



# Advancing Clinical Outcomes and Immunological Insights through Modern Sublingual Immunotherapy Approaches

Ahmed Al Farouq \*

Department of Respiratory and Allergic Diseases, Cairo University, Cairo, Egypt

## DESCRIPTION

Sublingual immunotherapy, commonly known as SLIT, represents a revolutionary advancement in the treatment of allergic diseases, offering a safe, effective and patient-friendly alternative to traditional Subcutaneous Immunotherapy (SCIT). It is particularly effective for allergic rhinitis, allergic asthma and sensitivities to environmental allergens such as pollen, dust mites and animal dander. SLIT involves the administration of allergen extracts in tablet or drop form under the tongue, allowing allergens to be absorbed through the oral mucosa to induce immune tolerance. Over the past two decades, extensive clinical research has established SLIT as a scientifically validated, convenient and widely accepted therapeutic approach, transforming the global landscape of allergy management.

The mechanism of action of SLIT is based on the concept of immune tolerance induction. When allergens are introduced via the sublingual route, they are captured by dendritic cells in the oral mucosa, which then migrate to regional lymph nodes and present allergenic peptides to T cells. This interaction promotes a shift from a T-Helper Type 2 (Th2) immune response, responsible for allergic inflammation, toward a more regulatory and tolerant phenotype characterized by the generation of T-regulatory (Treg) cells. These Treg cells secrete anti-inflammatory cytokines such as Interleukin-10 (IL-10) and Transforming Growth Factor-Beta (TGF- $\beta$ ), leading to the suppression of allergen-specific IgE production and the enhancement of protective Immunoglobulin G4 (IgG4) antibodies. Through this mechanism, SLIT not only alleviates symptoms but also modifies the underlying immune response, providing long-term benefits even after treatment cessation.

One of the most significant advantages of SLIT lies in its safety and ease of administration. Unlike subcutaneous immunotherapy, which requires repeated injections under medical supervision, SLIT can be self-administered at home after initial dose monitoring in a clinical setting. This greatly enhances patient adherence and quality of life, particularly

among children and individuals with needle aversion. The risk of systemic reactions, including anaphylaxis, is extremely low, with most adverse effects limited to mild local symptoms such as oral itching or throat irritation that typically subside with continued use. This excellent safety profile has contributed to the widespread acceptance of SLIT in both clinical practice and regulatory frameworks.

Clinical trials have consistently demonstrated the efficacy of SLIT in reducing symptoms and medication use in patients with allergic rhinitis and asthma. Studies involving grass pollen, house dust mite and ragweed allergens have shown significant improvements in nasal and bronchial symptoms, alongside enhanced quality of life scores. Moreover, SLIT has been shown to prevent the progression of allergic rhinitis to asthma and to reduce the development of new allergen sensitivities, particularly when initiated early in life. The long-term disease-modifying effects of SLIT are one of its most compelling advantages, as patients often maintain symptom relief years after completing therapy.

SLIT formulations are available as both liquid drops and rapidly dissolving tablets. The dosing schedules are typically allergen-specific, with treatment starting several months before the allergen season for pollen-related allergies or maintained year-round for perennial allergens such as dust mites. Compliance remains a key determinant of success and patient education regarding consistent dosing and duration—often three to five years—is crucial for achieving optimal results. In recent years, pharmaceutical advancements have focused on standardizing allergen extracts, optimizing dosage forms and improving bioavailability to ensure consistent immunological effects across diverse patient populations.

In addition to its established role in respiratory allergies, emerging research is exploring the potential of SLIT for food allergies and venom hypersensitivity. Early trials using peanut and milk allergens have demonstrated promising results in desensitization with fewer systemic reactions compared to oral immunotherapy. This opens the door for broader applications

**Correspondence to:** Ahmed Al Farouq, Department of Respiratory and Allergic Diseases, Cairo University, Cairo, Egypt, E-mail: ahmed.alfarouq@cu.edu.eg

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of the sublingual route in inducing immune tolerance across various allergic conditions. Moreover, combination strategies using SLIT with biologic agents such as omalizumab (anti-IgE) are being investigated to enhance efficacy and reduce treatment duration, particularly for highly sensitized individuals.

Despite its many benefits, challenges remain in optimizing SLIT protocols. Variability in allergen standardization, dosing regimens and treatment duration can affect outcomes across populations. Economic considerations also play a role, as long-term therapy may be costly in certain healthcare systems. Furthermore, adherence tends to decline over time, emphasizing the importance of patient motivation, follow-up and education. Continued efforts are needed to harmonize global treatment guidelines and establish predictive biomarkers to identify likely responders early in therapy.

Recent advances in molecular allergology have paved the way for precision medicine in immunotherapy. Component-resolved diagnostics enable the identification of specific allergenic proteins responsible for sensitization, allowing for more tailored

SLIT formulations. Nanotechnology and novel delivery systems are also under investigation to improve mucosal absorption and immunogenicity while maintaining safety. The integration of digital health tools, such as mobile applications for adherence tracking and symptom monitoring, is further enhancing patient engagement and real-world effectiveness.

## CONCLUSION

In conclusion, sublingual immunotherapy stands at the forefront of modern allergy treatment, combining safety, convenience and long-term efficacy. By targeting the immunological basis of allergic disease, SLIT goes beyond symptom control to achieve lasting immune tolerance. Its expanding role across respiratory and food allergies, coupled with ongoing innovations in formulation and delivery, ensures a promising future for this transformative therapy. As global healthcare systems continue to embrace patient-centered and preventive approaches, sublingual immunotherapy is poised to remain a cornerstone in the fight against allergic diseases worldwide.