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Original Research Article

A Comparative Evaluation of Venous Blood Gas between Arterial and Venous Blood Samples in Patients of Acute Breathlessness

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Abstract

Aim: The aim of the present study was to compare venous blood gas assessments for variables such as pH, pCO2, bicarbonate and base excess between arterial and venous blood samples.

Methods: This Prospective study was conducted at ANMMCH Gaya by Department of Emergency Medicine for the period of 2 years. 70 patients were included in the study.

Results: It was observed that the mean respiratory rate of the study conducted came out to be 32.2 breaths per minute. The mean SpO2 of the patients observed to be 88.4 at room air. The mean pH in arterial blood came out to be 7.43. The mean pH of venous sample observed to be 7.35 with p value of .028. The mean pCO2 values of arterial blood observed to be 33.07. The mean pCO2 value of the venous blood samples was observed to be 39.51. The mean arterial HCO3 level in the sample came out to be 17.63. The mean venous HCO3 value in the sample came out to be 20.07. The mean PO2 level of arterial blood came out to be 92.76. The mean PO2 level of venous blood came out to be 65.46.

Conclusion: The blood gas values for pH and HCO3 showed excellent agreement and correlation and can be considered clinically interchangeable with arterial values. On venous pCO2 we found differing results and therefore suggest the possible implementation of arterialization of venous blood gas which will make all these values even more accurate and will allow the use of venous pCO2 in the clinical setting.

Keywords: venous blood gas, pH, pCO2, bicarbonate

Introduction

Patients presenting to the emergency department (ED) with acute dyspnea require a rapid diagnostic work up to decide whether hospitalization or intensive care admission are needed and to guide further therapy. [1] Acute heart failure (AHF), exacerbation of chronic obstructive pulmonary disease (COPD), and pneumonia account for the majority of emergency consultations by patients with acute dyspnea. [2,3] As dyspnea is not a specific symptom, the rapid and accurate identification of the underlying causes remains a clinical challenge. Misdiagnosis causes morbidity and increases time to discharge and treatment cost. [4] In addition, treatment for one common disorder, e.g. AHF, might even be hazardous for patients with other conditions such as exacerbated COPD or pneumonia. [5]

At presentation to the ED, arterial blood gas analysis (ABGA) is often performed in dyspneic patients to assess acid-base disturbances, and to diagnose and quantify respiratory insufficiency. Accordingly, it has been recommended for the clinical work-up in several dyspnea-related diseases. [6-9] Several studies have investigated the value of ABGA in patients with suspected pulmonary embolism (PE) [10-12], but the usefulness of the different prediction rules proposed by these studies has been questioned. [13] In patients with community-acquired pneumonia (CAP), Levin et al. examined factors associated with the use of ABGA and also assessed whether measurement of ABGA in patients was associated with hospitalization, ICU treatment, or death. [14]

The aim of the present study was to compare venous blood gas assessments for variables such as pH,

pCO2, bicarbonate and base excess between arterial and venous blood samples.

Materials and Methods

This Prospective study was conducted at Department of Anaesthesia, Anugrah Narayan Magadh Medical College and Hospital, Gaya,Bihar, India by Department Of Emergency Medicine for the period of 2 years. 50 patients were included in the study.

Eligibility Criteria:

Inclusion Criteria – Age above 12 years of either sex Male/Female.

Exclusion Criteria – Age below 12 years of either sex Male/Female.

Blood sampling and laboratory methods

All patients underwent an initial clinical assessment that included history taking, a physical examination, non-invasive blood pressure measurement, 12-lead ECG, continuous ECG-monitoring, pulse oximetry, standard blood tests, and chest radiography. Venous blood samples were taken immediately after presentation to the ED after the initial assessment from the attending physician. If multiple samples were taken, only values from the first were included in the analysis. The decision to perform venous blood samples was made solely by the physician in charge, based on clinical grounds. If oxygen supply had been started prior to hospital entry, it was stopped for at least two minutes before collection of the sample. For venous blood samples, a 1 ml venous specimen of blood was collected from a radial artery into heparinized syringes and immediately analyzed using the Radiometer ABL™ 700 (Radiometer Medical ApS, Copenhagen, Denmark). The analysis included measurement of pH, the partial pressure of arterial carbon dioxide (PaCO2), and the partial pressure of arterial oxygen (PaO2) based on ion-selective electrodes with potentiometric measurement for pH and PaCO2, and amperometric measurement of PaO2. Standard bicarbonate (HCO3) was calculated from the observation parameters pH and PaCO2. The Radiometer ABL™ 700 has a high accuracy and repeatability (precision within run: pH 0.0020, for PaCO2 0.40 mmHg, and PaO2 0.9 mmHg; precision between run: pH 0.0084, PaCO2 0.66 mmHg, and PaO2 1.5 mmHg). Values of PaO2 above 10.8 kPa, PaCO2 4.7 to 6.1 kPa, pH 7.35 to 7.45, and HCO3 21 to 26 mmol/l were considered within normal ranges. To calculate the estimated glomerular filtration rate the abbreviated 4-variable Modification of Diet in Renal Disease study equation was used.

Statistical Analysis

Categorical variables are presented as numbers and percentage, continuous variables as mean ± standard deviation (SD) or median and 95% confidence interval (95% CI) or interquartile range (IQR). Comparisons were made using the Student's t-test, Mann-Whitney U test, Wilcoxon test, and Kruskal-Wallis test for numerical parameters and the chi-square test for categorical data where appropriate. Stepwise multiple logistic regression analysis was used to identify ABGA parameters that were independently correlated to a defined endpoint. HCO3 values were calculated from pH and PaCO2 and therefore not included in the regression model. (ROC) operating characteristics curves were calculated to determine the sensitivities, specificities, likelihood ratios, and predictive values for all independent ABGA parameters. Kaplan-Meier analysis was performed for survival and log-rank values to assess statistical significance. We used Cox proportional hazard models adjusted for age, sex, New York Heart Association (NYHA) class, history of coronary artery disease, COPD, any pulmonary disease or chronic kidney disease, smoking status, previous use of oral diuretics or inhaled beta agonists, systolic blood pressure, respiration rate, body mass index (BMI), more than one cause of dyspnea and pH at admission to compute hazard ratios (HR) and 95% CI of predictors of 12-month mortality. All hypothesis testing was two-tailed, and a P-value of 0.05 was considered statistically significant. Analyses were performed using SPSS (Release 19.0.0, SPSS Inc., Chicago, IL, USA) and MedCalc for Windows (Version 11.4.4, Mariakerke, Belgium).

Results

Table 1: Respiratory rate and SpO_2

	Mean	**SD**
Respiratory rate (BPM)	32.2	8.6
SpO_2	88.4	11.0

It was observed that the mean respiratory rate of the study conducted came out to be 32.2 breaths per minute. The mean SpO2 of the patients observed to be 88.4 at room air.

Table 2: Comparison of pH and PCo_2

pH			
Method	**Mean**	**SD**	**P Value**
ABG	7.43	0.19	0.028
VBG	7.35	0.19	
PCo_2			
ABG	33.07	17.3	0.080
VBG	39.51	18.5	

The mean pH in arterial blood came out to be 7.43. The mean pH of venous sample observed to be 7.35 with p value of .028. The mean pCO2 values of arterial blood observed to be 33.07. The mean pCO2 value of the venous blood samples was observed to be 39.51.

Table 3: Comparison of HCo_3 and Comparison of PO_2

pH			
Method	**Mean**	**SD**	**P Value**
ABG	17.63	6.4	0.12
VBG	20.07	5.4	
PCo_2			
ABG	92.76	8.0	0.0015
VBG	65.46	17.5	

The mean arterial HCO3 level in the sample came out to be 17.63. The mean venous HCO3 value in the sample came out to be 20.07. The mean PO2 level of arterial blood came out to be 92.76. The mean PO2 level of venous blood came out to be 65.46.

Discussion

Accordingly, current diagnostic strategies in the evaluation of suspected PE have focused on probability scores, d-dimer testing and radiological imaging techniques rather than ABGA parameters. [15] In patients with unexplained exacerbation of COPD, it has been suggested that one out of four patients may in fact have PE. [16,17] A drop of PaCO2 of 0.7 kPa compared with baseline, together with a history of thromboembolism and the presence of malignancy have been found to predict PE in those patients. [16] This study supported earlier findings [18], but contrasted to results of the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) study, that could not identify differences between patients with and without COPD. [19]

It was observed that the mean respiratory rate of the study conducted came out to be 32.2 breaths per minute. The mean SpO2 of the patients observed to be 88.4 at room air. The mean pH in arterial blood came out to be 7.43. The mean pH of venous sample observed to be 7.35 with p value of .028. The mean pCO2 values of arterial blood observed to be 33.07. The mean pCO2 value of the venous blood samples was observed to be 39.51. Although a fairly good agreement has been observed in several studies between venous and arterial blood gases parameters, particularly so for pH, a recent meta-analysis reported mean arterio-venous differences [95% confidence interval] of 0.03 [0.029,0.038] for pH and -3.88 [- 5.35,-2.42] mmHg for PCO2 (16), so that arterial and venous values are not interchangeable. Regarding pH for instance, biases (mean arterio-venous differences) of 0.03 and 0.04, with 95% limits of agreement of [-0.05;0.11] and [-0.05;0.12] have been described using Bland and Altman analyses in COPD [20] and undifferentiated critically ill patients respectively. [21]

The mean arterial HCO3 level in the sample came out to be 17.63. The mean venous HCO3 value in the sample came out to be 20.07. The mean PO2 level of arterial blood came out to be 92.76. The mean PO2 level of venous blood came out to be 65.46. Two studies compared arterial and venous CO2 values in patients presenting to ED with acute exacerbation of COPD. [22,23] Both studies reported potential cutoff PvCO2 values for detecting arterial hypercarbia (PvCO2 N45 and N46 mm Hg, respectively), indicating the level at which there were no false-negative results for arterial hypercarbia. This would reduce the requirement for arterial samples in this group by approximately one third. Further studies exploring the potential role of serial venous CO2 analysis, in combination with pH, to monitor trends in respiratory function in response to treatment would be important. Reliability in the assessment of trends in this patient group would avoid the need for placement of arterial lines in some cases.

Conclusion

The blood gas values for pH and HCO3 showed excellent agreement and correlation and can be considered clinically interchangeable with arterial

values. On venous pCO2 we found differing results and therefore suggest the possible implementation of arterialization of venous blood gas which will make all these values even more accurate and will allow the use of venous pCO2 in the clinical setting. The use of venous blood gas values has shown to be cost-effective and implementation of this procedure in the routine venous blood sampling will prove to be time and money saving, as it as well will reduce the risk factors for the patient and the health care worker. In presentations were pO2 values have to be determined precisely or in patients presenting with severe circulatory failure.

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