapy or mechanical ventilation, and adjust ventilatory settings appropriately [4]. Thus, ABG analysis serves as a cornerstone in the management of respiratory disorders in critically ill patients.

Beyond respiratory assessment, ABG analysis plays a pivotal role in evaluating metabolic disturbances. Conditions such as diabetic ketoacidosis, lactic acidosis, renal failure, and poisoning can result in significant metabolic acid–base derangements. Early identification of these abnormalities through ABG interpretation allows prompt initiation of corrective measures, such as insulin therapy, fluid resuscitation, electrolyte correction, or renal replacement therapy. Delay in diagnosis may lead to worsening organ dysfunction and increased mortality [5].

Arterial blood gas analysis is also valuable in monitoring disease progression and therapeutic response in critically ill patients. Serial ABG measurements provide insight into trends in a patient's physiological status, enabling clinicians to evaluate the effectiveness of ongoing treatment. Improvements or deterioration in ABG parameters often precede overt clinical changes, allowing for early modification of management strategies. This dynamic role of ABG analysis makes it an important prognostic and monitoring tool in critical care practice [6]. Despite advances in non-invasive monitoring techniques, ABG analysis continues to maintain its relevance due to its accuracy and comprehensive assessment of multiple physiological parameters. Pulse oximetry, for instance, provides information only on oxygen saturation and does not reflect ventilation or acid–base status. Similarly, clinical signs may be misleading in critically ill patients due to sedation, altered sensorium, or multi-organ involvement. ABG analysis, therefore, complements clinical evaluation and enhances diagnostic precision [2].

In resource-limited settings, such as many tertiary care hospitals in developing regions, the judicious use of ABG analysis is particularly important. Limited availability of advanced diagnostic modalities necessitates reliance on cost-effective and informative investigations. ABG analysis fulfills this role by providing rapid, actionable data that directly influence patient management. Studies from such settings have demonstrated that timely interpretation of ABG results can significantly improve clinical outcomes when integrated into routine critical care protocols [7]. The clinical significance of ABG analysis also extends to guiding end-of-life care and assessing the severity of illness. Severe and refractory acid–base abnormalities often reflect advanced disease and poor prognosis. In such scenarios, ABG findings assist clinicians and families in making informed decisions regarding escalation or limitation of care. Thus, ABG analysis contributes not only to active management but also to ethical and patient-centered decision-making in critical care.

Given its multifaceted role, understanding the clinical significance and interpretation of arterial blood gas analysis is essential for clinicians, intensivists, and laboratory professionals. Evaluating the patterns of ABG abnormalities in critically ill patients can provide valuable insights into disease burden, common physiological derangements, and their clinical implications. However, data from institutional studies, particularly from biochemistry laboratories in tertiary care centers, remain limited.

The present study was undertaken in the central laboratory of the Biochemistry Department at BMIMS, Pawapuri, Nalanda, Bihar, to assess the clinical significance of arterial blood gas analysis in critically ill patients. By analyzing ABG parameters in patients requiring critical care, this study aims to highlight the role of ABG analysis in diagnosis, monitoring, and management, and to reinforce its importance as a vital investigative tool in critical care practice.

Review of literature: The examination of arterial blood gas (ABG) is still a fundamental investigation in critical care treatment because it offers quick and crucial information about ventilation, oxygenation, and acid-base status. ABG interpretation has become a vital skill in the treatment of critically ill patients since it was first used in clinical medicine in the middle of the 20th century. Its diagnostic, therapeutic, and prognostic usefulness in a variety of

intensive care settings is highlighted by numerous research [8].

By monitoring pH, PaO_2, and $PaCO_2$, ABG analysis allows for the quick evaluation of respiratory failure. It directs ventilator adjustments and aids in assessing the sufficiency of gas exchange in patients on mechanical ventilation. Research shows that early detection of hypoxemia and hypercapnia by ABG helps with prompt intervention, which lowers morbidity in pneumonia, chronic obstructive pulmonary disease exacerbations, and acute respiratory distress syndrome (ARDS) [9].

ABG is essential for assessing acid-base disorders in addition to respiratory examination. Studies conducted in critical care highlight its value in the diagnosis of metabolic acidosis, specifically renal failure, diabetic ketoacidosis, and lactic acidosis in septic shock. Response to insulin, vasopressor, fluid resuscitation, and renal replacement treatment can all be tracked using serial ABG readings. In critically ill patients, elevated lactate levels—which are frequently interpreted in conjunction with ABG parameters—have been repeatedly linked to higher fatality rates [10].

ABG is useful in trauma and perioperative settings as well. Its function in the early identification of tissue hypoxia, hemorrhagic shock, and hypoperfusion is supported by literature. $PaCO_2$ monitoring using ABG helps control intracranial pressure and cerebral blood flow in neurocritical care [11].

Recent research, however, casts doubt on routine, recurrent ABG collection because of the hazards associated with frequent blood draws, including anemia, infection, and arterial damage. Comparative studies show that arterial sampling is still the best method for determining oxygenation, while venous blood gas analysis may be able to approximate pH and bicarbonate levels in a subset of stable individuals [12].

In emergency and critical care units, improvements in point-of-care testing have shortened turnaround times and enhanced bedside decision-making. The integration of ABG results with clinical evaluation and other monitoring modalities, as opposed to depending solely on isolated values, is becoming more and more important in contemporary literature [13].

The body of research continuously affirms that ABG analysis is a vital tool in critical care. It is essential to diagnosis, monitoring, and prognostication since it can offer real-time information into respiratory function, metabolic condition, and tissue perfusion. However, to optimize advantages and reduce risks, careful application in conjunction with clinical correlation is necessary [14].

Methodology

Study Design: This study was conducted as an observational analytical study to evaluate the clinical significance of arterial blood gas (ABG) analysis in patients admitted to critical care units. The study aimed to assess patterns of ABG abnormalities and their relevance in the diagnosis and monitoring of critically ill patients under routine clinical conditions.

Study Setting: The study was carried out in the Central Laboratory of the Biochemistry Department at Buddha Institute of Medical Sciences (BMIMS), Pawapuri, Nalanda, Bihar, India. The laboratory caters to samples from various critical care areas of the hospital, including intensive care units, emergency services, and high-dependency units. All arterial blood gas analyses included in the study were performed in this central laboratory using standardized protocols.

Study Duration: The study was conducted over a period of one year, from January 2025 to December 2025. During this period, arterial blood gas samples received from critically ill patients were systematically evaluated and included in the analysis based on predefined inclusion and exclusion criteria.

Study Population: The study population consisted of critically ill patients for whom arterial blood gas analysis was requested as part of routine clinical management. A total of 70 patients were included in the study. Patients represented a wide range of clinical conditions requiring critical care, including respiratory, metabolic, cardiovascular, and systemic disorders.

Inclusion Criteria: Patients admitted to intensive care units or emergency settings during the study period who required arterial blood gas analysis for clinical evaluation were included. Only patients from whom arterial blood samples were successfully obtained and analyzed were considered eligible for inclusion. Patients of either sex and all adult age groups were included to ensure a representative critical care population.

Exclusion Criteria: Patients were excluded from the study if arterial blood sampling was technically inadequate or if the sample was compromised due to improper collection, delayed transport, or processing errors. Repeated samples from the same patient were not included to avoid duplication, and only the initial arterial blood gas report for each patient was considered for analysis. Patients with incomplete clinical or laboratory data were also excluded.

Sample Collection: Arterial blood samples were collected by trained healthcare personnel following standard aseptic techniques. Samples were typically obtained from the radial artery, with alternative sites such as the femoral or brachial artery used when necessary. Prior to sample collection, patient

identity was verified, and appropriate precautions were taken to minimize discomfort and complications. Approximately one to two milliliters of arterial blood were collected into pre-heparinized syringes to prevent coagulation. Care was taken to expel any air bubbles from the syringe immediately after collection, as the presence of air could alter blood gas values. The syringe was sealed securely and transported promptly to the central laboratory for analysis.

Laboratory Analysis: Arterial blood gas analysis was performed using an automated blood gas analyzer installed in the central laboratory. The analyzer was calibrated regularly according to manufacturer recommendations, and internal quality control procedures were followed to ensure accuracy and reliability of results.

The parameters measured included pH, partial pressure of carbon dioxide ($PaCO_2$), partial pressure of oxygen (PaO_2), bicarbonate concentration (HCO_3^-), base excess, and arterial oxygen saturation. These parameters were recorded for each patient and interpreted in conjunction with clinical information provided on the laboratory requisition forms.

Interpretation of ABG Results: Arterial blood gas results were interpreted to identify acid–base disturbances and respiratory abnormalities. Acid–base disorders were classified as metabolic or respiratory acidosis or alkalosis, based on standard physiological criteria. Mixed acid–base disorders were identified when abnormalities in both respiratory and metabolic components were present.

Oxygenation status was assessed using PaO_2 and oxygen saturation values, while ventilatory status was evaluated using $PaCO_2$ levels. The relevance of ABG findings was assessed in relation to the patient's clinical condition, including indications such as respiratory failure, metabolic derangements, sepsis, and shock.

Data Collection: Relevant clinical and laboratory data were collected using a structured data collection format. Information recorded included patient demographics, clinical indication for ABG analysis, and ABG parameters. Each patient was assigned a unique identification code to maintain confidentiality. Data were entered into a digital database for analysis.

Statistical Analysis: Data analysis was performed using descriptive statistical methods. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Patterns of ABG abnormalities were analyzed to determine their distribution among the study population. The clinical significance of ABG findings was assessed based on their frequency and association with common critical care conditions.

Ethical Considerations: The study was conducted using data generated as part of routine patient care. Patient confidentiality was strictly maintained, and no personal identifiers were used in data analysis or reporting. Approval for conducting the study was obtained from the institutional ethics committee prior to data collection.

Results

A total of 70 critically ill patients admitted to intensive care units and emergency services during the study period were included in the analysis. Arterial blood gas (ABG) analysis was performed for all patients as part of routine clinical evaluation. The results are presented with respect to demographic characteristics, clinical indications for ABG testing, patterns of acid–base disturbances, and abnormalities related to oxygenation and ventilation.

Demographic Profile of Study Population: The study population consisted of adult patients of both sexes with varying underlying clinical conditions requiring critical care. The majority of patients belonged to the middle-aged and elderly age groups. Male patients constituted a slightly higher proportion of the study population compared to females. Patients were admitted to critical care for diverse indications, including respiratory failure, metabolic disturbances, sepsis, cardiovascular instability, and altered sensorium.

The age and sex distribution of the study participants is summarized in Table 1. This table provides an overview of the demographic characteristics of patients undergoing ABG analysis in the critical care setting.

Table 1: Demographic characteristics of critically ill patients undergoing ABG analysis (n = 70)

Variable	Number (n)	Percentage (%)
Age group (years)		
18–30	8	11.4
31–45	15	21.4
46–60	22	31.4
>60	25	35.8
Sex		
Male	42	60.0
Female	28	40.0

Clinical Indications for Arterial Blood Gas Analysis: Arterial blood gas analysis was requested for multiple clinical indications. The most common indication was suspected respiratory compromise, including hypoxemia and ventilatory failure. Other frequent indications included metabolic disturbances such as diabetic ketoacidosis and renal failure, septic shock, and hemodynamic instability. In several patients, ABG analysis was used to monitor response to ongoing treatment, such as oxygen therapy, mechanical ventilation, or correction of metabolic abnormalities. The distribution of primary clinical indications for ABG testing among the study population is presented in Table 2. This table highlights the diverse clinical scenarios in which ABG analysis played a role in patient assessment and management.

Table 2: Clinical indications for arterial blood gas analysis among study participants (n = 70)

Clinical indication	Number (n)	Percentage (%)
Respiratory failure / breathlessness	26	37.1
Metabolic disturbances (DKA, renal failure)	18	25.7
Sepsis / septic shock	14	20.0
Cardiovascular instability	7	10.0
Altered sensorium	5	7.2
Total	**70**	**100**

Acid–Base Status of Patients: Analysis of ABG parameters revealed that a majority of patients exhibited some form of acid–base disturbance. Metabolic acidosis was the most frequently observed abnormality, particularly among patients with sepsis, renal failure, and diabetic emergencies. Respiratory acidosis was commonly seen in patients with respiratory failure and chronic lung disease, while respiratory alkalosis was noted in some patients with sepsis and central nervous system involvement.

Metabolic alkalosis was less frequently observed and was primarily associated with conditions such as prolonged vomiting or diuretic use. A notable proportion of patients demonstrated mixed acid–base disorders, indicating the presence of simultaneous respiratory and metabolic disturbances. These mixed disorders reflected the complex physiological derangements commonly encountered in critically ill patients. The distribution of acid–base abnormalities identified through ABG analysis is detailed in Table 3, which categorizes patients based on the type of acid–base disorder detected.

Table 3: Distribution of acid–base disorders detected by ABG analysis (n = 70)

Acid–base status	Number (n)	Percentage (%)
Metabolic acidosis	24	34.3
Respiratory acidosis	14	20.0
Respiratory alkalosis	9	12.9
Metabolic alkalosis	6	8.6
Mixed acid–base disorders	11	15.7
Normal ABG	6	8.5
Total	**70**	**100**

Oxygenation and Ventilatory Abnormalities: Evaluation of oxygenation parameters revealed that a significant number of patients had reduced arterial oxygen levels. Hypoxemia was commonly observed among patients with respiratory failure, sepsis, and shock. Some patients demonstrated severe hypoxemia requiring escalation of respiratory support, including high-flow oxygen therapy or mechanical ventilation.

Ventilatory abnormalities were also evident based on $PaCO_2$ values. Hypercapnia was frequently observed in patients with respiratory acidosis, particularly those with hypoventilation or chronic obstructive airway disease. Hypocapnia was noted in some patients with respiratory alkalosis, often related to hyperventilation secondary to metabolic acidosis or sepsis. The patterns of oxygenation and ventilation abnormalities observed in the study population are summarized in Table 4. This table presents the distribution of patients based on PaO_2 and $PaCO_2$ abnormalities, emphasizing the role of ABG analysis in assessing respiratory status.

Table 4: Oxygenation and ventilation abnormalities based on ABG parameters (n = 70)

ABG abnormality	Number (n)	Percentage (%)
Hypoxemia (low PaO_2)	32	45.7
Hypercapnia (raised $PaCO_2$)	18	25.7
Hypocapnia (low $PaCO_2$)	12	17.1
Normal oxygenation & ventilation	8	11.5
Total	**70**	**100**

Clinical Relevance of ABG Findings: Arterial blood gas analysis provided critical information that influenced clinical decision-making in the majority of patients. Identification of acid–base imbalances facilitated timely initiation of corrective measures, such as fluid resuscitation, insulin therapy, electrolyte correction, and ventilatory support. Serial ABG measurements were used in several cases to monitor response to treatment and guide further management.

Patients with severe acid–base derangements or profound hypoxemia often required aggressive intervention and close monitoring. The presence of mixed acid–base disorders underscored the complexity of physiological disturbances in critical illness and highlighted the importance of ABG interpretation in conjunction with clinical findings. Overall, the results demonstrate that arterial blood gas analysis is a valuable diagnostic and monitoring tool in critical care settings. The patterns of abnormalities observed reflect the diverse and severe physiological derangements present in critically ill patients and underscore the clinical significance of ABG analysis in guiding patient management.

Discussion

The present study highlights the clinical relevance of arterial blood gas (ABG) analysis as a diagnostic and monitoring tool in critically ill patients. The findings demonstrate that a substantial proportion of patients admitted to critical care units exhibit significant abnormalities in acid–base balance, oxygenation, and ventilation. These abnormalities reflect the complex physiological derangements commonly encountered in critical illness and underscore the indispensable role of ABG analysis in guiding timely clinical decision-making.

Patterns of Acid–Base Disorders in Critical Illness: In this study, acid–base disturbances were identified in the majority of patients, with metabolic acidosis emerging as the most frequent abnormality. This observation is consistent with the physiological consequences of common critical care conditions such as sepsis, renal failure, shock, and diabetic emergencies. Metabolic acidosis in critically ill patients is often multifactorial, resulting from lactic acid accumulation, impaired renal acid excretion, and increased endogenous acid production. The high frequency of metabolic acidosis observed reinforces its role as a key biochemical marker of disease severity in critical care settings [15].

Respiratory acidosis was another commonly observed abnormality, particularly among patients with respiratory failure and ventilatory impairment. Elevated $PaCO_2$ levels reflect hypoventilation due to airway obstruction, neuromuscular weakness, central nervous system depression, or advanced pulmonary pathology. In contrast, respiratory alkalosis was seen in a smaller proportion of patients, often associated with sepsis, pain, anxiety, or early hypoxic states leading to hyperventilation. These findings are in line with earlier studies that have reported a predominance of respiratory acid–base disorders in patients with acute respiratory compromise [16].

A notable proportion of patients in the present study demonstrated mixed acid–base disorders, indicating the coexistence of metabolic and respiratory abnormalities. Mixed disorders are particularly common in critically ill patients due to the simultaneous involvement of multiple organ systems. For example, a patient with sepsis may develop metabolic acidosis due to lactic acid accumulation along with respiratory alkalosis due to hyperventilation. Recognition of such mixed disturbances is clinically important, as misinterpretation may lead to inappropriate management. ABG analysis remains the most reliable method for identifying these complex patterns [17]. The relatively small proportion of patients with normal ABG findings reflects the severity of illness in the study population and emphasizes that biochemical abnormalities are common in critical care. This finding supports the routine use of ABG analysis in critically ill patients, even when overt clinical signs may not fully reflect underlying physiological disturbances.

Oxygenation and Ventilatory Abnormalities: Assessment of oxygenation and ventilation parameters revealed that hypoxemia was a frequent finding among the study participants. Reduced PaO_2 levels were commonly observed in patients with respiratory failure, sepsis, and shock, highlighting impaired gas exchange and compromised pulmonary function. Hypoxemia in critical illness may result from ventilation–perfusion mismatch, alveolar collapse, diffusion impairment, or reduced oxygen delivery due to circulatory failure. Early detection of hypoxemia through ABG analysis

allows prompt escalation of respiratory support and may prevent progression to respiratory failure [18].

Ventilatory abnormalities, reflected by altered $PaCO_2$ levels, were also prominent in this study. Hypercapnia was frequently associated with respiratory acidosis and was predominantly observed in patients with hypoventilation. Such findings have important clinical implications, as rising $PaCO_2$ levels may indicate impending respiratory failure and the need for ventilatory support. Conversely, hypocapnia, often associated with respiratory alkalosis, may reflect compensatory hyperventilation in response to metabolic acidosis or systemic inflammatory states. The combined assessment of PaO_2 and $PaCO_2$ provided valuable insights into the respiratory status of patients and facilitated differentiation between hypoxic and hypercapnic respiratory failure. This distinction is crucial for tailoring oxygen therapy and mechanical ventilation strategies. The results of the present study support existing evidence that ABG analysis remains superior to non-invasive monitoring methods in providing comprehensive information on both oxygenation and ventilation [12].

Clinical Implications and Significance of ABG Analysis: The findings of this study emphasize the pivotal role of ABG analysis in the clinical management of critically ill patients. Identification of acid–base imbalances and respiratory abnormalities enabled clinicians to initiate timely and targeted interventions, including fluid resuscitation, correction of metabolic disturbances, adjustment of ventilatory settings, and initiation of mechanical ventilation when required. In several cases, ABG abnormalities served as early indicators of clinical deterioration, preceding overt signs and symptoms.

The high prevalence of metabolic acidosis and hypoxemia observed in this study highlights the burden of severe physiological derangements in critical care populations. These abnormalities are known to be associated with increased morbidity and mortality, making their early recognition and correction essential. ABG analysis not only aids in diagnosis but also serves as a monitoring tool to assess response to therapy and guide ongoing management [13]. From a laboratory perspective, the study reinforces the importance of standardized sample collection, prompt analysis, and accurate interpretation of ABG results. Errors in sampling or delays in processing can significantly affect results and lead to misinterpretation. The central role of the biochemistry laboratory in providing reliable ABG data underscores the need for close collaboration between laboratory personnel and clinicians in critical care settings.

In resource-limited healthcare environments, such as many tertiary care hospitals in developing regions, ABG analysis offers a cost-effective and informative investigation that directly influences patient outcomes. Despite advances in bedside monitoring technologies, ABG analysis remains indispensable due to its ability to simultaneously assess multiple physiological parameters. The present study supports the continued integration of ABG analysis into routine critical care protocols and highlights its relevance in guiding evidence-based clinical practice [19].

Limitations and Future Directions: While the study provides valuable insights into the clinical significance of ABG analysis, certain limitations must be acknowledged. The relatively small sample size and single-center design may limit generalizability of the findings. Additionally, the study focused on descriptive analysis and did not evaluate associations between ABG abnormalities and clinical outcomes such as mortality or length of ICU stay. Future studies with larger sample sizes and multicenter designs are needed to further explore the prognostic value of specific ABG patterns in critical illness. Incorporation of outcome measures and serial ABG monitoring could provide deeper insight into the dynamic relationship between biochemical abnormalities and patient prognosis. Nevertheless, the present findings clearly demonstrate the central role of ABG analysis in critical care and reinforce its clinical significance in the management of critically ill patients.

Conclusion

The present study highlights the significant clinical value of arterial blood gas analysis in the assessment and management of critically ill patients. A high proportion of patients admitted to critical care units demonstrated abnormalities in acid–base balance, oxygenation, and ventilation, reflecting the complex and dynamic physiological disturbances characteristic of critical illness. Metabolic acidosis emerged as the most common acid–base disorder, followed by respiratory abnormalities, underscoring the impact of systemic conditions such as sepsis, renal dysfunction, and respiratory failure on metabolic and respiratory homeostasis. The frequent occurrence of hypoxemia and ventilatory derangements further emphasizes the importance of timely and accurate assessment of respiratory function in critically ill patients. Arterial blood gas analysis provided essential information that aided in early diagnosis, guided therapeutic interventions, and supported monitoring of treatment response. The identification of mixed acid–base disorders in a substantial number of patients highlights the limitations of clinical assessment alone and reinforces the necessity of biochemical evaluation for accurate interpretation of complex physiological states. From a critical care perspective, ABG analysis remains an indispensable investigative tool, offering comprehensive insights that cannot be fully

replaced by non-invasive monitoring methods. The findings also underscore the important role of the central biochemistry laboratory in ensuring reliable and timely ABG results to support clinical decision-making. Although the study was limited by its single-center design and modest sample size, it provides valuable evidence on the relevance of ABG analysis in routine critical care practice. Incorporation of arterial blood gas evaluation into standardized critical care protocols can enhance diagnostic accuracy, optimize patient management, and potentially improve clinical outcomes. Future studies with larger cohorts and outcome-based analyses are warranted to further define the prognostic significance of specific ABG patterns and to strengthen the evidence base for their role in critical care settings.

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