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Original Article

Correlation Between Arterial Blood Gas Analysis and Venous Blood Gas Analysis Among Patients Reporting to Emergency Department of a Tertiary Care Hospital

Dr. K. Sushma Lakshmi[1], Dr. Kingsly Robert Gnanadurai[2] and Dr. Carolin Elizabeth George[3]

[1]Assistant Professor, Department of Emergency Medicine, BGS GIMS, Bangalore
[2]MD, MBA (H.A.), PGDMLE, Internal Medicine Physician, Flinders Medical Centre, Australia; ORCID ID: 0000-0003-1271-6041
[3]MD, Head of Community Health Department, Bangalore Baptist Hospital, Bangalore

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Corresponding Author:

Dr. K. Sushma Lakshmi
Assistant Professor, Department of Emergency Medicine, BGS GIMS

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ABSTRACT

Introduction: Arterial blood gas analysis is the gold standard procedure performed in the emergency room that guides the clinicians in establishing diagnosis and treatment plan and ultimately mortality and morbidity. However, venous sampling has lesser complications and is easier to collect.
Objective: To determine the correlation between the variables (pH, bicarbonate, pCO2, pO2) of arterial and venous blood gas analysis and to ascertain whether arterial blood gas analysis can be replaced by venous blood gas analysis in acutely ill patients.
Materials and Methods: This is an observational study of variables of blood gas analysis of acutely ill patients presented to emergency department of a tertiary care centre. From eligible patients, arterial and venous samples were collected, analysed and the results were correlated using Bland Altman statistical method and plotted.
Results: The study revealed a good statistical correlation of pH and bicarbonate with reference to the physician's acceptable range. There was good clinical correlation between arterial and venous blood gas analysis in determining the condition and management of the patients.
Conclusion: Venous sampling can be used as an alternative to arterial sampling in acutely ill patients presenting to emergency department as there is good clinical correlation.

Keywords: *Arterial blood gas analysis, Venous blood gas analysis, Pearson's correlation, Bland Altman statistical method.*

INTRODUCTION

Blood gas analysis is the most frequently performed procedure in Emergency Department and it is routinely performed on arterial sample. This test helps in determining acid base status and adequacy of ventilation which further establishes the diagnosis in acutely ill patients.[1] Certain complications are associated with Arterial Blood Gas (ABG) sampling mainly severe pain, requiring expertise, arterial injury, local hematoma, infection, thrombosis, hemorrhage, aneurysm formation, median nerve injury, reflux osteodystrophy and needle stick injury for health care professionals.[2]In contrary ,VBG is a painless procedure with less complications, less traumatic, less time consuming , much easier procedure as it is drawn from peripheral cannula even during ongoing resuscitation and most importantly values are more correlating.[3]

A systemic review and meta-analysis also looked into agreement between arterial and venous pH, bicarbonate PCO2 and lactates and revealed all values are within 2SD and interchangeable.[4] There are even multiple studies done in conditions like COPD, trauma, CKD and DKA in comparing the variables of arterial and venous sampling mainly pH, PCO2, PO2 and Bicarbonate. They reveal good correlation between the variables and thereby inferring VBG can be better alternative or substitute to ABG in the initial assessment and resuscitation in emergency department and critical care.[5] A study specifically on DKA by Bradenburg and Daniel, comparison of pH and bicarbonate between ABG and VBG, the values are within 2SD and interchangeable and strongly recommend VBG in DKA patients.[6] Despite these studies, VBG is not

widely practiced even in acute settings like emergency department as physicians are reluctant to accept the differences of variables between ABG and VBG even after knowing the fact that ABG will neither yield definitive diagnosis nor reflect actual abnormality.[7]

MATERIALS AND METHODS

This study was conducted in the Emergency Department of Bangalore Baptist Hospital, Bangalore, which is a tertiary care centre, from December 2017 to May 2018 on a sample of 100 patients with the approval of ethics committee.

Study Population & selection criteria: All patients who require arterial blood gas analysis in Emergency Department. Patients with age>18 years, and presenting with various illnesses like diabetic ketoacidosis, poisoning, acute exacerbations, Renal failure, sepsis requiring arterial sampling were included in the study. Patients who were intubated, and had time gap of more than 10 min between arterial blood gas analysis and venous blood gas analysis sample collection were excluded.

Methodology: All acutely ill patients meeting the inclusion criteria were selected and informed consent taken before collecting samples. From eligible patients, arterial and venous blood samples were collected in a pre-heparinized syringe. Venous sample was collected while placing the peripheral venous cannula and arterial sample was collected separately by Seldinger technique after performing Modified Allens test to check for colleterals.[7] Once the test was positive, arterial sample was collected and both samples were transited as soon as possible and analysed within 30 minutes of sample collection. Blood samples were analysed in a radiometer and results were compared for degree of agreement between the variables.[8]

Statistical analysis: Pearson's product moment correlation coefficient was calculated to assess the correlation between ABG and VBG.Means and 95% confidence intervals (CIs) were calculated for each arterial and venous variable (pH, pCO_2 and HCO_3) and for the differences between them and plotted on a graph. Bland Altman statistical method is used for correlating the variables of ABG and VBG.[9]

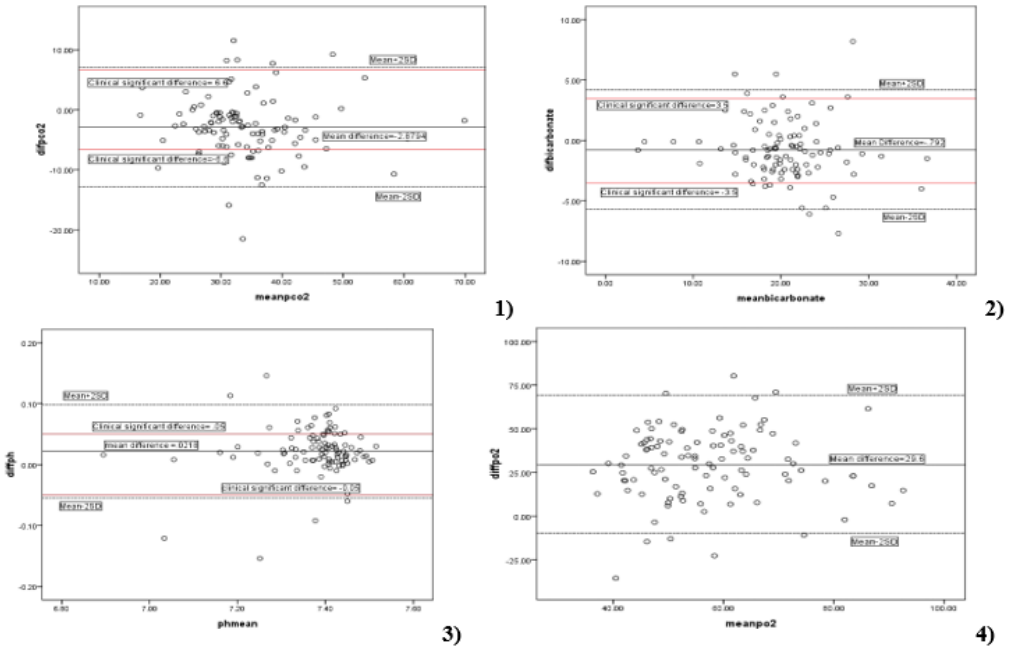
RESULTS

A total of 102 patients were enrolled in the study. Patients with cardiac arrest followed by ROSC prior to sampling and sodium bicarbonate injection before sampling were not included in the study. Below is the **Table 1** showing mean difference of variables of ABG and VBG arranged in ascending order.

Table 1: Correlation of variables of ABG and VBG (Data from original research; analysis using Bland Altman method[9])

VARIABLE	MEAN DIFFERENCE
pCO_2 (mmHg)	-2.87
Bicarbonate (mEq/L)	-0.79
pH (units)	0.02
pO2 (mmHg)	29.6

The difference between ABG and VBG values are plotted in graphical form with mean and 2 standard deviation. After that a clinical significance value (an agreeable difference between 2 values to say that they are equal which is acceptable by clinicians for pCO_2–6.6 mmHg; bicarbonate–3.5mEq/L; and pH–0.05 units) was plotted in the graph. Below are the Bland Altman graphs showing mean difference and 95% CI's with acceptable clinical mean difference of variables pCO_2, bicarbonate, pH and pO_2 (Graph 1,2,3,4 respectively).



Figures (1-4): Bland Altman Plots showing: – *1) mean difference and 95% CIs with acceptable clinical mean difference for* ***pCO₂****; 2) mean difference and 95% CIs with clinical mean difference for* ***bicarbonate****; 3) mean difference and 95% CIs with clinical mean difference for* ***pH****; 4) mean difference and 95% CI's for* ***pO₂***

(Data from original research; analysis using Bland Altman method[9])

When we plotted these graphs, we found that many values were lying outside the clinical significance line. Based on this insight, it was observed that ABG and VBG values were not exactly the same. After the Bland Altman analysis, we went through each patient's data and looked at clinical conditions, co-morbidities, blood pressure, pH and bicarbonate; and analyzed whether with the VBG value we would have made a difference in management. We found that only in 8 patients, we could have made a difference in management if we would have considered VBG values alone.

DISCUSSION

In the present study, a total of 102 patients were enrolled based on the inclusion and exclusion criteria. Primary objective was to check for the correlation of variables between ABG and VBG using Bland Altman technique. Statistical results (Mean Difference and 95% Confidence Interval) of pH and bicarbonate were 0.02 and 0.01 to 0.02; and -0.79 and -1.08 to -0.29 respectively which were correlating to the clinically acceptable range defined by Rang, et al.,[10] as 0.05 (0.04-0.06) units (pH), 3.5 (3.1-4) mEq/L (bicarbonate), 6.6 (5.6-7.6) mm Hg (pCO2). In the present study, statistical data for pCO_2 was Mean Difference of -2.87 and 95% CIs of -3.88to -1.87, like most of the studies pCO_2 can be used for trending purpose and to rule out hypercarbia and aid in further steps of management especially in COPDs[11]. PO2 did not show good correlation and we don't recommend its use for clinical decision making.

Various studies revealed good correlation between variables (pCO_2, bicarbonate, pH and pO2) of arterial and venous sampling in specific condition like COPD, sepsis, DKA, trauma. The present study considers correlation of variables in varied clinical conditions and physician's acceptable range of values for clinical decision making and management. Hereby, VBG can be considered in place of ABG in managing acutely ill patients in emergency department. The present study establishes the correlation between variables especially pH and bicarbonate of arterial and venous blood gas analysis and determines the clinical decision making and management of patients based on correlation.

Hence, we recommend considering VBG in place of ABG in terms of bicarbonate, and pH as there was no difference in clinical decision making and management of the patient in our setting. pCO_2 can be used for trending purpose and to rule out hypercarbia. It is ultimately the physician's decision to consider the differences of variables in clinical decision making and management in acute settings like Emergency Department.

Limitations:

1. Sample size was less to comment on correlation with varied clinical conditions. Even the subset analysis was also difficult to interpret with lesser sample size.
2. We could not get a statistical correlation of all the variables in spite of clinical correlation between the variables of arterial and venous blood gas analysis.

3. Capillary blood analysis was not included in the study.

CONCLUSION

From the present study, we conclude that VBG can be considered in place of ABG in acutely ill patients. It is ultimately the physician's decision to consider the differences of variables in clinical decision making and management in acute settings like Emergency Department.

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