Asthma: Why are we still guessing when omics can personalize care?

Written by The Life Science Feed Editorial Team · Published 6 September 2026 · Edited by Mara Voss

> Airway hyperresponsiveness, a hallmark of asthma, has long presented a diagnostic and therapeutic challenge, often relying on broad classifications and reactive management. But the field is shifting, with new approaches showing potential to refine how clinicians identify, predict, and treat this complex condition. The era of precision medicine, integrating advanced diagnostics and computational tools, aims to move beyond one-size-fits-all strategies.

KEY TAKEAWAYS

- The Pivot: Asthma management is transitioning from empirical treatment to biomarker-driven, personalised strategies, particularly in paediatric populations.
- The Data: Noninvasive diagnostics like fractional exhaled nitric oxide (FeNO) and induced sputum analysis improve inflammation monitoring and phenotype classification.
- The Action: Clinicians should consider integrating advanced noninvasive diagnostics and be aware of emerging omics and AI tools for more individualised patient care.

Paediatric asthma management, a field once characterised by rudimentary assessments, has undergone a significant transformation. Early 20th-century clinical observations lacked paediatric specificity, but the mid-20th century introduced functional assessments, spirometry, and the recognition of asthma as a chronic inflammatory condition. This foundational shift paved the way for more targeted interventions, moving away from symptomatic relief towards disease modification.1

The introduction of inhaled corticosteroids (ICS) marked a turning point for long-term management, transforming it by offering targeted control with reduced systemic risks. This class of drugs fundamentally altered the trajectory of asthma, particularly in children, by addressing the underlying inflammation rather than merely dilating airways. The widespread adoption of ICS significantly improved quality of life and reduced exacerbation rates across diverse patient cohorts.1

Evolving Diagnostic Paradigms

The diagnostic market for airway hyperresponsiveness has evolved considerably, moving towards noninvasive and more precise methods. Fractional exhaled nitric oxide (FeNO) measurements, for instance, offer a reliable, noninvasive biomarker for eosinophilic airway inflammation, guiding corticosteroid responsiveness and monitoring disease activity. Induced sputum analysis provides a direct assessment of airway inflammatory cell profiles, allowing for phenotype classification, such as eosinophilic or neutrophilic asthma, which has direct implications for treatment selection.1

Exhaled breath condensate (EBC) analysis, another noninvasive technique, allows for the measurement of various inflammatory mediators, oxidative stress markers, and even genetic material in the airways. While still largely a research tool, EBC holds potential for identifying novel biomarkers and monitoring therapeutic responses. Electronic nose technology, which detects volatile organic compounds (VOCs) in exhaled breath, represents a further step towards rapid, point-of-care diagnostics, aiming to identify specific disease signatures or predict exacerbations without invasive procedures. These technologies collectively enhance clinicians' ability to monitor inflammation, classify phenotypes, and assess therapeutic responsiveness with greater granularity.1

But the diagnostic utility of these advanced tools is not universally applied. Standardisation remains a challenge, particularly for techniques like induced sputum and EBC, where processing protocols can vary widely between laboratories. This variability limits comparability across studies and hinders widespread clinical adoption. The cost and accessibility of some of these technologies, especially in resource-limited settings, present barriers to equitable care. The practical integration into routine clinical workflows also requires further refinement and validation.1

The Omics Revolution and Personalised Interventions

The integration of omics technologies, including genomics, proteomics, and metabolomics, has provided deeper insights into the complex mechanisms underlying airway hyperresponsiveness. Genomics, the study of an organism's entire DNA, helps identify genetic predispositions and variants associated with asthma susceptibility, severity, and drug response. For example, specific gene polymorphisms can predict a patient's likelihood of responding to particular bronchodilators or corticosteroids, moving beyond trial-and-error prescribing.1

Proteomics, the large-scale study of proteins, allows for the identification of protein biomarkers in biological samples, such as blood or sputum, that correlate with disease activity, exacerbation risk, or therapeutic efficacy. These protein signatures can offer a real-time snapshot of the inflammatory state and help differentiate between asthma phenotypes that might otherwise appear similar clinically. Metabolomics, which analyses small molecule metabolites, provides insights into metabolic pathways altered in asthma, potentially revealing novel targets for intervention or markers of disease progression.1

These omics approaches facilitate early, individualised interventions by providing a comprehensive molecular profile of each patient's disease. This level of detail allows for a truly personalised medicine approach, where treatment decisions are guided by an individual's unique biological characteristics rather than broad diagnostic categories. For instance, identifying specific endotypes through omics data can inform the selection of targeted biologic therapies, ensuring that patients receive the most effective treatment for their specific inflammatory pathway. This is particularly relevant in severe asthma, where conventional treatments often fail, and severe asthma treatment decisions require a deeper understanding of underlying mechanisms.1

Aspirin-exacerbated respiratory disease (AERD), for example, represents a distinct asthma phenotype where biologics are transforming management. Laidlaw (2025) discusses how the advent of biologics has provided new therapeutic avenues for AERD, a condition historically challenging to manage due to its unique inflammatory pathways involving leukotrienes and prostaglandins. These targeted therapies offer a more precise approach than systemic corticosteroids or aspirin desensitisation alone.2

Artificial Intelligence and Machine Learning in Prognosis and Decision-Making

Artificial intelligence (AI) and machine learning (ML) are emerging as powerful tools for predicting exacerbations, identifying clinical subtypes, and enhancing decision-making through large-scale data integration. AI algorithms can analyse vast datasets, including electronic health records, omics data, and environmental factors, to identify complex patterns and correlations that human clinicians might miss. This predictive capability allows for proactive management, potentially preventing severe exacerbations and reducing hospitalisations.1

For example, ML models can predict asthma exacerbations by integrating data on lung function, FeNO levels, medication adherence, and exposure to allergens or pollutants. These models can alert clinicians to patients at high risk, allowing for timely interventions such as adjusting medication or providing patient education. AI also assists in identifying distinct clinical subtypes of asthma, moving beyond broad classifications to more granular endotypes that respond differently to various treatments. This phenotyping is essential for optimising therapeutic strategies, especially in complex cases.1

The integration of AI into clinical decision-making shows potential to enhance the precision of treatment selection. By analysing a patient's complete clinical and molecular profile, AI can recommend the most appropriate therapy, including specific biologics or combinations of medications, tailored to their individual needs. This data-driven approach supports clinicians in making more informed choices, potentially improving patient outcomes and reducing healthcare costs associated with ineffective treatments. The real-world evidence for triple therapy in asthma, for instance, could be further refined and applied through AI-driven insights.1

But the promise of AI comes with its own set of challenges. Algorithm transparency remains a significant concern; clinicians need to understand how AI models arrive at their recommendations to trust and effectively utilise them. The 'black box' nature of some advanced ML algorithms can hinder adoption and raise ethical questions. Paediatric-specific validation is also critical, as most AI models are developed using adult data and may not accurately reflect the unique physiological and developmental characteristics of children with asthma. Ensuring data quality and standardisation across different healthcare systems is paramount for AI models to perform reliably and equitably.1

Challenges and Future Directions

Despite these advancements, significant challenges persist in the journey towards fully realised precision medicine in airway hyperresponsiveness. Standardisation of diagnostic techniques, particularly for omics data and noninvasive biomarkers, remains an ongoing effort. Variability in sample collection, processing, and analytical methods can lead to inconsistent results, hindering the widespread clinical utility of these tools. Harmonising protocols across research institutions and clinical laboratories is essential for generating reliable and comparable data.1

Data quality is another critical hurdle. The effectiveness of AI and omics technologies hinges on the accuracy and completeness of the input data. Incomplete electronic health records, inconsistent coding practices, and lack of integration across different data sources can compromise the utility of these advanced tools. Ensuring equitable access to these sophisticated diagnostics and treatments is also a major concern. High costs and limited availability in many regions threaten to exacerbate existing healthcare disparities, creating a two-tiered system of care.1

The integration of digital health solutions and AI-assisted precision medicine requires robust interdisciplinary collaboration. Clinicians, researchers, data scientists, and policymakers must work together to develop and implement these new approaches effectively. Real-world validation of AI algorithms and omics biomarkers is crucial to ensure their efficacy and safety in diverse patient populations outside of controlled clinical trial settings. Policies that address data privacy, algorithm transparency, and equitable access will be vital for the successful and ethical deployment of precision medicine in asthma. For clinicians seeking a comprehensive reference on respiratory conditions, the Oxford Handbook of Respiratory Medicine provides practical guidance.1

The field must also address the holistic care integration of these technologies. Precision medicine should not merely focus on molecular targets but also consider the broader psychosocial and environmental factors influencing asthma outcomes. A truly personalised approach integrates biological insights with patient-centred care, addressing lifestyle, adherence, and social determinants of health. The ongoing evolution of our understanding of epithelial dysfunction in airway disease highlights the need for such integrated approaches.1

The open-label design of many early studies exploring these novel diagnostic and prognostic tools is an obvious caveat. While showing potential, the lack of blinding can introduce bias, particularly in subjective outcome measures. The generalisability of findings from highly specialised research centres to broader clinical practice also remains unclear. Future research must focus on large-scale, prospective, blinded trials to validate these technologies and demonstrate their clinical utility and cost-effectiveness in diverse real-world settings. The challenge lies in translating complex omics data and AI predictions into actionable insights for the busy general practitioner.1

CLINICAL IMPLICATIONS

The shift towards precision medicine in airway hyperresponsiveness, particularly in paediatric asthma, is not merely academic; it demands a re-evaluation of current diagnostic and therapeutic algorithms. Clinicians can no longer rely solely on broad symptomatic classifications when tools like FeNO and induced sputum offer clearer insights into underlying inflammatory phenotypes. Ignoring these advances risks suboptimal treatment and continued patient suffering, especially for those with severe or refractory disease.

The promise of omics technologies and AI is substantial, but their integration into routine practice will be gradual and uneven. While large academic centres may lead the charge, general practitioners and specialists in smaller clinics will need accessible, validated tools and clear guidelines for implementation. The industry must focus on developing user-friendly, cost-effective diagnostics and AI platforms that provide actionable insights, rather than just raw data, to avoid overwhelming clinicians.

Patients, particularly those with chronic, complex conditions like asthma, stand to benefit immensely from more personalised care. Reduced exacerbations, fewer side effects from ineffective treatments, and a better understanding of their disease trajectory could significantly improve their quality of life. But equitable access remains a critical concern; the benefits of precision medicine must not be limited to those in well-resourced healthcare systems. Policymakers must ensure that these innovations are accessible and affordable across the board.

EDITORIAL & AI STANDARDS

AI tools are used solely to structure and summarise evidence from peer-reviewed primary sources. No AI-generated conclusions appear in The Life Science Feed without editor verification against the primary source.

REFERENCES

1. 1. Ferrante G, Tenero L, Zaffanello M. The evolution of scientific knowledge in childhood asthma over time. Eur Respir Rev 2026.
2. 2. Laidlaw TM. Aspirin-exacerbated respiratory disease in the era of biologics. Ann Allergy Asthma Immunol 2025.