Comparison of Arterial and Venous Blood Gases in Patients Presenting with Acute Exacerbations of Chronic Obstructive Pulmonary Disease

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MKC RI conceived idea, MKC AH drafted the study, RI AH collected data, AH MKC did statistical analysis & interpretation of data, MKC RI critical reviewed manuscript, All approved final version to be published.

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The Authors declares that there is no conflict of interest.

Abstract

Background: Chronic obstructive pulmonary disease (COPD) is one of leading cause of morbidity and mortality worldwide. Exacerbations of COPD is considered as second most common cause of admission in the UK. The recognition that high flow oxygen therapy in susceptible patients during exacerbations of COPD can lead to hypercapnia and also that respiratory acidosis is usually associated with a worse outcome has led to a rise in arterial blood gas (ABG) sampling to measure the values of pH, PaCO2, PaO2 and HCO3.

Objectives: Objective was to study the correlation of ABG with VBG in in terms of pH, pCO2 and HCO_3 in patients presenting with exacerbation of COPD.

Methodology: Ninety two patients with acute exacerbation of COPD were included. Samples for ABG and VBG were taken simultaneously and analyzed using blood gas analyzer. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 20.

Results: Ninety two patients were included. Mean age was 47.50+8.27 years and 87% were male. Regarding correlation between ABGs and VBGs, it was seen that Pearson's correlation for pH was 0.81 with p value of <0.01 while correlation for PCO_2 was 0.86 with a p value of < 0.01. Pearson's correlation for PO_2 was 0.52 with p value of > 0.05. A strong correlation was found for PCO_2 of ABGs and VBGs i.e. 0.88 with a p value of < 0.01.

Conclusion: There was strong correlation between pH, PCO_2 and HCO_3 of ABGs and VBGs.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a one of the major public health issue and it is predicted to become the 3rd leading cause of mortality in USA.[1,2] Exacerbations of Chronic obstructive pulmonary disease (COPD) are the second most common cause of emergency admission in hospitals of UK, with an estimated 94 000 hospital admission per year.[1] The exacerbations Chronic obstructive pulmonary disease (COPD) have a very high risk of mortality and about 50% of people with a severe exacerbation will die within 4 years of an admission due to COPD exacerbation.[1]

It has been established that high flow oxygen therapy can induce hypercapnia in susceptible patients admitted in hospital with exacerbations of COPD,[2] and also that respiratory acidosis is associated with a worse outcome in such patients[3, 4] which has led to a rise in arterial blood gas (ABG) sampling to measure values of pH, PaCO2, PaO2 and HCO3. These variables provide important clinical information regarding patient's metabolic and respiratory function necessary for determining the further course of action. The recent National Institute for Health and Care Excellence (NICE) COPD guidelines recommend that an ABG should be obtained in all patients admitted to hospital with a COPD exacerbation.[5] Complications of the procedure include local pain, haematoma, arterial spasm and occlusion, vessel

trauma, air or clotted-blood emboli, infection and needle stick injury to the sampler.[1-5] It is technically more difficult to obtain arterial sample and reportedly has more adverse effects like pain than venous blood gas (VBG) sampling.[1,3-4] Using less invasive measures of PCO2 and SaO2 could greatly benefit patients in two ways that is by decreasing pain and streamlining the care pathway.[1]

Recent meta-analysis data suggested good agreement between venous and arterial measurements of pH, HCO_3 and base excess.[1-2] In patients with diabetes the arterial sampling has been replaced with venous sampling for the monitoring of diabetic ketoacidosis.[1-3] In patients with COPD the use of venous samples to guide treatment during exacerbations has been limited, perhaps because the relationship between arterial and venous measures of carbon dioxide is less strong, although a PvCO2 of >6 kPa (45mmHg) has been shown to have 100% (95% CI 97% to 100%) sensitivity in diagnosing patients with clinically relevant hypercapnia.[1]

There were some studies which have sought to determine the relationship between ABG and VBG giving mixed results.[2] Some of these studies included COPD exacerbation patients in certain sub groups, e.g., those requiring non-invasive ventilation in emergency department or intubation/ventilation.[3] Moreover, there was no local study on the correlation between ABG and VBG in patients with COPD exacerbation. Furthermore, the international studies report a wide variation in results with inconclusive data.[3] In a recent study by McKeever TM et al[4] showed good agreement between arterial and venous values of pH and HCO3- (mean difference 0.03 and -0.04, limits of agreement -0.05 to 0.11 and -2.90 to 2.82, respectively), and between SaO2 and SpO2 (in patients with an SpO2 of >80%). In this study it was also found that arterial sampling required more attempts and it was more painful than venous sampling (mean pain score was 4 (IQR 2-5) and 1 (IQR 0-2), respectively, p<0.001). Another study by McCanny P et al6 it was found that arterial and venous PCO2 had medium agreement with an average difference of 8.6 mm Hg and 95% limits of agreement of -7.84 to 25.05 mm Hg. For pH, mean difference between each group was 0.039 (range, -0.12 to 0.03). Arterial hypercarbia was present in 30 patients (33.7%; range, 51-140.19 mm Hg). All cases of arterial hypercarbia were detected using VBG sampling when a screening cutoff of 45 mm Hg was applied (sensitivity, 100%; 95% confidence interval, 88.7%-100% and specificity, 34%; 95% confidence interval, 23.1%-46.6%). Study from India6 found correlation between O2 to be poor with minimal mean difference and good correlation (r > 0.9) between arterial and peripheral venous sample for blood gases and acid base status. Correlation in PO_2 measurement was poor (r < 0.3). Similar was the case with O'Connor TM7 who found significant difference with mean venous pH of 7.371 and arterial pH of 7.407 with r = 0.5347, p < 0.0001). With these inconclusive and conflicting results, further studies are needed to study the potential correlation of VBG with ABG in patients with acute COPD exacerbation. This study was therefore set out to assess the relationship between arterial and venous measures of PCO_2, pH and HCO_3 during exacerbations of COPD, in order to establish whether VBG analysis could replace ABG analysis in the initial assessment of COPD exacerbations.

Methodology

This was a Cross sectional study and was conducted in Department of Pulmonology, Sheikh Zayed Hospital Lahore. We included ninety two patients of both genders with ages between 18-65 years and diagnosed case of COPD admitted with acute exacerbation.

We excluded the patients needing resuscitation or invasive mechanical ventilation (SpO_2 < 92%) or not willing to participate in the study and also excluded the patients with advance renal (creatinine > 5 mg/dl) and hepatic disease (INR > 2).

Samples for ABG and VBG were taken simultaneously by taking 3 ml of arterial and venous blood respectively. Sample was analyzed using blood gas analyzer as per standard protocol. Patients were managed using the standard protocol depending on values of arterial blood gases.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 20.

Table 1: Age Distribution of study cases

Age (in years)	No. of patients	Percentage (%)
<30	14	15.2
31-50	36	39.1
51-65	42	45.7
Total	**92**	**100**

Table 2: Duration of Symptoms among study cases

Duration (in days)	No. of patients	Percentage
Upto 3	70	76.0
> 3	22	24.0
Total	92	100.0

Pearson's correlation Coefficients was computed between the measures of arterial blood gas (ABG) and venous blood gas (VBG) parameters (i.e. pH, PCO_2 and HCO_3) with p value =0.05 considered statistically significant. Data was stratified for age and gender to address effect modifier. Post-stratification Pearson's correlation was computed with p value <0.05 considered as significant.

Results

According to results of our study, 45.7% patients were between the ages of 51-65 years while 39.1% were between ages of 31-50%. Remaining patients were of the age < 30 years. Mean age was 47.50+8.27 years. Most of patients i.e. 87% were male. Regarding duration of symptoms, 76% patients had symptoms duration for > 3 days. Mean for duration of symptom was 3.25+1.78 days.

Regarding correlation between ABGs and VBGs, it was seen that Pearson's correlation for pH was 0.81 with p value of <0.01 while correlation for PCO_2 was 0.86 with a p value of < 0.01 i.e. significant correlation was found between pH and PCO_2 of ABGS vs VBGs. Pearson's correlation for PO_2 was 0.52 with p value of > 0.05 i.e. no significant correlation was found between PO2 of ABGS vs VBGs. Strong correlation was found for PCO_2 of ABGs and VBGs i.e. 0.88 with a p value of < 0.01.

When we stratified our data for age, it was seen that weak correlation for pH, PCO_2, PO_2 and HCO_3 in different age groups i.e. p value >0.05. When we stratified our data further for gender, it was shown by results that there was no significant correlation was found between pH, PCO_2, PO_2 and HCO_3 among males and females i.e. p value >0.05.

Table 3: ABG & VBG Values of study cases (n=92)

Variable	ABG	VBG	Pearson Correlation	P Value
pH	7.3±0.1	7.3±0.1	0.81	P <0.01
pCO2	35.8±11.5	45.9±12.2	0.86	P <0.01
pO2	80.9±19.9	38.5±17.8	0.52	P >0.05
HCO3	21.2±3.6	22.1±2.8	0.88	P <0.01

Discussion

COPD is the fourth leading cause of morbidity and mortality worldwide and is projected to rankfifth in burden of disease in 2020. Exacerbations of COPD are considered as one of the most common cause of emergency hospital admission. The recognition that high flow oxygen therapy in susceptible patients during exacerbations of COPD can lead to hypercapnia7 and also that respiratory acidosis is usually associated with a worse outcome.[8] This has led to a rise in arterial blood gas (ABG) sampling to measure the values of pH, PaCO2, PaO2 and HCO3. Present study was conducted at Sheikh Zayed Hospital Lahore to study the relationship between arterial and venous values of PCO2, pH and HCO3 during acute exacerbations of COPD, in order to establish whether VBG analysis could replace ABG analysis in the initial assessment of COPD exacerbations. According to results of our study, mean age for patients was 47.50+8.27 years. In one study conducted at Iran, mean age of patients was 58.4±21.5 years.[9]

In our study, there was statistically significant correlation between pH of ABGs and VBGs i.e. r = 0.81 with a p < 0.01. Similar results were obtained in other studies. In a study conducted at Ireland, ABGs and VBGs pH was showed significant correlation i.e. r = 0.826 (P=0.001).[4] In another study conducted at Iran arterial pH had statistically significant difference than venous pH in COPD patients i.e. r = 0.864 and p<0.001.[10] Another conducted by Razi E et al showed similar results. In this study, Razi and his colleagues concluded that Linear regression equations for the estimation of arterial pH and venous pH was r=0.801 with a p value of <0.001.[7] So, results of these studies were consistent with our study.

Results of our study showed that there was correlation between arterial PCO2 and venous PCO2 i.e. r = 0.86, p < 0.01. Similar results were observed in other studies. One study conducted in Turkey showed that arterial PCO_2 is significantly correlated with venous PCO2 i.e. r = 0.873 and p < 0.001.[11] Another study showed that ABGs PCO2 was correlated to VBGs PCO2 i.e. r = 0.761, p < 0.001.[9]

According to results of our study arterial PO_2 was having weak correlation with venous PO_2 i.e. r = 0.52 and p > 0.05. In a study conducted at Iran, ABGs PO2 had weak correlation with venous PO2 i.e. r = 0.287.[9] In his study conducted by Esmaeilivand et al., showed that there only moderate correlation between arterial pO_2 and venous pO_2 i.e. r=0.29.[12]

According to results of our study arterial HCO_3 was having strong correlation with venous HCO3 i.e. r = 0.88 and p < 0.05. In a study conducted at Iran, ABGs HCO_3 had strong correlation with venous HCO3 i.e. r=0.810, p<0.001.7 In his study conducted by Raza et al., it was concluded that there is only strong correlation between arterial HCO_3 and venous HCO_3 i.e. r=0.749, p < 0.001.[10]

Conclusion

We concluded that there is strong correlation between pH, pCO_2 and HCO_3 of ABGs and VBGs samples from AECOPD subjects. Therefore, it is recommended that VBGs which is less invasive procedure can be performed instead of ABGs in patients with acute exacerbations of COPD. However, further larger studies should be done to endorse these scientific observations.

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