

## Original Research Article

# Effectiveness of the combination of terbutaline and budesonide inhalation in treating acute bronchial asthma during pregnancy

Guozhi Zhang<sup>1</sup>, Lina Zhou<sup>2</sup>, Shanshan Guo<sup>3</sup>, Mei Wang<sup>4</sup>, Ling Han<sup>5\*</sup>

<sup>1</sup>Department of Respiratory, PLA Strategic Support Force Characteristic Medical Center, <sup>2</sup>Department of Health Care, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, <sup>3</sup>General Family Medicine, PLA Rocket Force Characteristic Medical Center, <sup>4</sup>Department of Cardiothoracic Surgery, PLA Rocket Force Characteristic Medical Center, <sup>5</sup>Clinical Development, Gilead Sciences, Beijing 100020, China

\*For correspondence: **Email:** star1632023@163.com; **Tel:** 86013601318447

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### Abstract

**Purpose:** To investigate the therapeutic benefits of terbutaline sulfate aerosol inhalation combined with budesonide, and its influence on pulmonary function in pregnant women suffering from acute bronchial asthma attacks.

**Methods:** A total of 100 pregnant patients diagnosed with acute bronchial asthma in PLA Strategic Support Force Characteristic Medical Center, Beijing, China were divided into control and study groups ( $n = 50$  each). Control group received aerosol inhalation of normal saline along with standard treatments, viz, oxygen inhalation, sputum aspiration, anti-infection measures, and maintenance of water-electrolyte balance. Study group received combined terbutaline sulfate and budesonide aerosol inhalation in addition to standard treatment. Both groups underwent a 7-day treatment course, with inhalation therapy twice daily.

**Results:** Study group showed significantly shorter relief times for cough, wheezing, and chest tightness compared to control group ( $p < 0.05$ ). After treatment, 92.0 % of patients in study group exhibited improvement or relief from their symptoms, compared to 80.0 % in control group ( $p < 0.05$ ). Pulmonary function indices, including first vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), and FEV1/FVC, improved in both groups after treatment. Study group exhibited significantly lower laboratory indices, including immunoglobulin E (IgE), C-reactive protein (CRP), and eosinophils (EOS) compared to control group ( $p < 0.05$ ).

**Conclusion:** The combination of inhalation therapy of terbutaline sulfate with budesonide in pregnant women experiencing acute bronchial asthma demonstrates significant enhancements in clinical effectiveness, pulmonary function, and laboratory parameters. Clinical trials of this combined therapy should be carried out in other locations to ascertain the effect of population variation on treatment efficacy.

**Keywords:** Budesonide, Terbutaline, Pregnancy, Asthma, Aerosol inhalation therapy

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## INTRODUCTION

Gestational asthma is a common respiratory disease during pregnancy. It is characterized by chronic airway inflammation and airway hyper-responsiveness (AHR). Recurrent wheezing, cough, shortness of breath, and chest tightness are the main clinical manifestations of bronchial asthma [1]. Based on clinical presentations, gestational asthma is categorized into acute exacerbation, chronic persistence, and clinical remission [2]. An acute attack refers to the sudden onset of symptoms such as coughing, wheezing, shortness of breath, and chest tightness, or a significant worsening of pre-existing symptoms. Chronic persistence asthma, on the other hand, describes the occurrence of these symptoms at varying frequencies and intensities over the past three months [3]. Acute asthma symptoms develop rapidly, leading to severe conditions like dyspnea, and chest tightness. In some cases, even pneumothorax or purulent pneumothorax may ensue, and if not promptly treated, it negatively impacts the quality of life for pregnant women and poses health risks [4]. Patients with chronic persistent asthma experience recurrent symptoms that disrupt their daily lives. If not managed promptly, it leads to a decline in lung function, exacerbates severity of asthma, and complicates asthma treatment. In recent years, the prevalence of gestational asthma has increased globally [5]. Asthma has become a global disease affecting pregnant women, becoming a major reason for hospitalization.

At present, inhaled corticosteroids (ICS), long-acting  $\beta_2$  receptor agonists (LABA) and leukotriene receptor antagonists (LTRA) are the main control drugs, short-acting  $\beta_2$  receptor agonists (SABA) [7], inhaled anticholinergic drugs and short-acting theophylline are main relieving drugs for asthma in pregnant women both domestically and globally. Glucocorticoids (GCs) gain entry into cells through the cell membrane where they bind to glucocorticoid receptor (GR) located in the cytoplasm. Subsequently, the GC-GR complex translocates into the nucleus, where it binds to specific DNA sites. This binding initiates gene transcription, resulting in up-regulation or down-regulation of specific genes. These transcriptional changes affect levels of proteins involved in inflammatory response, ultimately modulating cellular and molecular processes required for inflammation. This mechanism contributes to the inhibition of airway inflammation in asthma [8].

Furthermore, glucocorticoids rapidly exert cellular effects through non-genomic actions, allowing for

a quicker onset of action in the treatment of acute asthma. The main mechanism of SABA is that it binds to  $\beta_2$  receptors on the surface of airway smooth muscle increasing the concentration of intracellular cAMP (cyclic adenosine monophosphate). As a signal molecule, cAMP finally transmits information to intracellular calcium pump, promotes intracellular calcium outflow to relax airway smooth muscle, increases airway flow of pregnant women with asthma, and relieves symptoms of shortness of breath and wheezing. Anticholinergic drugs dilate the airway and reduce mucus secretion and mediator release by blocking M3 receptors on airway smooth muscle and mast cells, thus reducing parasympathetic tension.

Clinical studies have shown that drug combination in treatment of asthma improve their efficacy and reduce adverse reactions. Aerosol inhalation of ICS combined with  $\beta_2$  receptor agonist is often used in treatment of asthma, but its effect on nocturnal attacks is poor, and symptoms are easily repeated.

Short-acting beta-agonists (SABA) not only exhibit anti-asthmatic effects but also mask airway inflammation. In recent years, the safety of exclusive long-term treatment of asthma using  $\beta_2$  receptor agonists has come under scrutiny. At night, the parasympathetic nervous system exerts a strong influence. As a relieving drug for treatment of asthma in pregnant women, M receptor blocker, ipratropium effectively blocks parasympathetic nerve response, thereby relaxing bronchial smooth muscles in asthma patients. Importantly, adverse reactions to ipratropium are infrequent and generally mild, contributing to its high safety profile [10].

Inhalation treatment of bronchial asthma is the first choice of the global asthma prevention and Treatment Initiative (GINA), and it has been widely valued by clinical medical workers. Therefore, this study aimed to assess the effectiveness of terbutaline and budesonide suspension in improving the complete control rate of bronchial asthma during pregnancy. This was achieved by evaluating relevant clinical indicators in pregnant individuals with bronchial asthma who received aerosol inhalation of terbutaline and budesonide suspension.

## METHODS

### General patient information

A total of 100 pregnant women diagnosed with asthma and treated in PLA Strategic Support Force Characteristic Medical Center, Beijing,

China between January 2020 to April 2023 were randomly divided into study group (n = 50) and control group (n = 50). This study was approved by the ethics committee of PLA Strategic Support Force Characteristic Medical Center (approval no. ZN-031). The procedures followed the guidelines of Helsinki Declaration [11] and informed consent was obtained from each patient before they were enrolled in the study.

### **Inclusion criteria**

Pregnant women diagnosed with asthma and treated from January 2020 to April 2023.

### **Exclusion criteria**

Patients with active bleeding, recently undergone nasal or facial surgery; the presence of chronic respiratory failure or patients who need long-term non-invasive ventilator-assisted ventilation, severe *cor pulmonale* and right heart failure, or other serious organ diseases, including uncontrollable hypertension, diabetes, liver and kidney insufficiency, metabolic disorders, patients with mental illnesses who are unable to comply with treatment, and allergic to drugs used.

### **Treatment protocols**

Patients in the two groups were treated with the same comprehensive treatment, including oxygen inhalation, anti-inflammatory and phlegm removing agents, while the study group in addition received 3 mL terbutaline sulfate, 3 mL normal saline, followed by 3 mL budesonide and 3 mL normal saline, administered through atomization inhalation twice daily. Pulmonary function test was performed in each group before treatment and 7 days after treatment, and the main clinical symptom relief time of the two groups was calculated at the same time.

### **Clinical analysis**

#### **Assessments**

The time it took for cough, wheezing, and chest tightness to alleviate, as well as any side effects of B2 receptor agonists and ICS, such as palpitations, dry mouth, hoarseness, and oral candida infection was recorded.

#### **Pulmonary function**

The SN65511 pulmonary function tester was used to assess pulmonary function.

Pulmonary function tests were conducted before and after treatment. Key treatment indices were first-second forced expiratory volume (FEV1), forced vital capacity (FVC), ratio of first-second forced expiratory volume to forced vital capacity (FEV/FVC), and peak expiratory flow (PEF).

#### **Blood analysis**

Venous blood (2 ml) was collected from patients' elbows before and after treatment to measure serum levels of C-reactive protein (CRP), immunoglobulin E (IGE), and eosinophil percentage (EOS).

#### **Treatment indices**

Evaluation of treatment effectiveness was based on criteria established by the Respiratory Branch of the Chinese Medical Association for diagnosing and assessing the curative effect of asthma. Criteria are as follows:

##### **Complete relief**

Patients were considered to have achieved complete relief if their asthma symptoms were entirely relieved, and occasional mild attacks could be resolved without need for medication. Additionally, if the increase in Forced Expiratory Volume in one second (FEV1) was greater than 35 %, or if post-treatment FEV1 was greater than or equal to 80 % of the expected value, it was categorized as complete relief.

##### **Very effective**

This category was assigned when asthma attacks had significantly improved compared to before treatment, with an increase in FEV1 ranging from 25 to 30 %, or if post-treatment FEV1 reached 60 - 79 % of the expected value. However, patients in this category still required glucocorticoids or bronchodilators.

##### **Effective**

Patients were classified as effective if their asthma symptoms had alleviated, with an increase in FEV1 ranging from 15 % to 24 %, and symptom relief exceeding 60 %. They also continued to require glucocorticoids or bronchodilators.

##### **Ineffective**

In cases where clinical symptoms remained unchanged or worsened, and there was no change in FEV1 measurements, treatment was

considered ineffective. The categories 'Effective' and 'Obvious Effect' were combined for statistical analysis as effective outcomes, while "Complete Relief" was considered highly efficient outcome.

### Statistical analysis

Statistical analyses were conducted using SPSS 21.0 software (IBM, Armonk, NY, USA). Categorical data were presented as frequencies and percentages (n, %) and analyzed using the chi-square test. Continuous data were expressed as mean  $\pm$  standard deviation (SD) and analyzed using t-test.  $P < 0.05$  was considered statistically significant.

## RESULTS

### General information

There were 28 primary parturients and 22 multi-parturients. Age range varied from 26 to 36 years, with an average of ( $31 \pm 1.81$ ) years. In control group, gestational periods ranged from 25 to 34 weeks, with an average pregnancy duration of ( $30 \pm 1.25$ ) weeks. Among participants, there were 28 primary parturients and 22 multi-parturients, with ages ranging from 26 to 36 years and an average age of ( $31 \pm 1.81$ ) years. In study group, gestational periods ranged from 24 to 36 weeks, with an average pregnancy duration of ( $30 \pm 1.57$ ) weeks. This group

comprised 27 primary parturients and 23 multi-parturients, with ages ranging from 25 to 37 years and an average age of ( $31 \pm 1.64$ ) years. No significant differences were observed between two groups in terms of general demographic data, including age, number of pregnancies, and gestational weeks ( $p > 0.05$ ; Table 1). There was also no statistical difference ( $p > 0.05$ ) between the two groups in terms of the course of disease, and lung function indicators (FEV1, FVC, FEV1/FVC, PEF), (Table 1).

### Symptom relief time after treatment

Treatment group exhibited significantly shorter relief times for symptoms like cough, wheezing, and chest tightness compared to control group ( $p < 0.05$ ; Table 2).

### Improvement of lung function

After treatment, there was a significant increase in percentage of predicted lung ventilation function indicators, including FVC and FVC % (Table 3), as well as FEV1 and FEV1 % (Table 4). Additionally, PEF and PEF % showed significant improvement (Table 5), along with FEV1/FVC % (Table 6). This improvement was observed in pregnant patients with bronchial asthma. Study group showed a significant increase compared to control group ( $p < 0.05$ ; Figure 1).

**Table 1:** General information on patients (mean  $\pm$  SD)

General information	Control group	Treatment group
Age (year)	30 $\pm$ 1.22	30 $\pm$ 1.57
FEV1 (L) before treatment	1.21 $\pm$ 0.12	1.20 $\pm$ 0.06
FEV1% before treatment	44.19 $\pm$ 11.27	42.19 $\pm$ 13.12
FVC (L) before treatment	1.96 $\pm$ 0.25	2.01 $\pm$ 0.19
FVC % before treatment	52.63 $\pm$ 14.22	52.13 $\pm$ 15.44
FEV1/FVC before treatment	0.64 $\pm$ 0.11	0.60 $\pm$ 0.10
PEF (L/min) before treatment	2.17 $\pm$ 0.21	1.99 $\pm$ 0.23
PEF% before treatment	34.25 $\pm$ 13.15	35.13 $\pm$ 14.11

**Table 2:** Symptom relief time after treatment (days)

Group	Cough	Pant	Chest distress
Treatment	4.89 $\pm$ 0.56	3.14 $\pm$ 0.51	4.12 $\pm$ 0.42
Control	6.81 $\pm$ 0.97	5.71 $\pm$ 0.64	6.13 $\pm$ 0.75
P-value	<0.05	<0.05	<0.05

**Table 3:** Comparison of FVC and FVC% before and after treatment (mean  $\pm$  SD)

Group	FVC (Liters)		FVC %	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Control	1.96 $\pm$ 0.25	2.32 $\pm$ 0.38	52.63 $\pm$ 14.22	65.63 $\pm$ 10.87
Study	2.01 $\pm$ 0.19	2.86 $\pm$ 0.81	52.13 $\pm$ 15.44	76.5 $\pm$ 14.65
P-value	>0.05	<0.05	>0.05	<0.05

**Table 4:** Comparison of FEV1 and FEV1 % before and after treatment (mean ± SD)

Group	FEV1 (Liters)		FEV1%	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Control	1.21±0.12	1.66±0.40	44.19±11.27	61.00±15.08
Study	1.20±0.06	2.22±0.50	42.19±13.12	80.44±10.78
P-value	>0.05	<0.05	>0.05	<0.05

**Table 5:** Comparison of PEF and PEF% before and after treatment (mean ± SD)

Group	PEF (L/s)		PEF %	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Control	2.17±0.21	3.25±0.86	34.25±13.15	48.00±15.16
Study	1.99±0.23	4.45±0.67	35.13±14.11	63.31±17.81
P-value	>0.05	<0.05	>0.05	<0.05

**Table 6:** Comparison of FEV1/FVC% before and after treatment (mean ± SD)

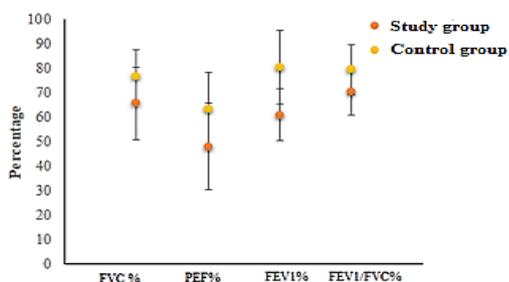
Group	FEV1/FVC (%)	
	Pre-treatment	Post-treatment
Control	64.14±9.13	70.56±10.16
Study	59.23±14.29	79.38±9.63
P-value	> 0.05	< 0.05

**Table 7:** Comparison of CRP, IgE and EOS levels before and after treatment (mean ± SD)

Group	CRP (mg/L)		IgE (IU/mL)		EOS (%)	
	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
Study	6.4±1.0	3.8±0.6	388.7±54.2	88.5±10.4	4.2±0.6	2.2±0.5
Control	6.7±0.9	5.1±0.9	389.4±55.3	153.4±16.7	4.3±0.8	3.3±0.6
T-value	1.4103	7.6012	0.0572	20.8637	0.6325	8.9075
P-value	>0.05	<0.05	>0.05	<0.05	>0.05	<0.05

**Table 8:** Comparison of therapeutic effects between two groups (N = 50)

Group	Proven effectiveness	Effective	Ineffective	Total effectiveness
Study group	35	11	4	92.0%
Control group	29	11	10	80.0%
$\chi^2$				4.235
P-value				< 0.05



**Figure 1:** Comparison of the percentage of FVC, FEV1, and PEF to expected values and FEV1/FVC% between the two groups after treatment

**Serum CRP, IGE, and EOS levels**

Before treatment, there was no statistically significant difference in serum CRP, IgE, and EOS levels in study and control groups ( $p > 0.05$ ). After treatment, serum CRP, IgE, and EOS

levels in both groups of patients were significantly lower than before treatment ( $p < 0.05$ ). Serum CRP, IgE, and EOS levels in study group after treatment were significantly lower than control group ( $p < 0.05$ ) (Table 7 and Figure 4).

**Treatment effectiveness**

After one week of treatment, there were 50 cases in study group, with a total effective rate of 92.0 %. There were 50 cases in control group, with a total effective rate of 80.0 %. Clinical efficacy of study group was better than control group ( $p < 0.05$ ) (table 8).

**Safety assessment**

Study group did not experience symptoms such

as nausea and pharyngeal discomfort after nebulizing medication. Patients were advised to rest appropriately during nebulization and rinse their mouths after nebulization to alleviate these symptoms. There was no significant difference in number of adverse reactions in study group compared to control group ( $p > 0.05$ ).

## DISCUSSION

Bronchial asthma is chronic non-specific inflammation of airways, which leads to airway hyper-responsiveness after its formation. Airway exposure to various risk factors leads to airway obstruction and airflow restriction (caused by bronchoconstriction, mucus embolism and the aggravation of inflammatory reaction) characterized by widely variable reversible airflow restriction. Main pathological and physiological changes during the onset of bronchial asthma are various secondary factors that cause smooth muscle spasm, inflammatory cell infiltration, mucosal congestion and edema, increased gland secretion leading to airway stenosis, and clinical manifestations such as hypoxia, and carbon dioxide storage [12]. Any level of asthma attack has the potential to be life-threatening. The goal of asthma treatment is to quickly control symptoms, reduce or prevent seizures, and improve lung function. Treatment principle quickly alleviates airflow obstruction, eliminates airway secretion, and reduces airway inflammation, thereby ensuring normal ventilation and ventilation function. Glucocorticoid inhalers are used as anti-inflammatory drugs.

Terbutaline is a short-acting  $\beta_2$  receptor agonist that primarily acts on small airways to relax bronchial smooth muscles, reduce vascular permeability, and improve lung function. However, long-term usage leads to reduction in number of receptors or a decrease in sensitivity. Its adverse reactions commonly include palpitations, tachycardia, and chest tightness, among others. Some studies indicate that terbutaline, when administered via inhalation achieved the most effective and rapid results in asthma treatment. Onset was within 5 to 10 min, reached its peak effectiveness within an hour, and maintained its effects for approximately 4 h [13]. But there are also reports that daily application of  $\beta_2$  receptor agonists causes severe acute asthma attacks and sudden death. A meta-analysis evaluation of Salpeter and others found that there was no significant increase in severity of asthma attacks and asthma-related hospitalization rates among those who used LABA and  $\beta_2$ -receptor agonists in treatment of asthma in pregnant women. A combination of budesonide suspension and

terbutaline has poor control of nocturnal asthma attacks and is prone to recurrent symptoms.  $\beta_2$ -receptor agonists have been widely used in clinical practice as rapid symptom-relief drugs [14].

In another study in pregnant patients complicated by acute attack of bronchial asthma, dose of terbutaline was reduced and ipratropium was administered to study group while control group received budesonide and terbutaline aerosol inhalation [15]. Frequency of medication administration was once every 6 h for patients during acute episodes and twice a day for patients during chronic durations. Combination of three drugs and nebulization inhalation accounts for the shortcomings of combination therapy in treatment of childhood asthma by simultaneously stimulating bronchial smooth muscle  $\beta_2$  receptors, blocking M receptors and up-regulating them. Results of this study showed that total effective rate of budesonide combined with terbutaline aerosol inhalation in study group was higher than control group for patients with acute attack. Compared with control group, the main clinical symptoms of study group, such as cough, wheezing, and chest tightness, disappeared and the hospital stay was shortened.

Pulmonary function measurement is used to evaluate the severity, reversibility, and variability of airflow restriction, which helps to establish the diagnosis of asthma. It is also the most important objective indicator for investigating the efficacy of anti-asthma drugs. Forced expiratory volume in 1 sec (FEV1) and the ratio of FEV1 to first vital capacity rate (FEV1/FVC %) are important parameters that reflect significant airway expiratory resistance, which is negatively correlated with the degree of airway obstruction in asthma patients. High airway response indirectly reflects changes in airflow [16]. In this regard, FEV1 has good reproducibility and is a basic testing item for asthma pulmonary function testing, used for initial diagnosis and grading of severity of asthma. The 1-second rate is more sensitive than 1-second forced expiratory volume, and asymptomatic mild asthma patients may have a normal 1-second forced expiratory volume, while 1-second rate often decreases.

Peak expiratory flow (PEF) is the instantaneous maximum flow rate at the end of deep inspiration when exhaling forcefully, and is not controlled by the environment. Peak expiratory flow (PEF) is of great value in reflecting airway instability, judging the severity of the disease, detecting its long-term changes, and measuring clinical treatment response, and it has a good correlation with

FEV1, PEF, FEV1, FVC, FEV1/FVC%. Maximum voluntary ventilation (MVV) predominantly indicates the functioning of large airways, while MMEF (maximum mid-expiratory flow), V50 (flow rate at 50 % of expiratory vital capacity), and V25 (flow rate at 25 % of expiratory vital capacity) primarily assesses small airway function. Bronchial asthma onset leads to airway obstruction caused by bronchial smooth muscle spasms, mucus secretion, and mucous membrane swelling. These factors result in reduced respiratory volume and impact both large and small airway functions, with a more pronounced effect on small airway functions. Primary alterations in lung function involve disorders in small airway ventilation, primarily characterized by obstructive ventilation issues, and followed by mixed ventilation disorders [17]. The lung volume index showed a decrease in FVC. Expiratory flow rate refers to the presence of moderate to severe damage to FEV1, with PEF significantly lower than normal. More frequent and prolonged onset causes more significant decrease in PEF and worsens the reversibility of the airway. During remission period of asthma, there is still significant inflammatory infiltration, hypertrophy of smooth muscles, edema of luminal mucosa, and embolism of luminal mucus in bronchial smooth muscle. Disappearance of elastic retraction force leads to excessive inflation, long-term small airway obstruction and difficulty in retraction, which leads to pulmonary dysfunction. Respiratory disorders during asthma remission period are mainly restrictive. Pulmonary function indicators showed significant improvement in large airway function, with the highest abnormal rate of PEF.

Relevant studies have indicated that there are no significant differences in FEV1 %, FEV1/FVC, in healthy young adults when compared to young and middle-aged patients during remission period. However, there is a notable contrast in FEV1 %, FEV1/FVC, between young, middle-aged asthma patients, and elderly patients with late-onset bronchial asthma during remission period. Analysis reveals that lung function tends to decrease with age. Some elderly patients may have a history of smoking, which is associated with chronic obstructive pulmonary disease (COPD). In some instances, routine lung ventilation function tests may reveal impaired small airway function in elderly patients. Following an asthma episode, further damage may occur to small airways, accelerating the progression of COPD. This also results in a more severe condition, slower recovery, and incomplete recovery in elderly patients with bronchial asthma [18].

After one week of atomization of terbutaline and budesonide, pulmonary function indices of patients were significantly increased. Combination of two drugs significantly improved the degree of airway obstruction in patients with acute exacerbation of pregnancy, complicated with bronchial asthma. In study group, there was significant difference in percentage of PEF in relation to expected value. This finding confirms a substantial improvement in large airway function during remission period of asthma. Conversely, the difference in FEV1/FVC % was the smallest, suggesting that this particular indicator is less sensitive when it comes to reflecting efficacy of bronchodilators. This is because increase in FVC after medication may offset increase in FEV1, resulting in a less significant increase in FEV1/FVC %, and even a decrease in some patients.

Airway inflammation detection indicators include eosinophil count and percentage in peripheral blood, induced sputum, exhaled nitric oxide, and CRP, amongst others. Asthma patients have clinical characteristics such as increased serum immunoglobulin E (IgE), and eosinophils (EOS). C-reactive protein (CRP) is an acute phase-responsive protein whose level rapidly increases during infection, inflammation, and tissue damage. Research results have shown that in more severe onset of asthma, CRP level increases. The level of CRP serves as an objective biochemical marker for evaluating the severity and control of asthma in clinical practice [19]. Immunoglobulin E (IgE) has cytopathic activity and combines with mast cells and basophils *in vivo*. It is a mediator of type I allergy. Research has shown that there is a positive correlation between the degree of asthma in children with bronchial asthma and expression level of serum total IgE. In clinical work, combined determination of expression levels of eosinophil cationic protein and IgE in serum, as well as FEV1 is of great significance in early diagnosis of asthma and determination of its severity [11]. Results of this study showed that for patients with acute exacerbations of pregnancy, IgE, CRP, and EOS of study group were significantly lower than control group ( $p < 0.05$ ). This indicated that asthma control in study group was better compared to control group, and the risk of future asthma recurrence was lower.

#### Limitations of the study

The fact that very few patients were used in this study in a single center is a major limitation followed by the short duration of study and the limited parameters that were investigated. There

is a need for further investigation on improving asthma control using a combination of terbutaline with budesonide in pregnant patients primarily because of their relative safety in this patient population.

## CONCLUSION

Efficacy of atomized inhalation of terbutaline combined with budesonide in the treatment of acute exacerbation of asthma in pregnant patients is high, It reduces the onset of chronic persistent asthma, reduces time of symptom disappearance in patients with acute exacerbation, improves lung function, shows fewer adverse reactions, and has a good safety margin. However, clinical trials in other centers are required to ascertain the effect of population variation on treatment efficacy.

## DECLARATIONS

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None provided.

### Funding

None provided.

### Ethical approval

This study was approved by the Ethics Committee of PLA Strategic Support Force Characteristic Medical Center (approval no. ZN-031).

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflict of Interest

No conflict of interest associated with this work.

### Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by them.

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