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# Effectiveness of Different Intranasal Corticosteroid Delivery Methods in the Management of Chronic Rhinosinusitis with Nasal Polyps: A Comparative Review of Sprays, High-volume Irrigations, Exhalation Delivery Systems and Steroid-Eluting Stents

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**Abstract**

Chronic rhinosinusitis with nasal polyps (CRSwNP) is a common inflammatory condition of the nose and paranasal sinuses persisting for 12 weeks or more. It is associated with substantial symptom burden and reduced quality of life. While intranasal corticosteroids (INCS) continue to be the baseline of treatment, their clinical efficacy is often hindered by suboptimal delivery. In order to improve patients' quality of life and decrease topical corticosteroid usage, special attention is paid to the role of health education in both the prevention and therapy of the condition.

**Aim:** This study aims to systematically compare the effectiveness and clinical outcomes of four major intranasal corticosteroid (INCS) delivery methods - conventional sprays, high-volume rinses, exhalation delivery systems, and steroid-eluting stents - in the management of CRSwNP.

**Material and methods of research:** This study is a brief review of the available literature mainly in the PubMed database and a comparison of the effectiveness of different intranasal corticosteroid delivery methods, with a focus on their therapeutic approach. Particular focus is given to adapting delivery method to patient's condition and medical history. Specifically, the review evaluates patient-relevant outcomes, including disease-specific quality of life, symptom control, polyp size reduction, and the need for surgical intervention. By addressing these objectives, this study seeks to provide clinicians with concise guide for selecting the most appropriate delivery method tailored to individual patient and clinical context.

**Results:** Across RCTs and systematic reviews, all topical corticosteroid strategies outperform placebo. Methods that enhance sinonasal deposition (high-volume irrigations and EDS) demonstrate larger and more consistent effects on polyp size and patient-reported outcomes than conventional sprays, particularly in post-surgical anatomy. Steroid-eluting stents provide targeted benefit in selected postoperative scenarios. Delivery method selection should consider disease severity, surgical status, patient preferences, costs and availability.

**Keywords:** Chronic rhinosinusitis, nasal polyps, intranasal corticosteroids, exhalation delivery system, steroid-eluting stents, rinses, sprays, drug delivery systems

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## Introduction

Chronic rhinosinusitis with nasal polyps (CRSwNP) is a common inflammatory disease affecting the upper airways lasting more than 12 weeks. The European Position Paper on Rhinosinusitis and Nasal Polyps 2020 defines it as inflammation of the nose and the paranasal sinuses characterized by two or more symptoms, one of which should be either nasal blockage, obstruction, congestion, or nasal discharge. Additional symptoms may include facial pain or pressure, reduction or loss of smell. Diagnosis of CRSwNP requires objective confirmation via nasal endoscopy visualizing polyps or characteristic findings on CT sinus imaging. [1]

The disease contributes to healthcare resource use because of repeat steroid courses and surgery. CRSwNP causes profound impairment in quality of life, by frequent comorbidity with late-onset asthma and the high frequency of relapses or exacerbations following surgery. Health-related quality of life (HRQoL) is further reduced, with impacts comparable to chronic diseases like rheumatoid arthritis or diabetes. [2][3] Sleep, day-to-day functioning and general well-being are all negatively impacted, making effective treatment important. The heterogeneous nature complicates disease management. To manage symptoms, topical corticosteroids are recommended. However, there is still uncertainty regarding the optimal route of administration.

## Pathophysiology

The pathophysiology of CRSwNP is complex and multifactorial. It is predominantly associated with a Type 2 immune response, characterized by activation of Th2 cells, type 2 innate lymphoid cells (ILC2s) and elevated cytokines such as interleukin-4, interleukin-5, and interleukin-13. [4] These mediators promote eosinophilic inflammation, local IgE production, mucus hypersecretion, and tissue edema, which together contribute to nasal polyp formation and growth. Abnormal fibrin deposition and tissue remodeling contribute to polyp development and persistence. [5] Upstream epithelial cytokines including thymic stromal lymphopietin (TSLP), interleukin-33 and interleukin-25 are released in response to epithelial barrier dysfunction. Alterations of the sinonasal microbiome and microbial dysbiosis, together with impaired mucociliary clearance, further perpetuate chronic inflammation. CRSwNP is often associated with comorbid asthma and aspirin-exacerbated respiratory disease [4]. Although it is more common in men than in women, no particular genetic or environmental factors have been found to be closely associated with its development to date [6].

## Rationale for intranasal steroids

The foundation of treatment for CRSwNP are intranasal corticosteroids (INCS), because of their local anti-inflammatory effects and a more favorable safety profile compared with systemic corticosteroids [1][7]. Their clinical efficacy depends not only on pharmacologic potency but also on the ability of the formulation and delivery device to deposit drug beyond the anterior nasal cavity. [5][8] Although endoscopic sinus surgery effectively removes obstructing polyps and improves sinus ventilation, long-term disease control requires ongoing medical therapy to suppress inflammation and reduce risk of recurrence. INCS remain the mainstay of both pre- and post-operative management. [9] Topical corticosteroids reduce mucosal inflammation through multiple mechanisms, including suppression of pro-inflammatory cytokine expression, inhibition of eosinophil recruitment and survival, reduction of vascular permeability and reversal of mucosal edema. [1] Because topical administration achieves high local concentrations with limited systemic exposure, it minimizes systemic adverse effects compared with repeated systemic steroid courses. [10]

## Clinical Application and Treatment Selection

Guidelines and systematic reviews concur that INCS delivered by various methods significantly improve nasal congestion, olfaction, and reduce the need for rescue surgery. Contemporary consensus notes that conventional sprays, exhalation-delivery systems, and steroid-eluting stents are among the most beneficial delivery options. [11] In practice, monotherapy with simple spray is often adequate for mild polyposis or maintenance therapy, whereas more aggressive delivery may be needed for severe or refractory disease.

## Intranasal corticosteroid safety profile

Topical corticosteroids across delivery methods maintain excellent safety profiles, with primarily local adverse events and negligible systemic absorption, making them preferable to oral steroids. However, differences in deposition, volume, and technique influence side effect incidence and severity.

## Delivery Methods

There are four principal INCS delivery methods in current practice — conventional nasal sprays, high-volume saline irrigations (rinses) with added steroid, exhalation delivery systems (EDS), and steroid-eluting stents — each with distinct sinonasal deposition patterns, practical advantages and limitations. [11], [12], [13], [14] Randomized trials and systematic reviews

indicate that delivery method affects clinical outcomes, such as polyp size reduction, symptom scores (SNOT-22), and endoscopic inflammatory measures. The magnitude of benefit varies by patient anatomy, prior surgery, and adherence. [12], [15], [16] Understanding the effectiveness of these different delivery methods is essential for optimizing treatment strategies and personalizing care for patients with CRSwNP.

**Sprays**

Conventional low-volume corticosteroid sprays are the most common first-line treatment for CRSwNP. They are the most studied and widely used, safe, inexpensive, and user-friendly. Multiple trials and reviews show sprays provide modest but consistent improvement in symptoms — particularly nasal congestion/obstruction — compared to placebo. [11] Sprays reduce polyp-associated inflammation and can slow polyp growth, but they seldom induce complete polyp regression in advance disease. Meta analyses indicate that sprays are mostly effective in mild and moderate forms of disease. [10] Their main limitations are restricted drug distribution (mostly anterior nasal cavity) and the need for diligent long-term use. In CRSwNP with large polyps or mucus, a spray may not reach the target site. The effectiveness of sprays is believed to be enhanced after sinus surgery due to improved access to sinus cavities. Higher steroid doses yield only marginally greater symptom benefit but about double the risk of mild nosebleeds and local irritation. Overall, sprays have an excellent safety profile with negligible systemic absorption. The most common side effect is epistaxis, usually linked to improper delivery technique (aiming the spray at the nasal septum). [11]

**High-Volume Nasal Irrigations (Nasal Rinses)**

High-volume irrigations (typically 200-240 mL per rinse) augmented with topical steroids mechanically cleanse mucus and deliver medication deeply into the sinuses. [8] Recent trials demonstrate their superiority over sprays in patients with significant polyps. A randomized, double-blind study directly compared sprays and rinses in 24 non-surgical CRSwNP patients over 12 weeks. Corticosteroid irrigation significantly improved objective endoscopic scores measuring polyp burden compared with spray delivery, indicating a better local anti-inflammatory effect on sinonasal mucosa and polyp size. [12] The greater effectiveness was also demonstrated in post-surgical patients showing more effective reduction in endoscopic evidence of recurrence [6].

In practice, irrigations are favored when deeper sinus penetration is needed - for example, patients with large or diffuse polyps or those recovering from surgery. This method works in

two ways: first, it mechanically cleanses the mucosa of secretions, inflammatory mediators, and allergens; second, it makes it easier for medications to reach large postoperative cavities. Results for patients who were not operated on, however, are less definitive. When compared to exhalation delivery systems, irrigations' capacity to enter non-opened sinus canals is still restricted, despite their effectiveness in eliminating mucus. Limitations include the requirement for patient training and adherence, longer administration time, dosing variability, and potential complications (ear fullness, mild epistaxis). Minor local effects can occur, but systemic side effects are essentially absent. Guidelines suggest adding high-volume nasal irrigations when sprays alone do not control disease and as option for postoperative care: after Functional Endoscopic Sinus Surgery (FESS) - when sinus ostia are widely opened. [17]

**Exhalation Delivery Systems (EDS)**

Exhalation Delivery Systems represent are breath-powered devices that deliver corticosteroid deeply into the posterior nasal cavity via positive exhalation pressure. [9]. Patient prevents drug dispersions by blowing out through the device, which shuts the soft palate and isolates the nose from downstream airways. A randomized, double-blind trial of 323 patients demonstrated that EDS produced clinically and statistically significant improvements in main symptoms, polyp grade, and quality of life in patients with CRSwNP. Notably, 62-67% fewer EDS-treated patients required subsequent surgery. [13] EDS is easy to use after instruction and is particularly useful in patients with prior sinus surgery or those who have inadequate symptom control with nasal sprays or rinses. The device should be considered in moderate-to-severe polyposis or longstanding disease, because it avoids the burden of mixing irrigation solutions.

**Steroid-Eluting Stents**

Bioabsorbable, steroid-eluting stents (implants) are placed by the surgeon into the sinuses (usually ethmoids or frontal recess) during or immediately after FESS surgery to provide sustained local corticosteroid release. The medication is slowly released over time directly to the ethmoid mucosa over weeks. Randomized trials have shown that this method reduces polyp recurrence and middle turbinate adhesions on the treated side. [14][17x] The main advantage is that these implants deliver high local steroid concentrations without patient effort, potentially improving wound healing. Adverse events of these stents are usually minor - nasal discomfort, mild bleeding or sinus infection. Implants are generally reserved for cases with extensive polyps or narrow frontal/ethmoid anatomy where restenosis risk is high. In practice, they help maintain sinus ostia patency and improve healing in the critical early postoperative period. Stents are not

first-line therapy and do not replace the need for ongoing nasal therapy, but are indicated in high-risk case.

**Conclusions**

Intranasal corticosteroids, regardless of delivery method, are effective at improving CRSwNP inflammation and remain the cornerstone of therapy across disease stages. Evidence from randomized trials and systematic reviews demonstrates that delivery technique strongly influences efficacy depending on patient profile. Conventional sprays are effective and safe for mild-to-moderate disease and as baseline maintenance therapy. [1][7][11] They improve symptoms compared to no treatment, but require prolonged use and may be less potent. In patients with persistent symptoms, extensive disease, or post-surgical anatomy, enhanced delivery should be considered. High-volume steroid irrigations surpass sprays in polyp reduction and symptom control, especially when deep sinus exposure or mucosal cleansing is desirable. This method should be considered particularly for patients with larger polyps and after FESS. [12][18x] Exhalation delivery systems consistently improve drug deposition to the middle meatus and sinuses and have shown robust reductions in polyp grade and nasal obstruction in RCTs. [13][16][19x] Using this method should be used for patients with inadequate response to conventional sprays. Steroid-eluting stents offer sustained, localized anti-inflammatory therapy and are most appropriate for selected postoperative patients, such as those with frontal sinus disease, early restenosis, or recurrent polyposis despite optimized topical therapy [14][20][21]. However, their use should be individualized, balancing clinical benefit against cost and procedural burden.

Symptoms relief is achieved across all delivery methods, but magnitude and speed vary. Regular aqueous nasal sprays continue to be the first-line treatment for CRSwNP due to wide availability and tolerability. Safety profiles are favorable across methods, with minimal systematic absorption. Adverse effects, like epistaxis or crusting may occur across all methods, but are generally minor. While conventional sprays have been extensively studied and are the most commonly prescribed formulation, evidence suggests that alternative delivery systems may offer superior outcomes for specific patient populations or disease severities.

In routine practice, treatment selection should be personalized based on disease severity, prior surgical anatomy, comorbidities, patient preference, and likelihood of adherence. [1][9][22][23] A stepwise approach is supported by current evidence: initiate with conventional sprays, escalate to high-volume irrigations or EDS in uncontrolled disease, and reserve stents for

carefully selected postoperative scenarios. Patients should be educated on proper technique and the need for consistent long-term use to obtain maximal benefit. Such stratified use of delivery modalities optimizes outcomes while maintaining safety and cost-effectiveness in the long term management of CRSwNP.

Despite remarkable advancements, there are still considerable gaps in the optimization of long-term management techniques. Future head-to-head trials are needed to refine the stepwise approach, but current evidence supports this tiered strategy based on disease severity and anatomy.

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