The application of artificial intelligence in allergy



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The application of artificial intelligence (AI) in disease management and medical research is a hot topic. Emerging numbers of medical research studies were published using AI by researchers during data mining processes to search for important findings among the complicated interactions between numerous different variables, and recently, AI is being applied to more and more allergy research studies.

In a publication in 2021 by Deng et al, AI machine learning algorithm was used to identify school and home risk factors for asthma- and allergy-related symptoms among children in New York.[1] In the past, risk factor identification was limited by collinearity problems: when multiple highly correlated variables and outliers were included in the same statistical model, it would lead to non-convergence, an issue impossible to be resolved by conventional statistical analysis. However, a commonly used machine learning method called 'Random Forest' can handle large number of variables simultaneously in one model as well as dealing with collinearity problems and outliers at the same time. By applying this method to build up the decision trees in the supervised machine learning algorithm, the authors analyzed 84 different variables simultaneously and subsequently identified family rhinitis history as the top contributing factor for asthma, and plant pollens for allergy-related symptoms for their study population in New York.

Additionally, machine learning was also applied to discover the biomarkers that could discriminate allergic and irritant contact dermatitis, as it is still clinically challenging to distinguish the two conditions by clinical phenotype alone.[2] Fortino et al recently analyzed a total of 89 positive patch test reaction biopsies against 4 contact allergens and 2 irritants via microarray. Contact sensitizers and irritants induced different transcriptomic profiles, and with the use of the 'Random Forest' machine learning algorithm, a set of potential biomarkers and selected biomarker models were identified.

AI empowered the development of new allergic diagnostic tests. In the study by Korb et al, the authors investigated the use of Fourier-transform infrared spectroscopy as a high throughput and cost-effective method to detect the characteristic alterations in serum samples of healthy, allergic or allergen immunotherapy treated patients.[3] When combined with supervised machine learning using MATLAB, Deep Learning Toolbox and Convolutional Neural Networks (CNN) Model Architecture, the results obtained could discriminate sera from healthy, allergic and allergen immunotherapy treated patients and the results were consistent with immunological changes.

Deep learning was also applied for allergy surveillance. Hay fever has been a major medical burden according to Australia Institute of Health and Welfare, and the medical expenditure on this disease had doubled between 2001 and 2010, with increases up to $226.8 millions per year. So Rong et al investigated the use of social media platforms assisted by deep learning-based approach to develop a cost-effective way for public health monitoring to complement the traditional survey-based approaches.[4] This new approach was reported to identify the hay fever related symptoms and treatments with an accuracy up to 87.9%.

Artificial intelligence has also been used to extract clinical information in electronic health record systems (EHRs) for clinical research in allergy, asthma and immunology.[5] The capability of natural language processing (NLP) techniques facilitated automated chart reviews, identified patients with distinct clinical features, and minimized methodological heterogeneity in defining clinical research data.

Recently, in order to predict peanut allergy in high-risk infants, AI was applied in the study by Suprun et al published in the Journal of Allergy and Clinical Immunology.[6] Samples from a prospective cohort of 293 high-risk infants were collected at different age periods to study the levels of sIgE, sIgG4, component proteins and 50 epitope-specific (es) IgE and esIgG4. Changes in the antibody levels were analyzed with mixed effect model. 'Random Forest' machine learning algorithms were used to identify those change combinations that can predict allergy status at 4+ years. Machine learning helped to identify the best combination of IgE and IgG4 binding epitopes. With the selected subset of esIgEs and peanut sIgE, the prediction accuracy outperformed other relevant IgE cutoffs for peanut allergy status at 4+ years, with the area under the curves of 0.84 at age 3-15 months and 0.87 at age 2-3 years.

The application of AI in allergy is rapidly expanding. Nowadays, with AI being more readily available and user friendly, it is not surprising that this machine deep learning technology will be applied to even more areas in allergy research, as well as clinical management and monitoring for allergic diseases in the near future.

References

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