



A case series of correlation between peripheral venous blood gas and arterial blood gas in patients of respiratory distress in ICU: A single Centre study

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Abstract

Background and Objectives: Arterial blood gas (ABG) analysis is very useful in evaluation of the underlying disease process in patients admitted to intensive care units (ICU) with respiratory distress. But, arterial puncture may cause unnecessary complications. The aim of this study was to determine whether venous blood gas (VBG) values can be used as an alternative to arterial blood gas measurements in patients of respiratory distress.

Methods: This study was conducted at Parul Sevashram hospital on 100 patients admitted to intensive care unit in respiratory distress. Biochemical parameters of venous and arterial blood samples were assessed using the blood gas analysis machine (ABL 80 FLEX).

Results: There was a statistically very significant correlation ($p < 0.05$) between all the parameters of ABG and VBG including the pO_2 thus meaning that all the parameters are comparable in emergency situations.

Keywords: arterial blood gas (ABG) venous blood gas (VBG) respiratory distress

1. Introduction

Blood gas analysis (mainly arterial) is frequently requested as part of the point-of-care testing for emergency or critical care patients presenting with metabolic or respiratory abnormalities. Historically, values obtained via VBG have been criticized for a perceived lack of accuracy in all domains. However, VBGs carry less risk of reflex sympathetic dystrophy, vascular injury, nerve damage, and cause much less pain to the patient along with lower risk for accidental needle-sticks as compared to ABGs. Increasing data shows that for most clinical indications, data from VBG correlates well, and are just as useful as that from ABG [1, 2]. There have been studies published on the correlation between ABGs and VBGs. However, many of these studies have concentrated only on certain patient populations such as diabetic ketoacidosis (DKA) [3], trauma [4], or chronic obstructive pulmonary disease (COPD) [5]. In clinical practice, the exact diagnosis is not always known early on and patients may have multiple underlying pathophysiologic states. The purpose of this study will be to investigate the correlation of ABG and peripheral VBG samples for all common parameters (bicarbonate, pO_2 , pH, base excess and pCO_2) in an ICU patient population exhibiting a variety of pathologies.

2. Materials & Methods

2.1 Study Population

This prospective study was conducted at Parul Sevashram hospital after approval from Institutional Ethics Committee. A total number of 100 adult patients of respiratory distress admitted in ICU were selected. Study was conducted over a period of 8 months.

2.2 Inclusion Criteria

- Age 18 to 70 yrs
- Patients admitted in ICU with respiratory distress

2.3 Exclusion Criteria

- Patients in respiratory arrest
- Patients not giving consent for the study

2.4 Investigations

The patients were investigated for:

- Complete blood count
- Arterial Blood Gas Analysis
- Peripheral Venous Blood Gas Analysis

2.5 Method

All patients were explained in detail about the purpose of the study and an informed consent was taken. Patient's details were incorporated into a proforma. Biochemical parameters were assessed via venous and arterial blood samples. Arterial and venous blood samples were obtained with a heparinized syringe, labeled and analyzed using blood gas analysis machine (ABL 80 FLEX) (available in the ICU) calibrated according to standard quality assurance protocols.

3. Statistical Analysis

The mean and standard deviation of pH, pCO_2 , HCO_3^- , pO_2 and BE values in arterial and venous samples were determined. P -value < 0.05 was considered statistically significant. Data was analyzed using SPSS version and appropriate tests were applied.

4. Results

The simultaneous venous and arterial blood samples were obtained from 100 patients (65 males, 35 females, mean age 50.92 ± 14.86 years). Clinical diagnoses included road traffic accident, sepsis, cerebrovascular accident, pulmonary disease, heart failure, renal failure, etc. Table 1 shows mean, standard deviation and p-value of arterial and venous blood gas values of pH, pCO₂, HCO₃⁻, pO₂ and base excess of the patients enrolled in the study.

Table 1: Arterial and Venous Blood Gas Analysis

| Variables | Arterial | Venous | P-value |
|-------------------------------|--------------------|-------------------|---------|
| pH | 7.40 ± 0.10 | 7.37 ± 0.10 | 0.0351 |
| pO ₂ | 105.28 ± 66.80 | 49.08 ± 22.39 | <0.0001 |
| pCO ₂ | 35.10 ± 20.54 | 43.72 ± 15.86 | 0.0011 |
| HCO ₃ ⁻ | 19.83 ± 6.21 | 16.73 ± 6.01 | 0.0004 |
| B.E. | -3.31 ± 7.01 | -1.05 ± 6.93 | 0.0229 |

5. Discussion

ABG analysis is a standard routine test for investigation of acid-base imbalance and ventilatory status. This study demonstrated that venous blood gas values especially pCO₂, base excess, and pH levels have relatively good correlation with ABG values.

Zeserson *et al.* conducted a prospective cohort study of 156 critically ill patients in the ED and ICU setting to evaluate the correlation between pH and pCO₂ when derived from ABG vs VBG with added pulse oximetry for estimating PaO₂ and concluded that arterial and venous pH and PCO₂ had good correlation^[1] which is comparable with our study. Byrne *et al.* conducted a meta – analysis of 1768 subjects from 18 individual studies and found that peripheral VBG correlates well with ABG with respect to pH but found an unacceptably wide 95% prediction interval when looking at the pCO₂^[2]. A review article by Kelly AM summarized data comparing ABG and peripheral VBG variables in ED all-comers also concluded that venous pH had sufficient agreement however concluded with a word of caution: there is no data to support that this correlation is maintained in shock states^[3]. Ma OJ *et al.* conducted a prospective trial looking at the utility of ABG in patients presenting to the ED with suspected DKA and found that ABG analysis changed management of DKA 1% of the time and concluded that VBGs are a viable substitute^[6]. Ogele E *et al.*^[7] did a study of VBG vs ABG in emergency department and found that, for most parameters of venous and arterial blood gas analysis, there is good correlation. However, there are a few important scenarios that may be exceptions. Not surprisingly, the major exception is pO₂; venous pO₂ readings do not correlate well with arterial PO₂. A workaround to this limitation is to estimate arterial oxygenation using SpO₂. In another study Malinoski *et al.*^[8] showed that in mechanically ventilated trauma patients, central venous and arterial PCO₂, pH, and base excess values were well correlated. In their study, in spite of high correlation between arterial and venous blood for pH, PCO₂, and base excess, the 95% limits of agreement were too wide to allow substitution^[8]. In a study by Rang *et al.* carried out on 218 patients with respiratory and metabolic illness, the correlation coefficient of pH, PCO₂ and HCO₃ values in arterial and venous samples was 0.913, 0.921, and 0.953 respectively. The mean differences of pH, PCO₂, and HCO₃ between arterial and venous samples were: 0.036, 6mmHg, and 1.5 mEq/L, respectively^[9].

In our set of patients, all the patients were admitted in

intensive care unit with respiratory distress and we found out a statistically very significant correlation between all the parameters of ABG and VBG including the pO₂ thus meaning that all the parameters are comparable in emergency situations. Also, in emergency situations, although despite taking utmost precautions, the arteries may be badly hit leading to a second prick in the arteries resulting in multiple complications, sometimes the fatal ones. It is therefore advisable to go for VBG in all emergency cases and if at all there is any doubt about the pO₂ values, it can always be cross-checked using the pulse oximetry and compare the pO₂ with SpO₂ which is a very noninvasive mode of checking the oxygen saturation.

Our study is unique in a way that, to our knowledge, it is one of the few studies to enroll a diverse group of undifferentiated critically ill patients in both medical and surgical intensive care units. Many a times, the underlying pathophysiologic state is not known for sure at the time of blood gas analysis, and multiple disease processes may occur simultaneously. By simplifying the enrollment criteria to a critically ill patient with respiratory distress in whom the treating physician orders an ABG, we captured a wide variety of patients and could not identify a subgroup in which the VBG failed to correlate with the ABG. We believe that this study design most realistically replicates real-world clinical practice scenario.

6. Conclusion

Very few such studies have been done, as per the literature review. Such a study will give a clinician immense knowledge regarding the probable parameters of blood gas analysis in a comparative manner thus giving more robust data for any future interventional studies in the view of proper management and avoiding secondary complications in routine and emergency medical practices. VBG, being a simple procedure, can monitor the accurate metabolic milieu in cases of medical/surgical emergencies.

7. Acknowledgements: Nil

8. References

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