



Clinical Diagnostic Value of Venous Blood Gas for Chronic Obstructive Pulmonary Disease Patients with Acute Exacerbation; Systematic Review

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Abstract

Aim: This study aimed to evaluate the VBG clinical application value in COPD diagnosis, and VBG, ABG differences in this diagnosis.

Method: The PRISMA standards were followed in the conduct of this study. Databases used include; Medline, EMBASE, and Google Scholar. The search was carried out for articles published in the period from 2006 to 2024. The target articles' whole texts were acquired in compliance with the predetermined inclusion criteria.

Result and Conclusion: Following a round of inspections, 173 substandard and unnecessary articles were removed. The study eventually comprised six papers that satisfied the inclusion criteria. The pH values of the COPD patients' ABG and VBG tests were analyzed and compared in four of the chosen articles. These studies demonstrated that there was no discernible variation between the ABG and VBG in the pH test results of the COPD patients who were having an acute exacerbation.

Keywords: Venous Blood Gas; Chronic Obstructive Pulmonary Disease; Acute Exacerbation

Introduction

One of the primary symptoms of chronic obstructive pulmonary disease (COPD) is airflow restriction. The restriction of airflow exhibits gradual growth and is totally irreversible. Its etiology has many different and intricate reasons, including as inflammation

and modifications to the lungs' internal and exterior structures and functioning. COPD has become a public health problem because to its high death rate and vast patient population, and its rates of morbidity and mortality are rising year [1]. In our nation, COPD is a prevalent chronic respiratory condition. It now holds the

top spot in terms of illness burden. In addition to having a major impact on a patient's life and health, COPD also causes significant financial hardship for those who suffer from it. About 24 billion dollars are spent on COPD treatment each year worldwide, with acute exacerbations requiring hospitalization accounting for 70% of those costs.

One of the stages of COPD progression is the COPD acute exacerbation. It has been disregarded for a long time since it is thought to have minimal impact on how the illness progresses. According to studies, patients with COPD experience exacerbations 2.5–3 times year on average [2,3]. Additionally, the severity of the condition increases the frequency of exacerbations, and almost half of them go unnoticed by patients. A key clinical characteristic of COPD is recurrent acute exacerbations, which are linked to both substantial physiological deterioration and elevated airway inflammation brought on by bacteria, viruses, and air pollution [4]. Frequent annoyance not only impairs people's health but also raises mortality and medical expenses. Attention must be paid to the identification and treatment of acute exacerbations of chronic obstructive edema because they continue to have a considerable impact on the prognosis of the condition [5,6]. In order to evaluate the clinical value of VBG in the COPD diagnosis, we sought to evaluate the ABG, VBG differences.

Method

This study was conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines [7]. Databases including Medline, EMBASE, and Google Scholar were searched using a keywords related to the VBG of patients with COPD. The search was conducted from 2006 and 2024. Searching terms include; blood gas analysis, Chronic obstructive pulmonary disease, emergency, case-control study, acute exacerbation, risk variables and cohort study. Following the predetermined inclusion criteria, the target articles' entire texts were acquired. To make sure no crucial papers were overlooked.

The papers had to fulfill the following requirements in order to be considered for inclusion in the review: Include patients with COPD in original research; analyze the results of measurements of pH, PaCO₂, and HCO₃; and employ the inspection techniques of ABG and VBG studies.

Two researchers independently examined the publications, extracted the data, and cross-checked it. Experts were engaged to resolve any disagreements regarding the data selection process.

After reading the publications separately, the two researchers assessed each one's completeness of data and original study. The aforementioned criteria were used to determine which publications were included in the study and which were not. A database was created to verify the data once it was retrieved in accordance with the defined tables. The author asked for the entire text of any research reports that were found to be lacking.

Results and Discussion

A total of 173 irrelevant and poor items were ultimately eliminated after a round of screenings (Figure 1). In the end, the study comprised six papers [8-13] that satisfied the inclusion criteria. Four of the selected publications examined and contrasted the pH readings of the COPD patients' ABG and VBG tests. These investigations showed that the pH test findings of the COPD patients experiencing an acute exacerbation did not significantly differ between the ABG and VBG analyses. Study design, aim and participants of the included studies were presented in (Table 1).

The aim of the McKeever, *et al.* [8] study was to determine if VBG analysis plus pulse oximetry might take the role of ABG analysis, which was used for the first evaluation of COPD exacerbations, while evaluating for respiratory failure. The authors showed acceptable agreement between VBG and ABG parameters in COPD exacerbations for pH, and SaO₂ at a SpO₂ >80%.

A meta-analysis of five trials that examined the use of peripheral VBG testing in COPD exacerbations in the ED found agreement between ABG and VBG and the inline graphic [14]. The pH and inline graphic weighted average discrepancies were 0.028 and 1.34 mmol, respectively, whereas the pCO₂ weighted average difference was 0.79 kPa. The somewhat decreased correlation between SpO₂ and SaO₂ at lower values is not surprising [15]. Any patient with a SpO₂ of less than 80% requires an ABG right away, as the suggested methodology shows.

Kelly, *et al.* (2013) [9] discovered narrow 95% limits of agreement for pH and excellent arteriovenous agreement. The 95% limits of agreement were too wide for pCO₂, even though the

mean arteriovenous difference was 8 mmHg. This is consistent with earlier research on non-inshock patients [16,17]. Additionally, they discovered that there was no significant difference in the arteriovenous pH between acidotic and non-acidotic individuals, and the same was true for pCO₂ between hypercarbic and non-hypercarbic patients. All things considered, it is now evident that venous pH closely reflects arterial pH in individuals with normotension, but venous pCO₂ is a poor indication of arterial PCO₂.

When a previously determined PCO₂ limit was used, VBG data correctly detected arterial hypercarbia in patients presenting with COPD acute exacerbations, according to a McCanny, *et al.* research [10] that compared matched VBG and ABG results [18]. In this patient group, arterial hypercarbia was 100% detectable with a PCO₂ threshold of more than 45 mm Hg. Venous CO₂ measurement cannot completely replace arterial CO₂ measurement when determining the degree of hypercarbia; however, it can accurately determine whether hypercarbia is present in this group, which is a crucial consideration for initiating NIV, as evidenced by the wide 95% CIs of agreement and the average difference of 8.6 mm Hg. McCanny, *et al.* found a strong association between arterial and venous pH levels, which is consistent with earlier findings [12,19].

Venous pH cannot be utilized as a stand-in for arterial pH, claim O'Connor, *et al.* ABG analysis delays cause a drop in observed pH values that is noticeable in individuals experiencing a COPD exacerbation after 30 minutes and reaches clinical significance after 42 minutes. Because of this, the authors advise that ABG samples be analyzed no later than 30 minutes, after which they should be discarded and remeasured. Air pollution causes a clinically and statistically significant increase in PO₂ in ABG samples right away. This rise continues over time, reaching a 54% increase after 180 minutes [11].

Ibrahim, *et al.* 2011 research demonstrates that replacing the arterial pCO₂ for its venous value is still not possible despite the benefit of a quicker turnaround time linked to point-of-care blood gas measurement. We have shown that the arterial and venous pCO₂ values are well correlated. Regretfully, a high correlation does not always mean that the measures agree exactly. Given the

large standard deviation in the recorded arteriovenous difference, we cannot advise using the venous pCO₂ value in place of the equivalent arterial value, even though there was great agreement between the VBG and ABG values in the limited number of outliers (5%).

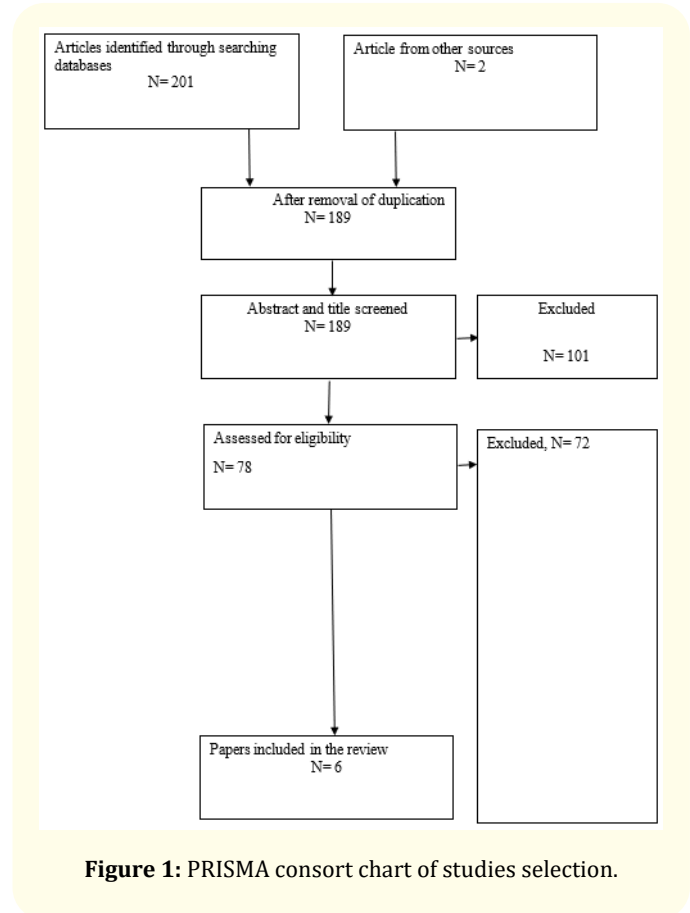


Figure 1: PRISMA consort chart of studies selection.

Conclusion

By gathering publications regarding the blood gas analysis of COPD patients, this study looked at the consistency of the results of the ABG and VBG tests with regard to three indicators. We found that the ABG and VBG analyses were more consistent with regard to HCO₃, but they differed considerably with regard to PaCO₂ and pH. Consequently, the VBG analysis can be used clinically to diagnose COPD, but further study is required to see if it can fully replace the ABG analysis.

Citation	Design	Study aim	Method and participants
McKeever, <i>et al.</i> 2016 [8]	Prospective cohort study	The authors evaluated whether venous blood gas measurements may be used in place of ABG values for preliminary evaluation.	Pairs of venous and arterial samples were obtained from patients who needed hospitalization for a COPD exacerbation. The agreement between arterial and venous pH, CO ₂ , and inline graphic was evaluated using Bland-Altman analysis. The connection between SaO ₂ and SpO ₂ was evaluated. Each sample's pain ratings and number of tries were counted.
Kelly, <i>et al.</i> 2013 [9]	Prospective study	The study sought to determine if adult patients using non-invasive ventilation have arteriovenous agreement for pH and pCO ₂ .	Adult patients receiving NIV for acute respiratory compromise in an emergency department were the subjects of this study. Staff also took a venous sample as nearly concurrently as feasible when ABG analysis was needed for clinical reasons. Demographics, clinical diagnoses, and blood gas analysis findings were among the information gathered. Arteriovenous agreement for pH and pCO ₂ was the main outcome of interest. An examination of Bland-Altman bias plots was employed.
McCanny, <i>et al.</i> 2012 [10]	Prospective study	The purpose of the study was to look at the clinical relationship between VBG and ABG readings in patients who were experiencing an acute flare-up of COPD and were brought to the emergency room.	Patients with COPD who arrived at the emergency department with acute ventilatory impairment were the subject of a prospective research. If a patient's attending physician thought ABG gas collection was crucial for their first evaluation, they were included. The bias plot and Spearman correlation techniques were used to compare data from arterial and venous samples.
O'Connor, <i>et al.</i> 2011 [11]	Comparative study	The impact of these mistakes was assessed by the authors in both controls and patients experiencing exacerbations of COPD.	Thirty patients with a COPD exacerbation and thirty controls had their venous and arterial samples examined. Arterial samples were split into air-contaminated specimens and non-air-contaminated and analyzed at different time intervals. Venous samples were analyzed right away.
Ibrahim, <i>et al.</i> 2011 [12]	Cross-sectional study	Using a bedside blood gas analyzer, the study sought to ascertain if venous pCO ₂ might take the position of arterial pCO ₂ in emergency patients.	The authors enlisted individuals that the attending emergency physicians determined needed ABG analysis to assess their acid-base or ventilation status. As closely as feasible in time, a venous and an ABG sample were obtained from the patient. The same bedside blood gas analyzer was then used to examine both samples as soon as they were collected.
Ak, <i>et al.</i> 2006 [13]	Prospective study	This study sought to determine if venous blood gas measurements of pH, PCO ₂ and PO ₂ , HCO ₃ , and oxygen saturation could accurately forecast ABG levels in individuals experiencing a flare-up of COPD.	This prospective research included 122 patients who had previously been diagnosed with COPD and who were presenting with an acute exacerbation based on COPD exacerbation criteria.

Table 1: Design, participants and aim of the included studies.

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