Research Article

Evaluating Arterial Blood Gas Modifications Before and After Corticosteroid Intervention in Acute Exacerbations of Chronic Obstructive Pulmonary Disease

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD), a prevalent and progressive respiratory disorder characterized by airflow limitation and chronic inflammation from prolonged exposure to harmful particles and gases, significantly affects patients' quality of life.

Objective: This study examines the impact of corticosteroid therapy on arterial blood gas (ABG) parameters in patients with acute exacerbations of COPD (AECOPD), evaluating ABG values before and after treatment to determine therapeutic effectiveness.

Methods: Conducted at Bahawal Victoria Hospital's Pulmonology Department from August 15, 2022, to January 15, 2023, this quasi-experimental study included 170 COPD patients meeting exacerbation criteria. Exclusions included severe systemic illness, unconsciousness, inability to clear airways, arterial blood pH < 7.35, hemodynamic instability, or cor-pulmonale. Patients consented to a 2-day regimen of nebulized corticosteroid (beclomethasone), with ABG parameters like PaO2 and pH measured before and after treatment. Data analysis was performed using SPSS Version 24.

Results: Initially, 202 patients with AECOPD were enrolled, and nebulized beclomethasone was administered. However, 32 patients who did not respond and required IV steroids were excluded. Among the remaining 170 patients, post-treatment mean PaO2 levels significantly increased from 58.74 mmHg to 69.51 mmHg ($p < 0.000$). Stratified analyses across different age groups and genders confirmed the therapy's effectiveness in enhancing arterial oxygenation.

Conclusion: Nebulized corticosteroid therapy have valuable role in the treatment of AECOPD patients with mild hypoxemia and significantly improves in Arterial oxygen.

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Keywords | COPD, Nebulized Corticosteroids, Acute Exacerbations, Arterial Blood Gas, Respiratory Therapy.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a globally prevalent and gradually progressive respiratory disorder of small airways. COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, sputum production) due to abnormalities of airways (bronchitis, bronchiolitis) and alveoli(emphysema) that cause persistent, often progressive, airflow obstruction.[1] COPD lead to both pulmonary and systemic health impacts that significantly deteriorate the quality of life.[2]

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https://doi.org/10.21649/akemu.v30i1.5603
2079-7192/

About 300 million people affected by COPD and its worldwide prevalence is 12.2% and mortality rate is 80% in developing countries. By the year 2030, it will be the 4th leading cause of death.[3] As compared to Global prevalace Pakistan have prevalence of 13.8%. In rural areas, it is common in females likely due to exposure to burning biomass fuel.[4]

Globally, COPD is one of the major disease leading an increasing challenge for hospitals.[5] The worsening air quality index worldwide is the major risk factor for disease progression and exacerbation.

Data regarding the optimal management of COPD is still scarce in developing countries like Pakistan.

Patients of Acute exacerbations of COPD (AECOPD) presents with worsening symptoms which includes cough, breathlessness and sputum production beyond daily variations, are critical events triggered by factors such as respiratory infections and environmental pollutants, often requiring immediate medical intervention and medication adjustments to manage the acute deterioration.[6-7]

Patient's outcome is influenced by these exacerbations. They lead to rapidly decline in lung functions, physical activity level, quality of life and exacerbate symptoms. Additionally exacerbations are significantly associated with faster disease progression and reduction in life expectancy.[8-9]

Corticosteroids play a vital role in the management of AECOPD. These medications, known for their potent anti-inflammatory properties, are proven to accelerate recovery from exacerbations.[10] They effectively enhance lung function, particularly the Forced Expiratory Volume in one second (FEV1), and ameliorate arterial hypoxemia (PaO2). Risks like early relapse, treatment failure, and the length of hospital stay are significantly reduced. The optimization of corticosteroid therapy, in terms of both dosage and duration, is therefore crucial in the management of AECOPD.[11]

Corticosteroids administered via oral and parenteral routes for the treatment of AECOPD.[12] However, emerging studies have begun to explore the efficacy of nebulized corticosteroids. These studies suggest that nebulized administration may provide similar benefits in improving lung function and reducing inflammation, with potentially fewer systemic side effects. This mode of administration is particularly advantageous for patients who have difficulty with oral medications or those who require rapid relief of symptoms.

ABGs plays a very important role for the diagnosis of respiratory failure and management of AECOPD.[13] This diagnostic test, essential in emergency and intensive care settings, provides crucial information about the patient's respiratory status. For these reasons AECOPD patients need repeated analyses of their arterial blood for pH, PCO2, 8 HCO3 and PO2 measurements.[14] Its importance extends beyond immediate clinical care, as it is also utilized in the ongoing evaluation of lung diseases and in monitoring the effectiveness of various treatments, including corticosteroids.[15]

There are number of studies internationally which elaborate the effects of corticosteroids in improving Arterial Blood Gases in AECOPD but there are not much studies about this in Pakistan. This study aims to identify the effect of nebulized corticosteroids in AECOPD with mild hypoxemia taking change PO2 in arterial blood as primary end point. This will help us to identify a better treatment approach and outcome. Elaborating change in arterial blood gases will help in tailoring the use of Nebulised steroids in local circumstances as well as promoting ABGs as a predictive tool in patient's improvement.

Methods

The quasi-experimental study was conducted at the Department of Pulmonology, Bahawal Victoria Hospital, Bahawalpur from 15th August 2022 to 15th January 2023. Total 202 with COPD were selected by using non-probability consecutive sampling technique. Inclusion criteria was: all the patients who met the criteria for exacerbation, both male or female patients aged between 40 to 70 years. Acute Exacerbation of COPD (AECOPD) is defined as: A known case of COPD presenting with acute worsening of respiratory symptoms including shortness of breath, cough, sputum with an Oxygen saturation (SpO2) 88% .

Patients were excluded if they suffered from severe systemic illnesses (such as sepsis, malignancy, or trauma), were unconscious, unable to spontaneously clear the airways, required immediate tracheal intubation, had an arterial blood pH less than 7.35 on admission, were hemodynamically unstable and SpO2 less than 88%.

Employing a 95% confidence level and an 80% power for the test, the required sample size was established to be 169 participants.[16]

Study was approved by the ethical committee of the hospital (approval date is 1/8/22 and letter number is 2331) and written informed consent was taken from every patient. Demographic data of the patients was recorded on a predesigned proforma. On day 0, about 2 ml of blood was drawn from the radial artery of patients using a disposable pre-heparinized system. The samples were stored on ice and processed within 15 minutes in a blood gas analyzer (Bayer Health Service Rapid lab 348) in the laboratory. Blood samples were analyzed for PO2 and pH. Measurement bias was controlled through calibration of standards and instruments and by repeating each test twice. The values of PaO2 pH were recorded on the predesigned proforma.

All patients received Nebulised corticosteroid (beclomethasone) 800 micrograms 4 hourly, nebulized salbutamol 0.5ml in 3ml normal saline every 4 hours, nebulized Ipratropium bromide 500 µ gram in 3ml normal saline every 4 hours, for 2 days. The second sample for comparison was taken on day 2, and the values of PaO2 and pH were again noted on the predesigned proforma.

The collected data was entered and analyzed in SPSS Version 24. Mean and SD was calculated for age, Pre and post ABGs status. Frequency and percentage was calculated for gender. Pair t-test was applied to control the pre and post ABGs status and to determine mean differences in pH and PaO2. Variations were controlled through stratification of age and gender to see the effects of variable post stratification by applying Pair T test. P-value < 0.05 was considered as statistically significant.

Results

The study initially included 202 patients with acute exacerbations of COPD who were administered nebulized corticosteroid (beclomethasone) aimed at improving PaO2 levels. However, 32 patients did not respond to the nebulized corticosteroid therapy and were subsequently managed with IV steroids, leading to their exclusion from the study. The analysis continued with the remaining 170 patients, who had a mean age of 57.04 years (SD = 6.90).

A paired sample t-test was conducted to compare the mean arterial oxygen partial pressure (PaO2) levels before and after corticosteroid therapy in these patients. The mean PaO2 level before the therapy was 58.74 mmHg (SD = 4.53), and the mean PaO2 level after the therapy was 69.51 mmHg (SD = 3.92). The matched example t-test uncovered a critical improvement in PaO2 levels post-treatment (p-esteem < 0.000). (Table 1)

Defined examinations were directed to survey changes in mean arterial blood oxygen partial (PaO2) levels before and after corticosteroid treatment across various age groups and genders. In the age groups of 40-55 years (n=56), the mean PaO2 level was 58.64 mmHg (SD = 4.78) before treatment and expanded to 69.64 mmHg (SD = 4.42) after treatment. A matched example t-test uncovered a measurably huge improvement in PaO2 levels (p-value < 0.000). For patients matured 56-70 years (n=114), the pre-treatment mean PaO2 was 58.79 mmHg (SD = 4.43), and the post-treatment mean was 69.44 mmHg (SD = 4.65). Additionally, the enhancement was statistically significant (p-value less than 0.000). Among male patients (n=105), the mean PaO2 expanded from 58.85 mmHg (SD = 4.66) before treatment to 69.54 mmHg (SD = 4.21) after treatment, with the change being genuinely critical (p-esteem < 0.000). Female patients (n=65) had a mean PaO2 level of 58.57 mmHg (SD = 4.36) prior to treatment, and this level rose to 69.45 mmHg (SD = 3.42) after treatment,

Table 1: *Comparisons of Mean PaO2 Values Before and After Therapy*

PaO_2 value	N	Mean	Std. Deviation	P Value
Before Therapy	170	58.74	4.53	0.000
After Therapy	170	69.51	3.92	

Table 2: *Comparisons of Mean PaO2 Values Before and After Therapy for Age Groups and Gender*

Age Group (Years)	Mean	Std. Deviation	P Value
40-55 years (n=56)			
Before Therapy	58.64	4.78	0.000
After Therapy	69.64	4.42	
56-70 years (n= 114)			
Before Therapy	58.79	4.43	0.000
After Therapy	69.44	4.65	
Male patients (105)			
Before Therapy	58.85	4.66	0.000
After Therapy	69.54	4.21	
Female patients (65)			
Before Therapy	58.57	4.36	0.000
After Therapy	69.45	3.42	

indicating a statistically significant improvement (p-value 0.000). (Table 2)

Discussion

Our research focused on evaluating the impact of nebulized corticosteroid therapy on arterial blood gas parameters in patients with acute exacerbations of Chronic Obstructive Pulmonary Disease (AECOPD) with mild hypoxemia. This evaluation is crucial in understanding the efficacy and safety of corticosteroid therapies, a cornerstone in the management of AECOPD. Our findings have to be contextualized within the broader spectrum of current research and clinical practices, as demonstrated by several high-quality studies.

In study comparative of Hu HS et al, nebulized and systemic corticosteroids, demonstrate a comparable improvements in lung function and ABGs parameters.[17] These findings are particularly relevant to our study, which also showed significant improvement in PaO2 post-nebulized corticosteroid therapy. Similarly, Zhao Y et al. (2018) reported that both (inhaled and systemic corticosteroids) improved clinical symptoms in COPD patients by increasing oxygen partial pressure and enhancing lung function. These studies reinforce the use of nebulized corticosteroids, aligning with our findings and suggesting their suitability as an alternative to systemic administration.[18]

In another study Cukic V. et al conducted in 2014, provides a longitudinal perspective on COPD treatment, showing a significant decrease in PaO2 and pH. This study underscores the progressive nature of COPD and the need for sustained and effective treatment strategies, such as those offered by nebulized corticosteroids.[19]

The study of Zhao Y et al is particularly illuminating in understanding corticosteroid use in special populations, such as pregnant women with COPD. Their findings suggest that inhaled corticosteroids, such as budesonide, are effective and less likely to cause side effects. This is important to think about when treating COPD flare-ups in people who are more likely to be affected by it.[18]

Meta-analyses by Hu HS et al. and Gu YL et al. compare systemic corticosteroids and inhaled corticosteroids thoroughly.

The findings from both studies emphasize that nebulized budesonide is not inferior to systemic corticosteroids in terms of improving FEV1 and PaO2. Nebulized budesonide in addition has the advantage of reducing the occurrence of side effects such as hyperglycemia.[17,20] These discoveries are important as they indicate a change in the approach to treatment, favoring the use of nebulized corticosteroids due to their effectiveness and reduced risk.

In addition , Liu X et al's research provides a unique perspective on the diverse approaches for managing COPD exacerbations at different levels of hospitals. The preference for local treatment, as shown in Liu X's study, also raises questions about accessibility and uniformity in COPD care.

One of the important aspect is reduction in incidence of side effects with nebulized corticosteroids, as documented by Hu HS et al and Zhao Y et al, is particularly significant. This aligns with our study and highlights the significance of safety profile for chronic disease management like COPD.[17,18]

While this study provides valuable insights, has several limitations that should be considered. First, the exclusion of patients who failed to respond to nebulized corticosteroids and required IV steroid., as well as those with worsening hypoxemia/respiratory failure requiring supplemental oxygen or those whose saturation PO2 dropped below 88% post-treatment were excluded and managed with systemic therapy. This selection could potentially limit the applicability of our findings to all patients with AECOPD.

Another limitation relates to the study design and timing of interventions.

In addition, the study's findings are based on observational data from a single demographic or geographical area, which might not be representative of COPD patient populations.

To overcome these limitations randomized controlled trials (RCTs) involving IV steroids are required to validate the efficacy and effectiveness of nebulized corticosteroids compared to systemic therapy Such studies should include a more diverse patient populations and explore different time frames and settings for measuring respiratory parameters.

Conclusion

This study highlights the potential benefits of nebulized

corticosteroid therapy, specifically beclomethasone, in improving arterial oxygen partial pressure (PaO2) in patients with acute exacerbations of Chronic Obstructive Pulmonary Disease (AECOPD). The significant increase of PaO2 following treatment with nebulized corticosteroids highlights that this is a viable and effective alternative to systemic steroid therapy for managing AECOPD with mild hypoxemia. However, the findings need to be further studied through randomized controlled clinical trials to fully determine the comparative efficacy and safety of nebulized versus systemic corticosteroids, in COPD patients.

Ethical Approval: The Institutional Ethical Review Board, Quaid-e-Azam Medical College, Bahawalpur approved the study vide letter No. 2331/DMI/QAMC Bahawalpur.

Conflict of Interest: The authors declare no conflict of interest.

Funding Source: None

Authors' Contribution:

SA: Conception & design, acquisition of data, analysis & interpretation of data,

MSS: Analysis & interpretation of data,

GA: Conception & design, drafting of article

RS: Analysis & interpretation of data, drafting of article, critical revision for important intellectual content, final approval

BL: Conception & design, Analysis & interpretation of data

KN: Analysis & interpretation of data

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