

Research Article

Relationship between Arterial and Venous Blood Gases in Patients Presenting with Chronic Obstructive Pulmonary Disease

Muhammad Nusrullah^{*1}, Muhammad Younus² and Yasir Nasir³

¹PG Trainee, Dept of Pulmonology, Institute of Chest Medicine, KEMU/ Mayo Hospital, Lahore; ²Assistant Professor, Dept of Pulmonology, Institute of Chest Medicine, KEMU/ Mayo Hospital, Lahore; ³Senior Registrar, Dept of Pulmonology, Institute of Chest Medicine, KEMU/ Mayo Hospital, Lahore.

Abstract | Arterial blood gas analysis is an important test for determining acid base balance of the body. Chronic obstructive pulmonary disease is characterized by chronic airflow limitation which is not fully reversible and it can lead to respiratory failure.

Objective: To determine the correlation between arterial and venous blood gases in patients presenting with chronic obstructive pulmonary disease.

Material and Methods: This cross sectional study was conducted at Department of Chest Medicine, Mayo Hospital, Lahore, Pakistan. After meeting the inclusion criteria, 100 patients were enrolled. Informed consent was taken and demographic information was obtained. Blood sample was obtained anaerobically from the radial artery and from a dorsal hand vein using 2 separate 5cc BD heparinized syringes with needle size 22G for each patient and pH, PCO₂, and HCO₃ were analyzed. All the collected data was entered and analyzed on SPSS version 21.

Results: The mean age of the patients was 52.68±10.51 years. Strong relationship was found between the VBGs and ABGs in pH, PCO₂ and HCO₃ i.e. r=0.913, 0.999 and 0.994 (p-value <0.0001), respectively.

Conclusion: A strong correlation was found among ABG's and VBGs in patients presenting with COPD.

Received | October 22, 2017; **Accepted** | January 10, 2018; **Published** | April 17, 2018

***Correspondence** | Dr. Muhammad Nusrullah, PG Trainee, Dept of Pulmonology, Institute of Chest Medicine, KEMU/ Mayo Hospital, Lahore; **Email:** mnusrullah195@gmail.com

Citation | Nusrullah, M., M. Younus and Y. Nasir. 2018. Relationship between arterial and venous blood gases in patients presenting with chronic obstructive pulmonary disease. *Annals of King Edward Medical University*, 24(1): 119-123.

DOI | <https://doi.org/10.21649/akemu.v24i1.2343>

Keywords | Chronic obstructive pulmonary disease, Arterial blood gases, Venous blood gases

Introduction

ABG's is a rapid and very reliable tool but sometime it is not acceptable by the patients because of the pain associated with this test. It can also cause injury to the vessel wall, hemorrhage, thrombosis, ischemia of the distal extremity, formation of aneurysm, infection and nerve injury.⁽¹⁾ As this test is needed several times, so an alternative to ABG's is VBG's samples obtained from a peripheral vein which is much easier, easily accessible and with less complication.

Multiple studies in the recent past have shown that pH, PCO₂, HCO₃ measured in the venous blood sample correlates well with arterial blood sample.^(2,3)

A study by Elborn et al in COPD patients have showed a significant correlation of CO₂ tension in arterial and venous blood samples.⁽⁴⁾ Another study by Rees et al conducted on patients of chronic lung disease showed that PH and PCO₂ have significant correlation in ABG's and VBG's sample.⁽⁵⁾

Especially arterial blood gases provide direct measurement of pH, PCO₂, PO₂, HCO₃ and these values are used to measure base excess, anion gap and Alveolar-arterial gradient indirectly. These variables provide us very important information regarding the metabolic and respiratory functions of the body and this information is useful for diagnosis, treatment and monitoring of the patient.⁽⁶⁾

Chronic obstructive pulmonary disease is the fourth leading cause of death worldwide. It is the major cause of morbidity and mortality.⁽⁷⁾ These patients have chronic inflammation leading to chronic airflow limitation which is not fully reversible and it is because of the mixture of small airway disease and parenchymal damage. These changes lead to respiratory failure and acidosis.⁽⁸⁾

Rationale of this study is to evaluate correlation between arterial and venous blood gases in patients presenting with COPD. Through literature, it has been noticed that there is a strong relationship between levels of ABGs and VBGS, thus ABGs can be replaced with VBGS. But there is no local evidence available, which enables us to implement the use of VBGS instead of ABGs, and ABGs is still in current practice. Therefore, we envisage to conduct this study and results will help us in implementing the screening of blood gases level through venous blood in COPD patients in routine tests. This will also help to get local evidence which can aid to update local guidelines.

Patients and Methods

This cross sectional study was conducted at Department of Chest Medicine, Mayo Hospital, Lahore and hundred cases were taken by non-probability, consecutive sampling and sample size was calculated by taking correlation coefficient of PaCO₂ $r=0.704^{(9)}$ of COPD patients with 5% type I error and 10% type II error. Patients of age 30-70 years of either gender presenting with COPD diagnosed at least 6 months ago were included and patients with MMRC grade 4, known to have bleeding diathesis on history and clinical examination and acute exacerbation of COPD within previous 6 weeks were excluded.

Chronic Obstructive Pulmonary Disease was defined as a disease state characterized by airflow limitation assessed on spirometer with FEV₁/FVC less than 70%. Patients diagnosed at least 6 months ago were

included in the study. ABGs was measured as level of pH, CO₂ and HCO₃ in arterial blood at time of presentation of patient and VBGS was measured as level of pH, CO₂ and HCO₃ in venous blood at time of presentation of patient.

One hundred patients fulfilling selection criteria were enrolled from outpatient department of Chest Medicine, Mayo Hospital, Lahore, Pakistan. Informed consent was obtained from the patient and their demographics including name, age, gender and duration of COPD was also obtained. Then blood sample was obtained anaerobically from the radial artery and from a dorsal hand vein by using 2 separate 5cc BD heparinized syringes with needle size 22G for each patient. All samples were sent to the laboratory of the hospital for assessment of pH, CO₂ and HCO₃ in ice within 15 minutes. Reports were assessed and pH, CO₂ and HCO₃ levels were noted for both arterial and venous blood. All the information was entered in pre-designed proforma.

Data was entered and analyzed through SPSS version 21. Age, duration of COPD and arterial and venous blood gases levels (pH, CO₂ and HCO₃) were calculated as mean and standard deviation. Pearson's correlation coefficient was calculated between ABG and VBG for pH, CO₂ and HCO₃. P-value of <0.05 was taken as significant.

Results

In present study total 100 cases fulfilling the inclusion criteria were taken. Mean age of the participants was 52.68 ± 10.51 years. In our study, 79(79%) were males and 21(21%) were females. The male to female ratio of the patients was 3.8:1. The mean duration of COPD was 7.31 ± 4.49 months with minimum and maximum duration of 7 and 15 months respectively.

In our study mean pH in ABG's was 7.39 ± 0.042 and in VBG's 7.36 ± 0.058 with p value <0.001. Mean PCO₂ in ABG's was 42.20 ± 5.36 and in VBG's it was 47.60 ± 6.38 with p value <0.001. Mean HCO₃ in ABG's was 24.06 ± 2.82 and in VBG's 25.30 ± 3.20 with p value <0.001 (Table 1).

In this study strong positive correlation was noted between the ABG & VBG pH of the patients i.e. $r=0.913$ with p value <0.0001 (Figure 1).

In this study positive correlation was noted between the ABG & VBG PaCO₂ of the patients i.e. $r=0.999$ with p value <0.0001 (Figure 2).

In our study positive correlation was noted between the ABG & VBG HCO₃ of the patients i.e. $r=0.994$ with p value <0.0001 (Figure 3).

Table 1: Mean values of ABG's and VBG's

	ABG's	VBG's	P value
PH	7.39±0.042	7.36±0.058	<0.001
PCO ₂	42.20±5.36	45.60±6.38	<0.001
HCO ₃	24.06±2.82	25.30±3.20	<0.001

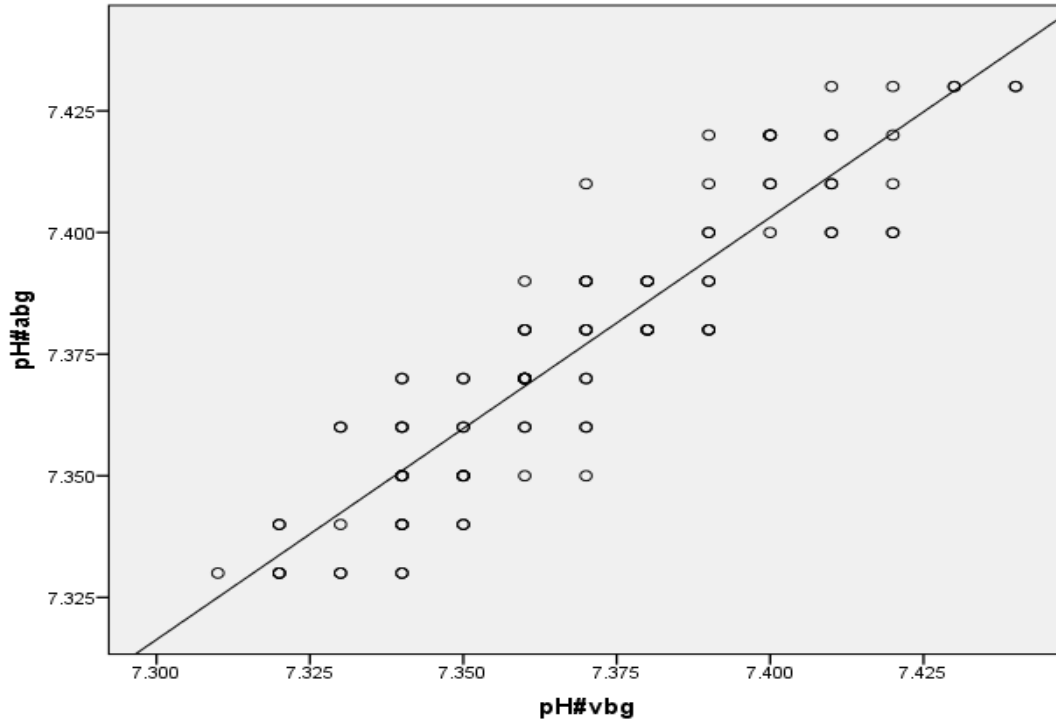


Figure 1: Correlation between the VBG & ABG pH
 $r=0.913$, p -value ≤ 0.0001 (Significant)

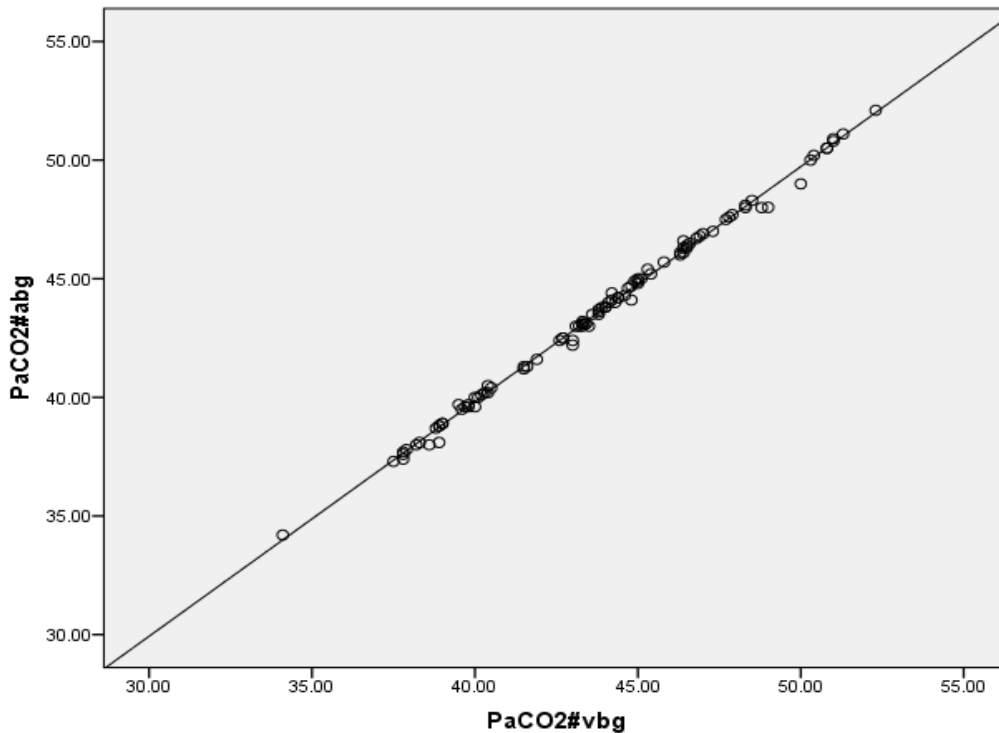


Figure 2: Correlation between the VBG & ABG PaCO₂
 $r=0.999$, p -value <0.0001 (Significant)

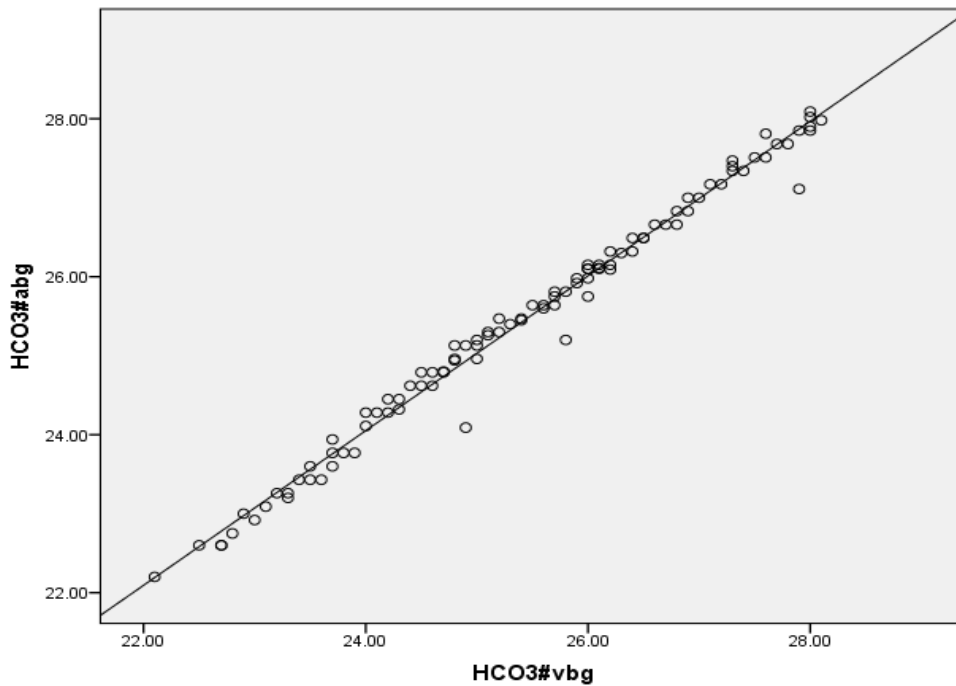


Figure 3: Correlation between the VBG & ABG HCO₃
 $r=0.994$, p -value<0.0001 (Significant)

Discussion

Blood gas analysis is routinely performed in emergency and critically ill patients to diagnose metabolic and respiratory abnormalities. COPD is a common disease and its prevalence is increasing. It is the major cause of morbidity and mortality worldwide. (10)

In our study there is a strong correlation was noted between the VBG's and ABG's in pH, PCO₂ and HCO₃ i.e. $r=0.913, 0.999, 0.994$ respectively (p value <0.0001). This study was conducted on stable COPD patients, to determine the correlation of pH, PCO₂ and HCO₃ between ABG's and VBG's in patients presenting with COPD.

A study conducted by McCanny P et al. (11) showed that arterial pH and HCO₃ have strong correlation with venous pH and HCO₃ (p value <0.001). They showed that venous CO₂ is 100% sensitive to detect the arterial hypercarbia while using the cutoff value of CO₂ of 45 mmHg. (11)

Another study by Elborn J⁽⁴⁾ showed a strong correlation between venous and arterial pH, HCO₃ (p value<0.001) in COPD patients and these values are comparable with our results. Another study by Novovic M et al⁽¹²⁾ done on patients of acute exacerbation of COPD showed a statistically significant correlation between arterial and venous pH, PCO₂ and H-

CO₃ (p value <0.001). These results are comparable with our study.

According to Razi E et al. (13), values of pH and PCO₂ have good correlation in ABG's and VBG's samples (p value <0.001). Study by Kim BR et al⁽⁹⁾ on 34 patients in intensive care unit HCO₃ in arterial and venous blood samples have statistically significant correlation (p value <0.0001).

A study by McKeever TM et al⁽¹⁴⁾ performed on the COPD exacerbation that pH, PCO₂, HCO₃ and PO₂ have significant correlation in ABG's and VBG's samples and VBG's can be used as replacement of ABG's. Another study by Kelly AM⁽¹⁵⁾ done on patients with acute respiratory disease used venous pH and PCO₂ for screening of significant hypercarbia and they showed that pH in venous blood can be substituted for arterial blood and venous PCO₂ can be used as a screening test for hypercarbia with cut off of 45 mmHg.

Study by Treger R et al⁽¹⁶⁾ conducted on intensive care patients showed significant correlation between arterial and venous blood samples in pH, PCO₂ and HCO₃ (p value <0.001). These results are comparable with our study.

According to the results of our study pH, PCO₂, HCO₃ in arterial and venous samples have strong and statistically significant correlation. So ABG's can

be replaced with VBG's to decrease the chances of complication of arterial puncture. We recommend more studies with larger sample size to confirm the finding of our study.

Conclusion

According to our study results a strong correlation was noted between ABG's and VBGs in patients presenting with COPD.

Author's Contribution

Both authors contributed equally in data collection, analysis and manuscript writing.

References

1. Barker. Arterial puncture and cannulation . In: Roberts JR, Hedges JR, eds. clinical procedures in emergency medicine, 3rdedn. Philadelphia: WB Saunders, 1998. p.308-332.
2. Toftegaard M, Rees SE, Andreassen S. Correlation between acid-base parameters measured in arterial and venous blood sampled peripherally, from vena cavae superior, and from the pulmonary artery. *Eur J Emerg Med.* 2008; 15(2):86-91 <https://doi.org/10.1097/MEJ.0b013e3282e6f5c5>.
3. Malatesha G, Singh NK, Bharija A, Rehani B, Geol A. Comparison of arterial and venous PH, bicarbonate, PCO₂ and PO₂ in initial emergency department assessment. *Emerg Med J.* 2007; 24(8):569-71. <https://doi.org/10.1136/emj.2007.046979>
4. Elborn J, Finch M, Stanford CF. Non-arterial assessment of blood gas status in patients with chronic pulmonary disease. *The Ulster medical journal.* 1991;60(2):164-7.
5. Rees SE, Hansen A, Toftegaard M, Pedersen J, Kristensen SR, Harving H. Converting venous acid-base and oxygen status to arterial in patients with lung disease. *Eur Respir J.* 2009; 33(5):1141-7. <https://doi.org/10.1183/09031936.00140408>
6. Malinoski DJ, Todd SR, Slone S, Mullins RJ, Schreiber MA. correlation of central venous and Arterial blood gas measurements in mechanically ventilated trauma patients. *Arch Surg.* 2005; 140(11):1122-5. <https://doi.org/10.1001/archsurg.140.11.1122>
7. Mathers CD, Loncar D. Projection of global mortality and burden of disease from 2002 to 2030. *PLoS Med.* 2006; 3:e442. <https://doi.org/10.1371/journal.pmed.0030442>
8. GOLD. The Global Initiative for Chronic Obstructive Lung Disease. 2016 [cited 2017]; Available from: <http://www.goldcopd.com/>.
9. Kim BR, Park SJ, Shin HS, Jung YS, Rim H. Correlation between peripheral venous and arterial blood gas measurements in patients admitted to the intensive care unit: A single-center study. *Kidney Research and Clinical Practice* . 2013; 32(1):32-8. <https://doi.org/10.1016/j.krcp.2013.01.002>
10. Ak A, Ogun CO, Bayir A, Kayis SA, Koylu R. Prediction of arterial blood gas values from venous blood gas values in patients with acute exacerbation of chronic obstructive pulmonary disease. *The Tohoku journal of experimental medicine.* 2006; 210(4):285-90. <https://doi.org/10.1620/tjem.210.285>
11. 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. *The American journal of emergency medicine.* 2012; 30(6):896-900. <https://doi.org/10.1016/j.ajem.2011.06.011>
12. Novović M, Topić V. Correlation between arterial and venous blood gas analysis parameters in patients with acute exacerbation of chronic obstructive pulmonary disease. *Srpski arhiv za celokupno lekarstvo.* 2012;140(7-8):436-40. <https://doi.org/10.2298/SARH1208436N>
13. Razi E, Moosavi GA. Comparison of arterial and venous blood gases analysis in patients with exacerbation of chronic obstructive pulmonary disease. *Saudi medical journal.* 2007; 28(6):862-5.
14. McKeever TM, Hearson G, Housley G, Reynolds C, Kinnear W, Harrison TW, et al. Using venous blood gas analysis in the assessment of COPD exacerbations: a prospective cohort study. *Thorax.* 2015; [thoraxjnl-2015-207573](https://doi.org/10.1136/thoraxjnl-2015-207573).
15. Kelly A-M, Kyle E, McAlpine R. Venous pCO₂ and pH can be used to screen for significant hypercarbia in emergency patients with acute respiratory disease. *J Emerg Med.* 2002; 22(1):15-9. [https://doi.org/10.1016/S0736-4679\(01\)00431-0](https://doi.org/10.1016/S0736-4679(01)00431-0)
16. Treger R, Pirouz S, Kamangar N, Corry D. Agreement between central venous and arterial blood gas measurements in the intensive care unit. *Clin J Am Soc Nephrol.* 2010; 5(3):390-4. <https://doi.org/10.2215/CJN.00330109>