Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
January-June 2024 5(1), 2024–2030

A COMPARATIVE STUDY OF ARTERIAL BLOOD GAS AND VENOUS BLOOD SAMPLES AMONG PATIENTS PRESENTING WITH HIGH-ACUITY TRIAGE SCORES IN THE EMERGENCY DEPARTMENT OF A SELECTED HOSPITAL, BIKANER

Nikhil Taneja [1], Dr. Jyoti Arora [2], Chirag Ajmera [1]

[1] Ph.D. Nursing Scholar, Tantia University, Sri Ganganagar, India
[2] Professor, Tantia University, Sri Ganganagar, India

DOI
10.29121/shodhkosh.v5.i1.2024.4904

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Introduction: Arterial blood gas (ABG) analysis is the gold standard for assessing acid-base status and respiratory function in critically ill patients, though it carries risks of vascular injury and infection from repeated sampling. Venous blood gas (VBG) analysis, requiring fewer punctures, is safer for patients and providers, and often practical when central catheters are present. Peripheral VBG sampling may offer a suitable alternative, providing similar parameters including electrolytes, lactate, and hemoglobin. **Methodology:** A quantitative, comparative cross-sectional study design will assess the concordance between arterial and venous blood gas values among patients presenting with ATS 1 and ATS 2 triage scores in the Emergency Ward at Jeevan Raksha Hospital, Bikaner. Consecutive sampling will recruit. Patients refusing consent or presenting with venous blood gas samples will be excluded. Blood samples will be simultaneously collected and analyzed. Data analysis will utilize SPSS version 11.5, employing paired Student's t-tests for correlation. The study duration will be one year following ethical clearance. **Result:** The study enrolled 300 patients (Female: 57.3%; Male: 42.7%). The most common diagnoses included COPD exacerbation (22%), CKD with pulmonary edema (13.3%), sepsis (9.3%), pneumonia (8.3%), and poisoning (8%). Blood glucose levels from ABG analyzers were significantly higher than auto-analyzers (mean difference: 11.91 mg/dl, p=0.000). Sodium (mean difference: 4.82 mmol/L, p=0.000) and potassium (mean difference: 0.60 mmol/L, p=0.000) results also showed significant differences, indicating non-interchangeability without correction factors. Hemoglobin levels were clinically comparable (mean difference: 0.12 g/dl, p=0.031), thus interchangeable for clinical practice. **Conclusion:** Na^+ and K^+ values obtained via ABG and auto-analyzer differ significantly and aren't interchangeable clinically per USCLIA guidelines, highlighting the need for institution-specific correction factors to prevent misdiagnosis. However, Hemoglobin and Random Blood Sugar values showed acceptable agreement. Correction factors identified were Na^+ (4.82 mmol/L), K^+ (0.60 mmol/L), Hemoglobin (0.12 g/dl), and Random glucose (11.91 mg/L).

Keywords: Arterial Blood Gas, Venous Blood Sample, High-Acuity, Triage Score, Emergency Department, Comparative Study

1. INTRODUCTION

In emergency departments and intensive care, the routinely performed procedure is arterial blood gas analysis (ABG). ABG is the gold standard procedure to know about the acid-base balance, oxygenation and ventilation-perfusion in patients in critical care treatment. Arterial blood gas analysis requires a sample of arterial blood, which is obtained

mostly from radial or femoral arteries. The sampling requires deep puncture into one of the arteries, which can be painful to the patient. It may also lead to various complications like bleeding, hematoma formation, infection, embolism and formation of arterial aneurysm or in very severe cases compartment syndrome. The alternative to ABG is venous blood gas analysis (VBG). In intensive care and patients presenting to the emergency department, venous sampling is more convenient and easy to perform. Few venepunctures are required, thereby reducing the risk of needle stick injury to the health care professionals. Acid-base balance measured through blood gas analysis plays a critical role in the planning of the course of treatment. 1

Emergency department (ED) acuity is the general level of patient illness, urgency for clinical intervention, and intensity of resource use in an ED environment. The relative strength of commonly used measures of ED acuity is not well understood. 2 Triage is a vital component in the process of assessing and prioritizing patients and defined as "the process of sorting people in need of medical attention in order to determine priority."3

Triage is a decision-making process to identify emergency patients requiring immediate treatment. Moreover, it serves as a tool to mitigate ED overcrowding by effectively categorizing patients within the confined spatial and resource constraints of the ED. Various triage systems are used around the world, including the Emergency Severity Index in the United States, the Manchester Triage Scale in the United Kingdom, the Canadian Triage and Acuity Scale (CTAS), and the Australian Triage Scale.

2. NEED FOR STUDY

In emergency care, rapid physiological assessment is vital for informed decision-making and better outcomes. While arterial blood gas (ABG) is standard, venous blood gas (VBG) offers a less invasive alternative. This study assesses VBG's clinical utility in predicting early interventions and influencing triage. Identifying its role in patient management can optimize emergency protocols, minimize arterial sampling risks, and improve patient-centered care. Establishing VBG reliability ensures efficient, evidence-based decisions for high-acuity cases in critical care settings.4

Accurate blood gas assessment is crucial for managing acute COPD exacerbations in emergency settings. While ABG is the gold standard, VBG is less invasive and more accessible. This study evaluates the correlation between ABG and VBG, particularly in detecting hypercarbia and assessing pH levels. Validating VBG as a reliable alternative can enhance patient comfort, reduce arterial sampling risks, and improve emergency department efficiency. Implementing VBG in COPD management may optimize workflows and support timely, effective clinical decision-making.5

Blood gas measurement is crucial for diagnosing, managing, and monitoring critically ill patients. This study evaluates the correlation and agreement between arterial blood gas (ABG) and peripheral venous blood gas (PVBG) measurements, specifically for pH, pCO_2, HCO_3, and pO_2. Understanding this relationship helps determine whether VBG can serve as a reliable surrogate for ABG in the initial management of critically ill patients. 6

Accurate and timely assessment of critical biochemical parameters is essential for managing high-acuity patients in emergency settings. Arterial blood gas (ABG) analysis is widely used for rapid evaluation; however, venous blood sampling is less invasive and more convenient. The reliability of venous samples as an alternative to ABG remains debated, particularly for parameters such as pH, bicarbonate, and electrolytes. This study is necessary to determine the concordance between ABG and venous blood analysis in high-acuity cases, ensuring evidence-based decision-making. Establishing clinical interchangeability can reduce unnecessary arterial punctures, improve patient comfort, and optimize emergency department workflows.

Aim of Study: The aim of this study is to compare arterial and venous blood gas results among patients presenting with high-acuity triage scores. The study seeks to assess concordance between the two sampling methods. It aims to determine whether venous samples could reliably replace arterial samples in emergency clinical practice.

3. METHODOLOGY

3.1. OBJECTIVES

The main objective of study:

1) To measure parameters of the Arterial blood gas and venous blood sample

2) To compare the blood glucose, sodium, potassium, Hemoglobin of Arterial blood gas and venous blood sample in high acuity triage score Patient.

Research Approach: A quantitative, comparative cross-sectional approach will be adopted to assess concordance between arterial and venous blood gas parameters among high-acuity patients.

Research Design: A comparative cross-sectional research design was utilized for this study.

Research Setting: The study will be conducted at the Emergency Department of Jeevan Raksha Hospital, Bikaner.

Population: Population refers to a total category of persons or objects that meets the criteria for the study established by the researcher, any set of persons, objects or measurements having an observable characteristic in common. 7 The study population consists of patients presenting at the Emergency Department with Australian Triage Scale (ATS) scores of 1 and 2.

4. PARTICIPANT SELECTION CRITERIA

Inclusion criteria:

1) Patients presenting with ATS scores 1 and 2.
2) Patients older than 16 years.

Exclusion criteria:

1) Patients refusing consent.
2) Patients presenting exclusively for venous blood gas analysis.

Sample Size and Sampling Technique: The sample size calculated for this study is 52 participants, based on previous studies and statistical calculations. However, we considered a larger sample size of 300 participants to involve as many patients as possible who underwent arterial and venous blood gas analysis. A consecutive sampling technique, a non-probability sampling method, will be used to select eligible patients until the desired sample size is achieved.

Data Collection Procedure: After obtaining ethical approval, verbal consent will be collected from patients or their relatives. Paired arterial and venous blood samples will be simultaneously collected before initiating treatment. Arterial blood will be drawn from the radial artery following a positive Allen's test, analyzed using the ABL800 Blood Gas Analyzer. Venous blood samples will be collected via intravenous cannulation, stored briefly, and analyzed using an auto-analyzer.

Parameters Studied: Parameters compared include sodium (Na^+), potassium (K^+), blood glucose, and hemoglobin.

Statistical Analysis: Data analysis will be performed using SPSS software (version 11.5). Paired Student's t-test will evaluate correlations and differences between ABG and venous samples. Statistical significance will be established at $p<0.05$.

Ethical Considerations: Ethical clearance will be obtained from the Institutional Review Board (IRB). Patients or their relatives will receive detailed information about the study and retain the right to refuse or withdraw at any stage. Participant confidentiality and privacy will be strictly maintained.

5. RESULT

Section I: Demographic Distribution of Patients

A total of 300 patients were enrolled, comprising 172 females (57.3%) and 128 males (42.7%). This indicates a higher proportion of females requiring blood gas and associated laboratory tests in the Emergency Department at Jeevan Raksha Hospital, Bikaner during the study period.

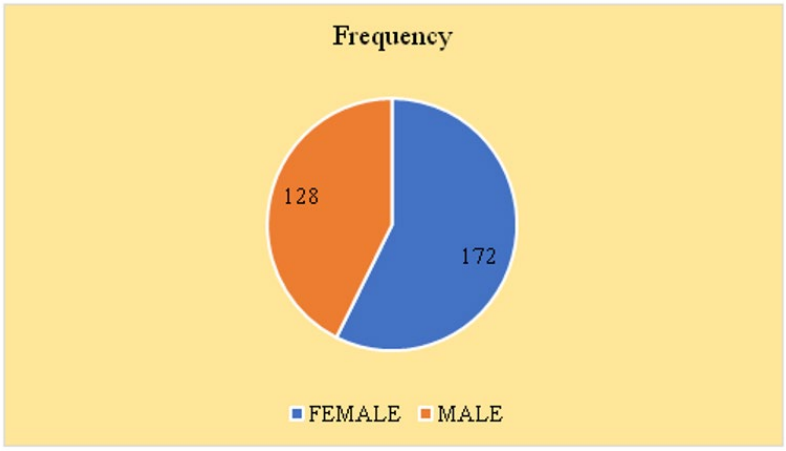

Fig 1: Shows Frequency of male and female

Section II: Disease Distribution Among Patients

Table 1: Common diseases of patients presenting in the Emergency of Jeevan Raksha Hospital, Bikaner for which Blood Gas Analysis was performed and serum electrolytes, Hemoglobin, Blood sugar were measured (n=300)

Diagnosis	**Frequency**
AE of COPD	66
CKD with Pulmonary edema	40
Sepsis	28
CAP	25
POISONING	24
CVA with Aspiration Pneumonia	12
SAIO with Shock	11
DKA	8
CLD with UGI bleed	8
Chronic Heart Failure	7
ACS	7
Hypovolemic shock	6
CCF with AF with FVR	6
Seizure disorder	5
Acute Pancreatitis	5
Hypertensive Urgency	4
Burn	3
AE of Bronchial Asthma	3

Among the 300 patients, the most frequent diagnosis was Acute Exacerbation of COPD (n=66, 22%), followed by CKD with pulmonary edema (n=40, 13.3%), sepsis (n=28, 9.3%), CAP (n=25, 8.3%), and poisoning (n=24, 8%). Other notable diagnoses included CVA with aspiration pneumonia, DKA, and ACS, demonstrating the varied critical conditions managed at Jeevan Raksha Hospital, Bikaner. Additionally, 30 cases represented unique diagnoses, emphasizing the wide range of acute presentations requiring urgent assessment.

Section III: Comparison of Laboratory Parameters

Table 2: Comparison of Mean Values of Biochemical Parameters Measured by Gas Analyzer and Auto-Analyzer (n=300)

Parameter	Mean (Gas Analyzer)	SD (Gas Analyzer)	Mean (Auto-analyzer)	SD (Auto-analyzer)	Mean Difference	P value
Glucose (mg/dl)	152.77	84.596	140.86	81.032	11.91	0
Sodium (mmol/L)	131.08	7.234	135.9	7.431	4.82	0
Potassium (mmol/L)	4	0.994	4.6	1.044	0.6	0
Hemoglobin (g/dl)	11.29	3.515	11.41	3.402	0.12	0.031

- **Blood Glucose:** Mean glucose level measured by the blood gas analyzer (152.77 mg/dl ± 84.596) was significantly higher than the auto-analyzer (140.86 mg/dl ± 81.032), with a mean difference of 11.91 mg/dl (p=0.000). This suggests careful consideration is required when interpreting these values interchangeably.
- **Sodium:** Mean sodium level by the blood gas analyzer (131.08 mmol/L ± 7.234) was significantly lower compared to the auto-analyzer (135.90 mmol/L ± 7.431), with a mean difference of 4.82 mmol/L (p=0.000). A correction factor should thus be applied clinically when using these measurements interchangeably.
- **Potassium:** Mean potassium measured by the blood gas analyzer (4.0 mmol/L ± 0.994) was significantly lower compared to the auto-analyzer (4.6 mmol/L ± 1.044), showing a mean difference of 0.60 mmol/L (p=0.000). Results from these methods require correction factors to avoid diagnostic errors.
- **Hemoglobin:** Mean hemoglobin by blood gas analyzer (11.29 g/dl ± 3.515) was slightly lower than the auto-analyzer (11.41 g/dl ± 3.402). Despite statistical significance (mean difference: 0.12 g/dl, p=0.031), the difference is clinically minimal, allowing interchangeability without major clinical implications.

Clinical Implications

Results indicate that glucose, sodium, and potassium levels obtained from ABG and auto-analyzers differ significantly, necessitating the use of correction factors. Hemoglobin measurements, however, demonstrated acceptable clinical interchangeability.

6. DISCUSSION

A total of 300 patients were enrolled in our study, with 172 females (57.3%) and 128 males (42.7%). This indicates a higher proportion of females undergoing blood gas and associated laboratory tests in the Emergency Department at Jeevan Raksha Hospital, Bikaner during the study period. According to Erturk ZK et al., among 350 patients, 173 (49.4%) were female and 177 (50.6%) were male. The average patient age was 58 years, ranging from 18 to 96 years. The average age of male patients was 60 years, while that of female patients was 56 years.8

This study assessed the concordance between arterial blood gas (ABG) and auto-analyzer (AA) measurements for glucose, sodium, potassium, and hemoglobin in emergency patients. Results showed significantly higher glucose levels in ABG (152.77 mg/dl) than AA (140.86 mg/dl) with a mean difference of 11.91 mg/dl (p=0.000). Sodium (131.08 vs. 135.90 mmol/L) and potassium (4.0 vs. 4.6 mmol/L) levels were significantly lower in ABG (p=0.000). Hemoglobin levels showed minimal difference (11.29 vs. 11.41 g/dl, p=0.031), indicating strong agreement. While hemoglobin values are interchangeable, correction factors are needed for glucose, sodium, and potassium measurements in clinical practice. A similar study conducted by Zhang JB et al. evaluated the accuracy of arterial blood gas (ABG) analyzers compared to laboratory measurements based on the US Clinical Laboratory Improvement Amendment (USCLIA) criteria. The findings revealed that hemoglobin levels measured by ABG closely matched laboratory results, with a mean bias within 4% and

a strong correlation coefficient of 0.94, indicating excellent clinical agreement. In contrast, potassium measurements from ABG analyzers were consistently lower by an average of 0.43 mmol/L compared to laboratory results. Although this bias was within the acceptable USCLIA threshold of ±0.5 mmol/L, the wide 95% limits of agreement (−0.29 to 1.16 mmol/L) suggest careful interpretation and potential clinical significance.9

The present study examined discrepancies between arterial blood gas (ABG) and auto-analyzer (AA) measurements for sodium, potassium, glucose, and hemoglobin in emergency patients. Significant differences beyond USCLIA limits were found for sodium (4.82 mmol/L) and potassium (0.60 mmol/L), requiring correction before interchangeability. Key factors included transport time, electrode methods, calibration differences, and heparin type. Despite minimizing errors through immediate transport, analyzer variability persisted. Hemoglobin showed minimal differences, allowing interchangeability. The study emphasizes hospital-specific concordance assessments and regular calibration with external standards (e.g., NIST SRM 956) to ensure clinical reliability. A similar study conducted by Anunaya Jain et al. evaluated discrepancies in sodium and potassium measurements obtained via arterial blood gas (ABG) analyzers and laboratory auto-analyzers (AA). Results showed a significant difference in sodium levels among patients with normal values (mean difference: 3.4 mmol/L, p=0.005), although this difference remained within acceptable clinical limits defined by US CLIA guidelines. Potassium measurements demonstrated no statistically significant difference between ABG and AA (mean difference: 0.46 mmol/L, p=0.2679). Despite statistical comparability, ABG consistently reported lower potassium values (71.5%), suggesting caution when interpreting these measurements clinically. The study emphasizes careful interpretation of electrolyte data obtained from different methods.10

7. CONCLUSION

Na^+ and K^+ test results obtained from arterial blood gas (ABG) analyzers and auto-analyzers (AA) differ significantly, making them unsuitable for interchangeable clinical use, as they fall outside acceptable criteria defined by the US Clinical Laboratory Improvement Amendment (USCLIA). Physicians must recognize these differences to prevent potential misdiagnoses, unnecessary treatments, or inappropriate investigations. Therefore, hospitals should individually assess and establish concordance between electrolyte values measured by blood gas analyzers and central laboratory analyzers, due to variations in instrumentation, calibration, and methodologies used at different institutions. Each healthcare facility must perform its own comparative analysis and derive specific correction factors to account for these discrepancies, ensuring clinical accuracy and patient safety. Conversely, hemoglobin and random blood sugar levels obtained from ABG and AA demonstrate acceptable concordance, meeting clinical interchangeability standards. Thus, results from both methods for these parameters can be reliably used interchangeably in clinical settings without significant risk of error.

In this study, specific correction factors calculated to address differences between ABG and AA measurements included sodium (4.82 mmol/L), potassium (0.60 mmol/L), hemoglobin (0.12 g/dL), and random glucose (11.91 mg/L). Utilizing these factors will enhance clinical decision-making, promoting accuracy and consistency in patient management.

CONFLICT OF INTERESTS

The authors certify that they have no involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this paper.

ACKNOWLEDGMENTS

None.

REFERENCES

Thangaraj RK, Chidambaram HHS, Dominic M, Chandrasekaran VP, Padmanabhan KN, Chanjal KS. A comparison of arterial and venous blood gas analysis and its interpretation in emergency department: A cross-sectional study.

Eurasian J Emerg Med [Internet]. 2021;20(3):178–82. Available from: https://pdfs.semanticscholar.org/2b8d/5f97901ffd0c07aa67d98915e98c7f697c7f.pdf

Yiadom MYA, Baugh CW, Barrett TW, Liu X, Storrow AB, Vogus TJ, et al. Measuring Emergency Department Acuity. Academic emergency medicine : official journal of the Society for Academic Emergency Medicine [Internet]. 2018 [cited 2025 Mar 12];25(1):65. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5764775/

Peta D, Day A, Lugari WS, Gorman V, Ahayalimudin N, Pajo VMT. Triage: A global perspective. J Emerg Nurs [Internet]. 2023;49(6):814–25. Available from: https://www.sciencedirect.com/science/article/pii/S0099176723002143

Alwosibei A, Alqurashi H, Alghazwi M. Role of venous blood gase (VBG) analysis in patient triage in the adult emergency department. The Journal of Medicine, Law & Public Health [Internet]. 2023;3(3):275–9. Available from: https://www.researchgate.net/publication/375064953_Role_of_Venous_Blood_Gase_VBG_Analysis_in_Patient_Triage_in_the_Adult_Emergency_Department

McCanny P, Bennett K, Staunton P, McMahon G. Venous vs arterial blood gases in the assessment of patients presenting with an exacerbation of chronic obstructive pulmonary disease. Am J Emerg Med [Internet]. 2012;30(6):896–900. Available from: https://pubmed.ncbi.nlm.nih.gov/21908141/

Prasad A, ShwetaSahai, Linu MA, Arun V, Yadav A. A Comparative Study of Arterial and Venous Blood Gas Analysis in Critically Ill Patients. IJOCM [Internet]. 2019 [cited 2025 Mar 12];7(1):53–9. Available from: https://ijop.net/index.php/ijocm/article/view/1026

Atkinson, J., Anker, S., Nardini, M., Braddick, O., Hughes, C., Rae, S., & Wattam-Bell, J. (2002). Infant vision screening predicts failures on motor and cognitive tests up to school age. Strabismus, 10(3), 187–198. doi:10.1076/stra.10.3.187.13885

Erturk ZK, Evrin T, Ekici B, Ertürk B, Uzunget SC, Çandar T. Are blood gas analyzers reliable in electrolytes and other parameters? Disaster Emerg Med J [Internet]. 2024;9(2):73–9. Available from: https://journals.viamedica.pl/disaster_and_emergency_medicine/article/view/97695

Zhang JB, Lin J, Zhao XD. Analysis of bias in measurements of potassium, sodium and hemoglobin by an emergency department-based blood gas analyzer relative to hospital laboratory autoanalyzer results. PLoS One [Internet]. 2015;10(4):e0122383. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4388527/

Jain A, Subhan I, Joshi M. Comparison of the point-of-care blood gas analyzer versus the laboratory auto-analyzer for the measurement of electrolytes. Int J Emerg Med [Internet]. 2009;2(2):117–20. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC2700230/