

# Exploring the Therapeutic Role of Budesonide in Respiratory and Gastrointestinal Disorders: A Review

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**Abstract: Objectives:** This review examines the efficacy, safety, and therapeutic role of budesonide in respiratory and gastrointestinal disorders, focusing on asthma and Crohn's disease.

**Evidence Acquisition:** A comprehensive analysis of existing literature, including systematic reviews and clinical trials, was conducted.

**Results:** Budesonide showed high efficacy in asthma and Crohn's disease management with fewer systemic side effects compared to conventional corticosteroids.

**Conclusion:** Budesonide is an effective corticosteroid for managing chronic inflammatory diseases, with reduced systemic complications. Future research should focus on long-term safety and optimal dosing strategies.

**Keywords:** Formoterol, budesonide, Asthma, Gastrointestinal disorders

## INTRODUCTION

Budesonide is a very potent corticosteroid that, because of its powerful anti-inflammatory effects and targeted delivery mechanisms, has become a staple therapeutic agent in the treatment of various respiratory and gastrointestinal disorders. The use ranges from asthma to Crohn's disease, where inflammation characterizes these diseases.

In respiratory diseases, budesonide is applied to the treatment of asthma. Budesonide administered through inhalation, it substantially decreases airway inflammation associated with the management of asthma and also prevents signs of asthma. Through inhalation, the route ensures that there remains a high concentration of local drugs in the lungs with low systemic exposure; this is meant to address side

effects typical of systemic corticosteroids (3) Budesonide is usually used in combination with long-acting beta-agonists, such as formoterol, for enhanced efficacy regarding the improvement of well-being and reduction in asthma exacerbations. Clinical studies have well established the fact that budesonide, especially in the combination formulations, results in better control over asthma symptoms and improves the quality of life of patients (4,5).

The major use of budesonide is in the treatment of the mild to moderate forms of ileo and right colon Crohn's disease. Formulated this way, budesonide is only released within specific areas within the gastrointestinal tract, and it minimizes systemic absorption as well as the side effects that usually accompany its absorption. On these grounds, budesonide works better than other traditional corticosteroids in the induction of remission in patients diagnosed with Crohn's disease. Studies established that budesonide significantly decreases the inflammation of the intestine and achieves clinical remission with a superior safety profile compared to systemic corticosteroids (1,2)

Generally, the implications of the ability of budesonide to deliver selectively anti-inflammatory effects without systemic side effects are huge in the treatment of chronic inflammatory diseases. An introduction represents an overview of the role of budesonide in respiratory and gastrointestinal disorders so as to demonstrate clinical benefits, safety profile, and therapeutic applications.

Table 1. Systemic Corticosteroid Properties

Medication	Anti-Inflammatory Potency (relative)	Equivalent Potency (mg)	Duration of Effect (hypothalamic-pituitary-adrenal axis) (h)	Mineralocorticoid Potency (relative)
<b>Short acting</b>				
Hydrocortisone	1	20	8-12	1
<b>Intermediate acting</b>				
Prednisone	4	5	18-36	0.8
Prednisolone	4	5	18-36	0.8
Methylprednisolone	5	4	18-36	0.5
<b>Long acting</b>				
Dexamethasone	25	0.75	>36	0

Figure 1: properties of systemic corticosteroids

Evidence Acquisition:

Pharmacological activity:

Budesonide is one of the very potent glucocorticoids and has all the pharmacological actions in the treatment of both respiratory and gastrointestinal tract disorders. The efficacy is found to be particularly owing to its strong anti-inflammatory profile and its effects on the modulation of immune responses. Thus, the pharmacological actions of budesonide are presented below table 1:

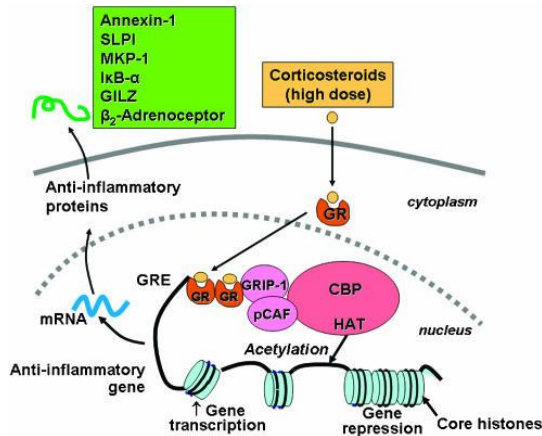


Figure 2: mechanism of action of corticosteroids (7)

Respiratory Diseases

1. Anti-Inflammatory Activities: Budesonide markedly reduces inflammation in the airway. This is due to;

- Inhibition of synthesis and release of pro-inflammatory mediators such as cytokines, leukotrienes, and prostaglandins.

Table 1: pharmacological actions of budesonide

Action	Mechanism
Anti-Inflammatory	Inhibits pro-inflammatory cytokines, leukotrienes, and prostaglandins (6)
Gene Expression Modulation	Binds glucocorticoid receptors and alters transcription of inflammatory genes (7)
Reduction of Airway Hyperresponsiveness	Decreases chronic airway inflammation (3)
Mucus Production Inhibition	Suppresses goblet cells and mucin gene activity (6)

- Reduced infiltration and activity of inflammatory cells like eosinophils, T-lymphocytes mast cells and macrophages (6)

2. Gene Expression: Budesonide alters expression of genes that account for anti-inflammatory and pro-inflammatory activities by:

- The process starts with binding to glucocorticoid receptors in the cytoplasm with the formation of steroid-receptor complex.

This complex then Trans locates to nucleus where it binds to glucocorticoid response elements (GREs) in DNA with the enhancement of the transcription of anti-inflammatory genes and repression of the transcription of pro-inflammatory genes (7)

3. Reduction of Airway Hyperresponsiveness: Budesonide reduces the airways' sensitivity to different stimuli by:

- Decreases chronic inflammation, which in turn decreases airway hyperresponsiveness; this is the signature of the clinical presentation of asthma (3)

4. Mucus Production Inhibition: Budesonide diminishes mucus secretion by:

- Suppression of the activity of mucin genes and function of goblet cells those are responsible for mucus production (6)

5. Combination Therapy: When administered as a combination with LABAs such as formoterol:

This is because of the anti-inflammatory action of budesonide coupling with the LABAs effects, which are supposed to enhance lung function as well as reduce exacerbation more effectively than the respective agents working alone.

Gastrointestinal Disorders

1. Site-Specific Anti-Inflammatory Activity: Budesonide preparations in the treatment of Crohn's disease have their controlled release formulations targeted at the inflamed area of the gut, where it (table 2):

- Inhibits inflammation by suppressing inflammatory cytokine production, including TNF- $\alpha$  and IL-1 $\beta$ , and suppression of the activity of pro-inflammatory cells at the intestinal mucosa (1)

2. Immunosuppressive Activity: Budesonide suppresses the immune response by

- It decreases the activation and proliferation of the immune cells like T cells and macrophage, thereby

reducing chronic inflammation in the lining of the intestine (8)

3. Inhibition of NF-kB: Budesonide inhibits the transcription factor, nuclear factor-kappa B (NF-kB), which plays an important role in the expression of many pro-inflammatory genes:

- By inhibiting NF-kB, budesonide reduces inflammatory response inside the gut as a whole (9).

4. High first-pass metabolism: Budesonide undergoes extensive first-pass metabolism in the liver, which yields:

- Very low systemic bioavailability, thereby reducing side effects at systemic level and the drug is safer for long-term use in comparison to conventional steroids (2)

Table 2: budesonide vs conventional corticosteroids in crohn's disease

Parameter	Budesonide	Conventional Corticosteroids
Systemic Side Effects	Fewer systemic side effects	Higher risk of systemic side effects
First-Pass Metabolism	Extensive first-pass metabolism (2)	Limited first-pass metabolism
Long-term Use	Safer for long-term use	Higher risk of side effects with long-term use
Target Area	Ileum and right colon	Systemic distribution

Budesonide-Formoterol Combination for Asthma Treatment

The budesonide-formoterol combination is one of the most treasured treatments for asthma since it may be used by patients who require both maintenance and reliever treatment. The budesonide-formoterol combination combines budesonide, an inhaled corticosteroid (ICS), and formoterol, a LABA.

Components and Their Functions

- Budesonide: Inhaled corticosteroid that functions by reducing the inflammation characteristic of asthma in the airways and leads to decreased frequency and severity of asthma attacks (11).

- Formoterol: Long-acting beta-agonist: causes relaxation of smooth muscles in airways, thus producing quick and prolonged bronchodilation.

Indications

- Maintenance Therapy: They aid in control of asthma symptoms for a long term and prevent exacerbations of the disorder.

- Reliever Therapy: They provide relief in acute asthma symptoms due to rapid onset of action demonstrated by formoterol.

Mechanism of Action

- Budesonide: This drug is anti-inflammatory; hence it suppresses the inflammatory response in the

airways, reduces mucus production, and prevents hyperresponsiveness of the respiratory tract.

- Formoterol: It has the action at beta-2 adrenergic receptors in the bronchial smooth muscle to bring about bronchodilation, and this decreases the airway resistance and facilitates easy breathing. (16)

Dosage and Administration

- Maintenance: The drug is given twice a day though its dosage varies with the severity of asthma and other patient-related factors. (17)

- Reliever: It can be used as required for transient relief of acute symptoms. This two-for-one approach is called Single Maintenance and Reliever Therapy (SMART). (18)

Advantages

- Better overall asthma control: This is contributed by the combination of anti-inflammatory and bronchodilator properties. (19)

- Reduced exacerbations: This combination of treatment has a lower incidence of asthma exacerbation compared with treatment alone with ICS or any other therapy. (20)

- Convenience: Having a single inhaler for both maintenance and reliever therapy has an additive effect on increasing compliance and providing the therapy regimen in an easier manner. (21)

Side Effects

- Local Side Effects: Oral thrush (candidiasis) and hoarseness due to the corticosteroid component .(22)
- Systemic Side Effects: There is a risk of systemic effects with long-term usage, which may include adrenal suppression, though less likely than oral corticosteroids .(23)
- Beta-Agonist Associated: Shakiness, palpitations, and headaches associated with formoterol, and these are normally mild and short-lived. (24)

Monitoring and Considerations

- Adherence: The patient needs to be aware of the side effects so that adherence to the prescribed regimen is ensured.
- Proper Inhalation Technique: Education on proper use of inhalers should be coupled with follow-up and review as appropriate to assure proper delivery of medication.
- Studies and Guidelines: All such trials and guidelines, such as Global Initiative for Asthma (GINA), would support budesonide-formoterol in both as a maintenance and reliever treatment with the strong message that benefits would be more in improving asthma control and reduction in exacerbations than other regimens.

Table 3: budesonide-formoterol combination in asthma

Component	Function
Budesonide	Anti-inflammatory, reduces airway inflammation (11)
Formoterol	Bronchodilation, relaxes smooth muscle in the airways (16)
Combination Therapy	Provides both maintenance and relief in asthma (18)
Exacerbation Control	Reduces asthma exacerbations more effectively than monotherapy (19)

Budesonide in Asthma and Obstructive Airways Disease

Budesonide is a corticosteroid that is administered for treatment of asthma and other obstructive airway diseases like COPD. Given through aerosol suspension, dry powder inhaler and nebulized solutions, budesonide is basically used to reduce inflammation within the airways, prevent exacerbations and improve a patient's quality of life, especially among children and patients who are unable to use their traditional inhalers.

Mechanism of Action

Budesonide is an anti-inflammatory corticosteroid that regulates asthma and obstructive airway diseases through a few central actions:

- Decrease inflammation: This medication decreases the inflammation of the airways and reduces the frequency and severity of exacerbations both in asthma and COPD (11).
- Decrease the production of mucuses: This facilitates the reduction of mucus and makes the process of breathing easier (12).
- Prevent the action of airways hyperresponsiveness: It decreases the possibility of exacerbation of asthma by not permitting the airways to act overboard on a stimulus (13).

Indications

Budesonide is prescribed for the condition when there exists:

- Maintenance therapy, long-term: To be used for chronic control and prevention of asthma symptoms and exacerbations of COPD (14).
- Pediatric asthma: For young children who can't easily use device-driven inhaler devices (15).

Dosage and Administration

- Administration: Administer budesonide inhalation suspension by a nebulizer, where the solution is aerosolized into a mist for direct inhalation into the lungs (16).
- Dose: Generally in the range of 0.25 to 1 mg/day depending on the age of the patient and his or her intensity of disease (17).

Advantages

- Good Control of Asthma and COPD: The patients experience fewer exacerbations as this offers long-term control of asthma and COPD symptoms
- Ease of Administration: This medication is appropriate for younger children and others who have challenges in the use of metered-dose or dry powder inhalers
- Site of Administration: It is delivered directly to the lungs, thus avoiding all systemic side effects.
- Increases Lung Function: Benefits lung function by an improvement in FEV1 and PEFr (13).

## Side Effects

### Local Side Effects

- Oral Candidiasis: Local immunosuppression may lead to oral candidiasis and may be minimised by rinsing after use (21).
- Dysphonia: Hoarseness or alteration in voice is due to the effects from the drug to the vocal cords (17).

### Systemic Side Effects

- Adrenal Suppression: Prolonged use, especially at therapeutic doses, leads to suppression of the adrenals (22).
- Bone Mineral Density Loss: Prolonged use is suspected to lead to loss of bone mineral density, thereby raising the risk of osteoporosis and fractures (19).
- Growth Suppression in Children: Long-term use may lead to slight suppression of growth in children; however, this is dose dependent (20).

### Follow-Up and Precautions

- Maintenance Monitoring: The patient should be monitored concerning the control of asthma/COPD, side effects, and adherence to treatment(23).
- Monitoring of Growth: In pediatric patients, growth should be monitored during long-term treatment (24).
- Preventive Measures: Rinsing the mouth after inhalation decreases the likelihood of oral candidiasis. Long-term users are advised to undergo regular bone density measurements (25).

### Comparative Effectiveness

- Asthma: Budesonide is very efficient in managing long-term asthma and usually administered in a combination with LABAs for the optimal control of symptoms (22).
- COPD: It reduces the frequency of exacerbations and is commonly used concomitantly with LABAs or LAMAs. It must be used cautiously, however, as pneumonia is a risk, though (23).

## RESULTS

Asthma: Budesonide combined with formoterol effectively reduces asthma symptoms, improves lung function, and minimizes exacerbations, providing superior control over monotherapy.

Crohn's Disease: Budesonide's controlled-release formulation targets the ileum and colon, reducing inflammation with minimal systemic side effects, making it safer for long-term use.

## DISCUSSION

Budesonide's localized anti-inflammatory effects and high first-pass metabolism make it an optimal treatment for asthma and Crohn's disease. The drug's combination with formoterol further enhances asthma management, while in Crohn's disease, it reduces the need for systemic corticosteroids.

## CONCLUSION

Budesonide presents a favorable therapeutic option for respiratory and gastrointestinal disorders, combining high efficacy with a reduced side effect profile. Future research should address long-term safety and optimal dosing strategies to further improve treatment outcomes.

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### Conflicts of Interest

The authors declare no conflicts of interest.

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