

Comparative Analysis of Budesonide Treatments on Blood Gas and Inflammation in Chronic Obstructive Pulmonary Disease Remission

Wei Liu*

Department of Family Medicine, Zhongshan Hospital, Dalian University, Dalian 116001, Liaoning, China

*Corresponding author: Wei Liu, dlliwei0325@163.com

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Abstract: *Objective:* To investigate the effects of budesonide on blood gas and inflammation indexes in patients with chronic obstructive pulmonary disease (COPD) during remission. *Methods:* Fifty-one patients with COPD in remission, admitted to Zhongshan Hospital of Dalian University from July 2021 to December 2022, were selected and divided into two groups based on a randomized numerical table method. The control group (25 cases) received budesonide formoterol treatment, while the observation group (26 cases) received budesonide geforce treatment. Various indexes, including clinical efficacy, blood gas indexes, inflammation indexes, St. George's Respiratory Questionnaire (SGRQ) scores, Chronic Obstructive Pulmonary Disease Assessment Test (CAT) scores, and 6-minute Walking Distance Test (6MWD) results, were compared between the two groups. *Results:* After 21 days of treatment, the total clinical effectiveness rate of the observation group was higher than that of the control group, with a statistically significant difference ($P < 0.05$). Post-treatment, the PaO₂ level and pH value in both groups were higher, and the PaCO₂ level was lower compared to pre-treatment levels. The observation group showed better improvements in these indicators than the control group, with statistically significant differences ($P < 0.05$). SGRQ and CAT scores for both groups were lower post-treatment, with the observation group scoring lower than the control group. Additionally, the 6MWD results were farther for both groups post-treatment, with the observation group achieving greater distances than the control group, with statistically significant differences ($P < 0.05$). *Conclusion:* Budesonide can effectively improve blood gas indexes in patients with COPD in remission, alleviate related clinical symptoms, reduce inflammatory responses, and promote patient recovery. The treatment efficacy is significant.

Keywords: Chronic obstructive pulmonary disease; Recovery; Budesonide; Blood gas indices

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1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common respiratory disease with a high morbidity rate, often attributed to genetic factors and airway hyperresponsiveness. The primary pathological feature of COPD is restricted airflow in the respiratory tract, leading to varying degrees of coughing and sputum production in patients^[1,2]. COPD consists of periods of acute exacerbation and remission, with drug therapy being the main

intervention during the remission period. Budesonide formoterol is a commonly used therapeutic drug for COPD, classified as an inhaled topical agent. It effectively reduces clinical symptoms and promotes recovery^[3].

Budesonide, a bronchodilator, significantly inhibits mucus secretion, expands the airway, and alleviates symptoms such as cough and dyspnea in COPD patients during the recovery period, thereby enhancing the overall clinical treatment effect. This study aims to investigate the impact of budesonide on blood gas and inflammation indexes in patients with COPD during remission.

2. Materials and methods

2.1. General information

This study has been authorized by the Medical Ethics Committee of Zhongshan Hospital of Dalian University after a professional review, based on which all research subjects and their families were informed of the study qualifications, and they all voluntarily signed the relevant informed consent documents. Fifty-one patients with chronic obstructive pulmonary disease in remission admitted to Zhongshan Hospital of Dalian University from July 2021 to December 2022 were selected and divided into the control group (25 cases) and observation group (26 cases) according to the randomized numerical table method. Control group: 14 males and 11 females; age 52.41 ± 4.28 years; disease duration of 12.07 ± 2.01 years; 18 cases with smoking history. Observation group: 16 males and 10 females; age 52.43 ± 4.26 years; disease duration of 12.05 ± 2.04 years; 20 cases with smoking history. Comparison of the aforementioned data between the two groups showed no significant difference ($P > 0.05$) and were comparable.

2.2. Diagnostic, inclusion, and exclusion criteria

- (1) Diagnostic criteria: All patients need to meet the content of the relevant diagnostic criteria in the “Guidelines for Primary Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2018)”^[4].
- (2) Inclusion criteria: (a) Those whose clinical manifestations and corresponding examination results are in line with the diagnostic criteria; (b) Those who do not have a history of lung surgery; (c) Those who do not have consciousness problems and can cooperate with medical personnel; (d) Those who do not have a combination of pulmonary tuberculosis, bronchial dilatation, and other diseases.
- (3) Exclusion criteria: (a) Those who have allergic reactions to the study drugs; (b) Those who have pulmonary fibrosis; (c) Those who have abnormal immune function or autoimmune-related diseases; (d) Those who have other diseases interfering with the study during the treatment period.

2.3. Methods

Patients in the control group received a budesonide formoterol powder inhaler (National Drug Code: HJ20160447, specification: 60 inhalations) manufactured by AstraZeneca AB (Sweden). They were instructed to inhale 2 doses per session, twice a day. Patients in the observation group received a budesonide formoterol powder inhaler (Approval Number: H20190063, specification: 120 doses/bottle) manufactured by AstraZeneca Dunkerque Production. They were instructed to inhale 1 dose per session, twice a day. Each treatment cycle lasted for 7 days, with both groups treated for a total of 21 days.

2.4. Observation indexes

- (1) Clinical Efficacy: The clinical efficacy of the two groups of patients after 21 days of treatment was evaluated according to the relevant standards in the “Guidelines for Primary Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2018)”^[4]. The criteria included: (a) Obvious effect:

Disappearance of lung rales and improvement of symptoms such as wheezing, shortness of breath, coughing, and chest tightness by 90% or more after treatment; (b) Effective: Basic disappearance of lung rales and improvement of symptoms such as wheezing, shortness of breath, coughing, and chest tightness by 60% to 89% after treatment; (c) Ineffective: No change in patients' symptoms and signs after treatment. The total effective rate is calculated as the sum of obvious effect and effective cases divided by the total number of cases and multiplied by 100%.

- (2) Blood gas indexes: 2 mL of radial artery blood was extracted from both groups before treatment and 21 days after treatment. The partial pressure of oxygen (PaO₂), partial pressure of carbon dioxide (PaCO₂), and pH were measured within 5 minutes of blood sampling using a blood gas electrolyte analyzer (Chengdu Smart Technology Co., Ltd., model: SG1). Normal values: PaO₂: 80–100 mmHg; PaCO₂: adult male 35–48 mmHg, adult female 32–45 mmHg; pH: 7.35–7.45.
- (3) Inflammation indicators: Serum C-reactive protein (CRP), interleukin-6 (IL-6), and procalcitonin (PCT) levels were measured before and after 21 days of treatment. 3 mL of fasting venous blood was collected, and serum was prepared by centrifugation (10 min at 3,000 r/min). Serum levels of CRP, IL-6, and PCT were measured using enzyme-linked immunosorbent assay (ELISA). Normal values: CRP: 0–10 mg/L, IL-6: < 7 pg/mL, PCT: < 0.5 ng/L.
- (4) Assessment Tools: (a) St. George's Respiratory Questionnaire (SGRQ) Score: Assesses the severity of dyspnea symptoms on a scale from 0 to 100; (b) Chronic Obstructive Pulmonary Disease (COPD) Assessment Test (CAT) Score: Assesses the severity of COPD symptoms on a scale from 0 to 40, with higher scores indicating greater severity; (c) 6-Minute Walk Distance (6MWD) Test: Measures the distance a patient can walk in 6 minutes, indicating their functional exercise level.

2.5. Statistical analysis

SPSS 26.0 was applied to calculate the relevant data in this study, and $P < 0.05$ was used as the criterion for the existence of significant differences in the data, and the measured data and count data were expressed as () and [case (%)] in turn, and the test was t and χ^2 test.

3. Results

3.1. Clinical efficacy

After 21 days of treatment, the total clinical efficacy rate of the observation group was significantly higher than that of the control group ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of clinical efficacy between the two groups [n (%)]

Group	Obvious effect	Effective	Ineffective	Total effective rate
Control group ($n = 25$)	7 (28.00)	11 (44.00)	7 (28.00)	18 (72.00)
Observation group ($n = 26$)	10 (38.46)	15 (57.69)	1 (3.85)	25 (96.15)
χ^2				5.622
P				0.018

3.2. Blood gas index levels

After 21 days of treatment, the PaO₂ level and pH value of patients in the 2 groups were higher than before treatment, and the PaCO₂ level was lower than before treatment, while the level of each index in the observation

group was significantly better than that in the control group ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of blood gas index levels between the two groups before and after 21 days of treatment (mean \pm SD)

Group	PaO ₂ (mmHg)		PaCO ₂ (mmHg)		pH value	
	Before	After 21 d	Before	After 21 d	Before	After 21 d
Control group ($n = 25$)	55.86 \pm 5.33	72.61 \pm 6.70*	61.41 \pm 5.20	46.20 \pm 3.54*	7.15 \pm 0.15	7.26 \pm 0.20*
Observation group ($n = 26$)	55.84 \pm 5.36	77.40 \pm 7.57*	61.43 \pm 5.23	43.33 \pm 3.51*	7.16 \pm 0.17	7.44 \pm 0.38*
<i>t</i>	0.013	2.389	0.014	2.907	0.222	2.104
<i>P</i>	0.989	0.021	0.989	0.005	0.825	0.041

* $P < 0.05$ compared to before treatment.

3.3. Inflammation index levels

As shown in the results of analyzing the levels of various arterial blood gas indicators of the control group and the observation group before treatment and after 21 days of treatment in **Table 3**, the levels of serum CRP, IL-6, and PCT of the two groups after 21 days of treatment were lower than those before treatment, and the latter group was significantly lower than the former group ($P < 0.05$).

Table 3. Comparison of the levels of inflammatory indicators between the two groups (mean \pm SD)

Group	CRP (mg/L)		IL-6 (pg/L)		PCT (ng/L)	
	Before	After 21 d	Before	After 21 d	Before	After 21 d
Control group ($n = 25$)	42.60 \pm 5.21	9.80 \pm 1.03*	16.26 \pm 1.51	5.33 \pm 1.06*	2.70 \pm 0.35	0.39 \pm 0.05*
Observation group ($n = 26$)	40.63 \pm 5.23	6.41 \pm 0.71*	16.33 \pm 1.54	4.08 \pm 0.69*	2.63 \pm 0.39	0.21 \pm 0.03*
<i>t</i>	1.347	13.549	0.048	5.284	0.668	15.435
<i>P</i>	0.184	< 0.001	0.962	< 0.001	0.507	< 0.001

* $P < 0.05$ compared to before treatment.

3.4. SGRQ score, CAT score, and 6MWD

After 21 days of treatment, the SGRQ scores and CAT scores of the 2 groups were lower than before treatment, the observation group also showed lower scores than the control group ($P < 0.05$). The 6MWD results showed that both groups had further distance after treatment, and the observation group had a significantly further distance than the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of SGRQ score, CAT score, and 6MWD between two groups (mean \pm SD)

Group	SGRQ score (points)		CAT score (points)		6MWD (m)	
	Before	After 21 d	Before	After 21 d	Before	After 21 d
Control group ($n = 25$)	70.32 \pm 7.57	64.81 \pm 5.15*	25.41 \pm 4.20	22.28 \pm 3.31*	202.41 \pm 14.35	235.41 \pm 16.12*
Observation group ($n = 26$)	70.34 \pm 7.55	60.40 \pm 4.60*	25.44 \pm 4.22	19.30 \pm 2.10*	202.43 \pm 14.37	247.18 \pm 17.30*
<i>t</i>	0.009	3.228	0.025	3.855	0.005	2.511
<i>P</i>	0.993	0.002	0.980	< 0.001	0.996	0.015

* $P < 0.05$ compared to before treatment.

4. Discussion

Chronic obstructive pulmonary disease (COPD) is a type of chronic airway inflammation characterized by airflow obstruction. Budesonide-formoterol is a commonly used drug for treating COPD during the recovery period. Although it can have a therapeutic effect, there are still some limitations.

The results of this study showed that the total clinical effective rate of the observation group after 21 days of treatment was higher than that of the control group. Additionally, the PaO₂ level and pH value of the patients in the observation group after 21 days of treatment were higher, and the PaCO₂ level was lower than before treatment. This indicates that budesonide-formoterol can effectively improve the blood gas indexes of patients in the remission stage of COPD and enhance the clinical therapeutic effect, which aligns with the results of Bian *et al.* [8]. Budesonide-formoterol is a compound preparation based on active ingredients such as formoterol fumarate, graneroside, and budesonide. It has a high affinity for the body's cholinergic receptors, can inhibit the contraction of bronchial smooth muscle, relieve spasms, promote the restoration of pulmonary ventilation and lung function, regulate the water-electrolyte balance, and improve blood gas indexes [9].

The results of this study also showed that the serum CRP, IL-6, and PCT levels, as well as the SGRQ and CAT scores of patients in the observation group after 21 days of treatment, were lower than those of the control group. Additionally, the 6-minute walk distance (6MWD) was greater in the observation group. This indicates that budesonide-formoterol can effectively reduce inflammatory reactions in patients with COPD during the remission stage, improve clinical symptoms, and promote recovery, consistent with the findings of Chen *et al.* [10]. Serum CRP, IL-6, and PCT are key indicators reflecting the inflammatory state of the body. Patients with COPD in the recovery period are in a state of long-term airway hyperreactivity, with elevated levels of inflammatory mediators and related cytokines. Budesonide-formoterol can effectively relax the central and peripheral airways, block the M3 cholinergic receptors in bronchial smooth muscle, act on the M1 receptor, and combine with muscarinic receptors. This down-regulates the expression of inflammatory factors, reduces the inflammatory response, and promotes recovery [11].

In conclusion, budesonide-formoterol can effectively improve the blood gas indexes of patients with COPD in remission, improve clinical symptoms, reduce the inflammatory response, and promote patient recovery, demonstrating accurate therapeutic effects.

Disclosure statement

The author declares no conflict of interest.

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