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PERSPECTIVES

Through a Translational Lens: How Does Inflammation Contribute to the Pathogenesis of Asthma and Allergy?

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Abstract: Single cell and animal models have been critical to understanding how inflammation that occurs in asthma and allergy contributes to the pathogenesis of these allergic diseases. Recent technological advances enabled scientific discoveries to be translated into clinically relevant approaches.

Keywords: airway immunology, asthma, allergy

Recent technological advances—leveraging genome-wide Clustered Regularly Interspaced Palindromic Repeats (CRISPR) screening, systems immunology, and spatial transcriptomics—have empowered researchers to investigate fundamental immunological questions using human cells and tissues.[1] Translational immunology bridges scientific discovery and clinical application, transforming immunological insights into practical solutions for human health challenges.[2] Notable examples include vaccine development for infectious diseases and the engineering of novel therapeutics for inflammatory disorders.

While animal models are instrumental in identifying therapeutic targets, interspecies differences often hinder the direct translation of findings into effective human treatments. By applying cutting-edge single-cell molecular approaches to rigorously curated human cells and tissues from donors with and without disease, we are optimistic that translational immunology will develop innovative therapeutics for asthma and allergy. The findings from this themed issue aim to provide novel pathways and biomarkers that, when selectively targeted, could explain things like heterogeneity of therapeutic response, thereby providing targets for clinical intervention and markers for more in-depth identification of asthma subtypes.

The Journal explores how translational immunology sheds light on the inflammatory mechanisms underlying asthma and allergy pathogenesis. The complexity and heterogeneity of these human conditions present challenges in developing universal therapeutic strategies. However, by integrating refined methodologies—such as systems immunology (computational methods and mathematical modeling of cellular and molecular networks present in the immune system[3]—for example within Th2 allergic asthma), genome-wide CRISPR screening (to selectively knock out genes[4] thought to be involved in specific endotypes of asthma), genome-wide microarrays, and spatial transcriptomics (to identify specific cell types and networks of cells[5] that will not only help to characterize endotypes of asthma, but to identify biomarkers and provide novel targets for disease intervention)—applied to diseased and non-diseased human-derived cells and tissues, we can bridge fundamental discoveries with clinical applications. Additionally, the use of novel models to study airway inflammation, including organoids, lung-on-a-chip, human precision cut lung slices, and systems that examine the interplay between multiple cell types present in the airways (including studying immunologic synapses between immune cells and structural/mesenchymal cells[6–9]) offer powerful platforms for the study of airway inflammation in the context of asthma. These approaches can potentially uncover molecular phenotypes that predict therapeutic responses and disease progression, paving the way for more precise and effective treatments for asthma and allergy.

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Disclosure

Dr Cynthia Koziol-White reports she is co-editor-in-chief for Current Research in Pharmacology and Drug Discovery. The authors report no other conflicts of interest in this work.

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