

Comparison of Simultaneously Obtained Central Venous Blood Gas and Arterial Blood Gas Analysis for pH, pCO₂, BE and K⁺ in Patients Attending Emergency Medicine of Tertiary Care Centre

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Received on 06.02.2020

Accepted on 16.03.2020

Abstract

Background: Estimation of blood gas values is vital in critically ill patients. The arterial blood gas estimation has some complications. Venous blood gas values can substitute the arterial blood values. This study was undertaken to compare the arterial and venous blood gas values in emergency care setting. **Materials and Methods:** A cross sectional study was conducted in Emergency Department of Basaveshwara Medical College and Hospital, Chitradurga among 85 patients. The samples were obtained from the artery and central vein of the patients with 2 mins apart. The sample was sent to the laboratory for estimation of blood gases including pH, pCO₂, BE and K⁺. **Results:** This study had shown that, pH, pCO₂, BE and K⁺ were correlated significantly but there is slight difference in the K⁺ between the Arterial and venous blood samples. The central venous sample had shown to have less potassium than the arterial blood. The pH, pCO₂ and BE values can be explained physiologically where the pH will be slightly lesser in venous samples and pCO₂ will be higher. **Conclusion:** This study concludes that, there was a good correlation between the arterial and venous pH, pCO₂, BE and K⁺ values.

Keywords: Blood gas analysis; Arterial blood; Central Venous Blood; Scatter plot; Correlation.

How to cite this article:

Sudheendra Rao T, Rajesh MS. Comparison of Simultaneously Obtained Central Venous Blood Gas and Arterial Blood Gas Analysis for pH, pCO₂, BE and K⁺ in Patients Attending Emergency Medicine of Tertiary Care Centre. Indian J. Emerg Med. 2020;6(2):105-110.

Introduction

Arterial Blood Gas analysis provides important information about the physiologic status of the patients and also progress of the disease. The acid base status and metabolic condition (pH, pCO₂, pO₂, HCO₃⁻, BE) oxygenation and ventilation can be provided by the arterial Blood Gas analysis. This plays a crucial role in evaluation and treatment of the patient.^{1,2} This test is often requested as point of care testing among the patients with metabolic or respiratory abnormalities. It is a standard method for

the evaluation of oxygenation, ventilation and status of acid and bases but may land up in complications. The complications include hematoma, aneurysm formation, thrombosis, embolism and possibility of the needle stick injury.^{3,4}

Venous blood gas assessment is an alternative method of blood gas measurement as alternative to the Arterial blood gas measurement. Both methods helps the clinician to estimate pH, Oxygen pressure, carbon dioxide pressure, oxygen saturation and the level of HCO₃⁻. The rate of complications is quite less and venepuncture is easy to perform, involves

decreased costs, labor and decreased risk of needle stick injury. A number of studies compared the relationship between the arterial and venous blood gas analysis.^{5,6} A study Vishwa Reddy et al had shown that, pH, pCO₂ and BE were found to be correlated well with the arterial and venous samples as per linear regression analysis. But there was a poor correlation of K⁺. They concluded that the central venous blood gas values of pH, pCO₂ and BE can be considered instead of arterial values but not potassium.⁷ Hence, it was decided to take up this study to compare the pH, pCO₂, BE and K⁺ between the arterial and venous blood gas analysis in a tertiary care setting.

Materials and Methods

A cross sectional study was undertaken in the department of Emergency Medicine of Basaveshwara Medical College and Hospital, Chitardurga between January, 2015 to December, 2019. A total of 85 patients attending emergency Medicine OPD constituted the sample size. Approval from ethics committee was obtained before the study was started. An informed consent was obtained from the patient attenders before the including the subjects in to the study. The patients who were unstable, critically ill with respiratory, cardiovascular, neurological, renal dysfunction and hepatic impairment and polytrauma cases during the study period were included in to the study. The patients length of stay of less than 2 hours and pregnant women were excluded from the study. Arterial and venous blood samples were obtained simultaneously from each patient. Arterial sample (0.5 – 1 ml) was obtained in heparinised disposable syringe either from radial or femoral artery. Five ml of the blood was drawn from vein by using central catheter. About 0.1 mL of blood was drawn from the catheter by using heparinised syringe and five mL blood initially drawn was returned back to the patient. There was a delay of 2 mins between the two samples. A predesigned proforma was used collect the information from the patient. The samples were analyzed as early as possible and the readings (pH, pCO₂, BE, K⁺) were recorded in the proforma.

The data thus obtained was compiled and analyzed using Statistical Package for Social services (vs 20). A pearson correlation test and Paired T test were used to compare the readings of artery and vein.

Results

Table 1: Socio demographic characteristics of the study sample

	Characteristics	Frequency	Percent
Age group	Less than 20 years	26	30.6
	21 - 30 years	6	7.1
	31 - 40 years	7	8.2
	41 - 50 years	12	14.1
	51 - 60 years	6	7.1
	More than 60 years	28	32.9
Sex	Male	41	48.2
	Female	44	51.8

This study included a total of 85 patients attending emergency medicine department. Most of the patients were either older than 60 years or younger than 20 years. Most of them were females.

Table 2: Mean values of arterial and CVBG samples

Parameter	Arterial blood Mean (± SD)	CVBG Mean (± SD)	P value	Mean Difference
pH	7.11 ± 0.42	6.83 ± 0.42	0.000, Sig	0.28
pCO ₂	38.29 ± 10.88	42.41 ± 0.12.0	0.000, Sig	4.12
B.E	-9.16 ± 4.19	-11.11 ± 3.91	0.000, Sig	1.94
K ⁺	4.95 ± 0.84	3.99 ± 0.76	0.000, Sig	0.96

The mean pH value was higher in arterial blood and pCO₂ was higher in the venous blood. The base excess was -9.16 in the arterial and -11.11 in the venous blood sample. The potassium was higher in the arterial blood when compared with to the venous blood. These difference were statistically significant between the arterial and venous samples.

Table 3: Correlation between the arterial and venous samples

Parameter	Correlation Coefficient (r)	95% CI	p value
pH	0.83	0.76 – 0.88	0.000, Sig
pCO ₂	0.97	0.95 – 0.97	0.000, Sig
B.E	0.95	0.92 – 0.98	0.000, Sig
K ⁺	0.87	0.82 – 0.92	0.000, Sig

The pH, pCO₂, BE and K⁺ correlation coefficient was more than 0.76 which was positive and statistically significant.

The scatter plot for the arterial versus venous pH shows that, most of the measurements were closer to the line indicating perfect agreements. Hence, it can be opined that there is a perfect agreement of arterial and venous samples.

The plot displays that the arterial and venous measurements of pCO₂ measurements were closer to the line of perfect agreement and this agreement was statistically significant.

The scatter plot for the base excess shows that, there was an agreement between the arterial and venous samples of the blood for base excess and it was statistically significant.

The scatter plot shows that the paired measurements are often in agreement with a slight departure from the median line. The agreement was perfect and significant between the arterial and venous samples.

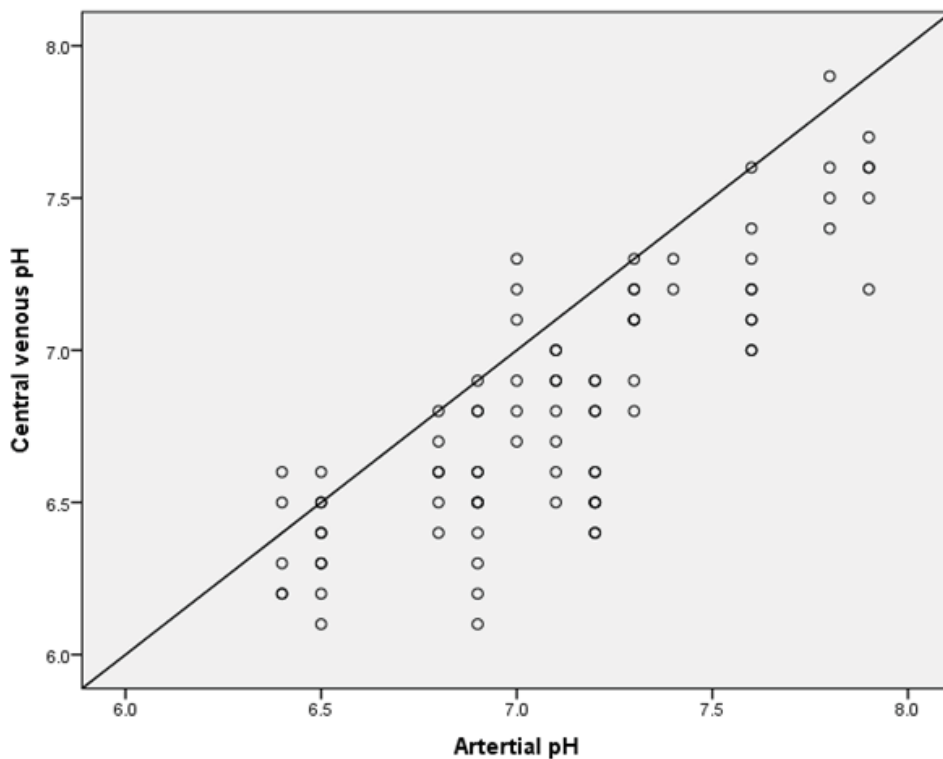


Fig. 1: Scatter plot – arterial with venous blood samples (n=85)

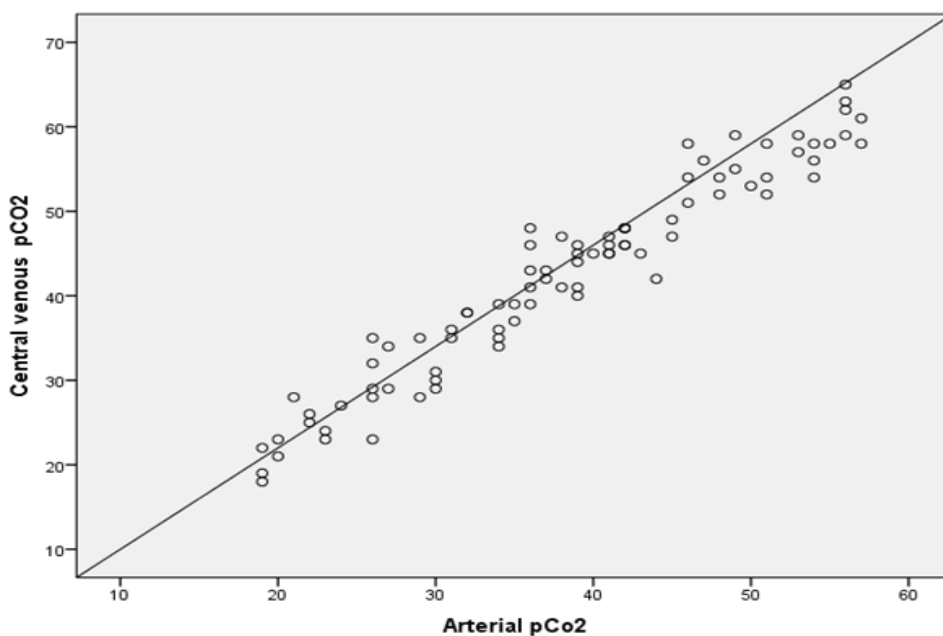


Fig. 2: Scatter plot – Arterial versus Central Venous pCO₂ (n=85)

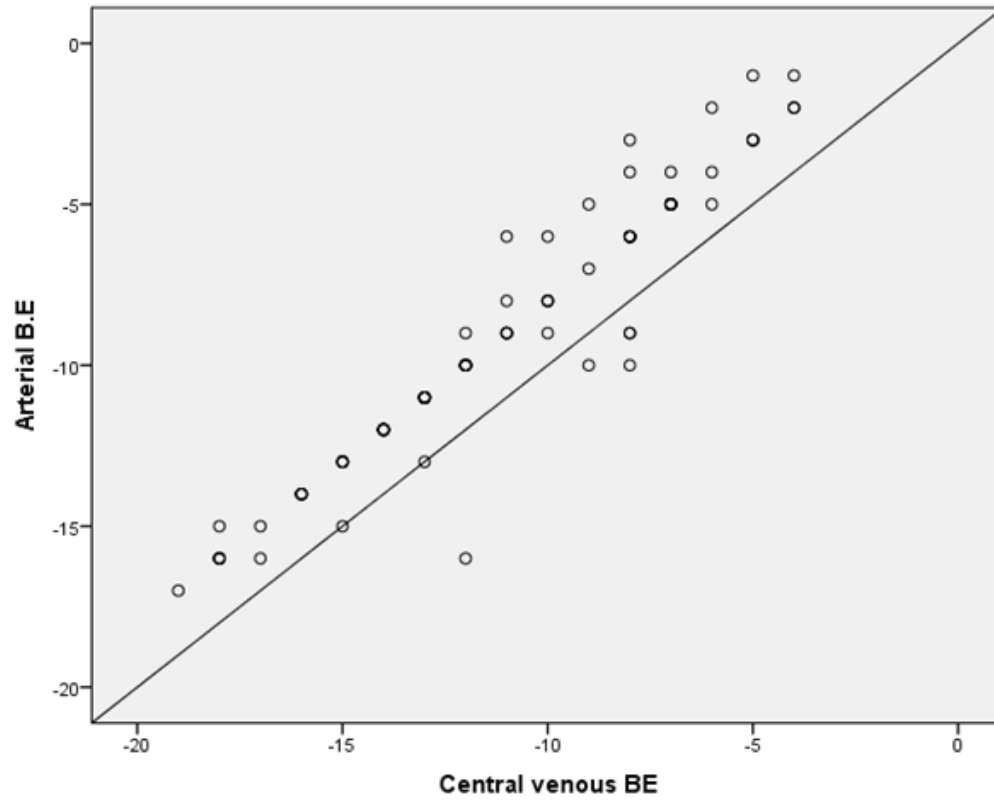


Fig. 3: Scatter plot indicating the base excess of arterial and venous blood samples

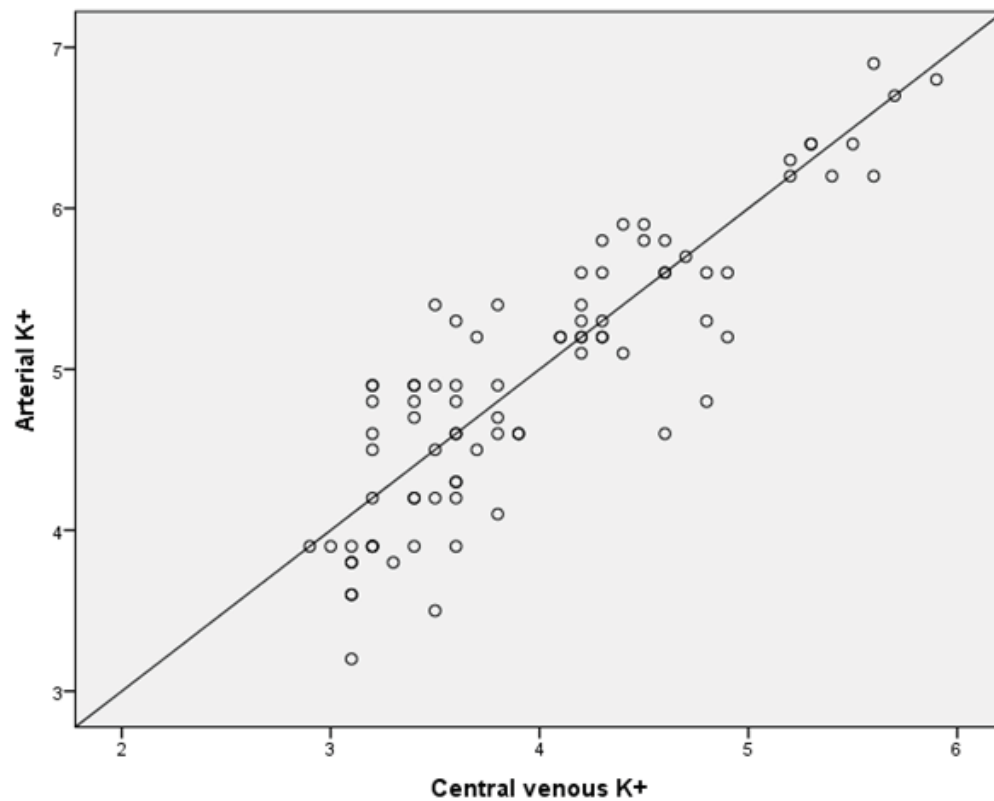


Fig. 4: Scatter plot - for the arterial and venous K⁺

Discussion

The arterial blood sample for the blood gas analysis had shown to have more complications as observed by many studies available. The patient safety is an important motto of the treating emergency physician. A cross sectional study was conducted to study the feasibility of using central venous blood sample instead of arterial sampling for the blood gas analysis. The study was able to establish the relationship between the arterial and venous blood samples with respect to pH, pCO₂, BE and K⁺. This study had shown that, pH, pCO₂, BE and K⁺ were correlated significantly but there is slight difference in the K⁺ between the Arterial and venous blood samples. The central venous sample had shown to have less potassium than the arterial blood. The pH, pCO₂ and BE values can be explained physiologically where the pH will be slightly lesser in venous samples and pCO₂ will be higher. The base excess is an important measure where it indicates the acid – base disturbance and provides the amount of acid or alkali required to return the plasma to normal pH.

A similar study conducted by Vishwa reddy et al. had shown that, the arterial values of pH, pCO₂ and BE had significant correlation with the central venous blood gas values. But, the potassium values were found to be poorly correlated with the arterial and venous values. They opined that the central venous blood gas can be considered instead of arterial blood gas for pH, pCO₂ and BE in critically ill patients but not for potassium levels.⁷ In contrary to these findings, this study had shown that, even once can consider potassium levels also but the values will be lesser in venous sample than the arterial values.

Khan and co-workers had noted good correlation of pH, pCO₂, HCO₃⁻, BE and BB between the arterial and venous samples in a group of 100 lumbar disc surgery patients which each sample was drawn 2 hours apart.⁸ Another study by Malatesha et al. had shown that, They used Bland – Altman method for estimating pH, pCO₂, pO₂ and bicarbonate. The study noted that, there was agreement for pH values but other values had poor correlation unlike the results of this study.⁹ Darren and co-workers compared the central venous blood gas measurements of pH, pCO₂ and bases excess with the arterial blood gas values. The reported that, the Central venous and arterial pCO₂, pH and base excess values correlate well. But VBGs cannot be substituted for the ventilated trauma patients during initial phases of resuscitation, clinically

reliable conclusions could be reached by using VBG analysis.¹⁰

Conclusion

This study was mainly undertaken to compare the central venous blood gas values with the arterial blood gas values. The study was able to show that, there was a good correlation between the arterial and venous pH, pCO₂, BE and K⁺ values. Hence, it can be used as substitute for arterial blood gas values.

References

1. Ak A, Ogun CO, Bayir A et al. 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):285–290.
2. Kelly AM, McAlpine R, Kyle E et al. Agreement between bicarbonate measured on arterial and venous blood gases. *Emergency Medicine* 2004; 16(5–6):407–9.
3. Mortensen JD. Clinical sequelae from arterial needle puncture, cannulation, and incision. *Circulation* 1967;35(6):1118–23.
4. Kelly AM, Kyle E, McAlpine R et al. 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.
5. Bilan N, Behbahan AG, Khosroshahi AJ et al. Validity of venous blood gas analysis for diagnosis of acid–base imbalance in children admitted to pediatric intensive care unit. *World J Pediatr* 2008;4(2):114–7.
6. Razi E, Moosavi GA. Comparison of arterial and venous blood gases analysis in patients with exacerbation of chronic obstructive pulmonary disease. *Saudi Med J* 2007;28(6):862–5.
7. Vishwa Reddy G, Raghu K, Sai Satyanarayana PV, et al., Comparizon of Simultaneously Obtained Central Venous Blood Gas and Arterial Blood Gas Analysis for pH, pCO₂, BE and K⁺ in Patients Presenting to Emergency Medicine and Critical Care Unit, *Indian Journal of Emergency Medicine* 2017: January – June: 3:1:7–.14
8. Khan ZH, Samadi S, Sadeghi M, et al: Prospective study to determine possible correlation between arterial and venous blood gas values. *Acta Anaesthesiologica Taiwanica* 2010;48(3):136–139.

9. Malatesha G, Singh NK, Bharija A, et al. Comparison of arterial and venous pH, bicarbonate, PCO_2 and pO_2 in initial emergency department assessment. *Emergency Medicine Journal* 2007;24(8):569-571.
 10. Malinoski DJ, Todd SR, Slone DS, et al. Correlation of central venous and arterial blood gas measurements in mechanically ventilated trauma patients. *Archives of Surgery* 2005;140(11):1122-1125.
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