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Editorial

Machine Learning in Pediatric Chronic Respiratory Diseases: Beyond Asthma

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Machine learning (ML) is an artificial intelligence (AI) tool that learns as it is fed data to create predictive algorithms. In medicine, it is increasingly used to predict future events that could be anticipated by preventing health-related risk factors. Until now, most medical AI research has focused on adults. Within pediatric subspecialties, pediatric pulmonology accounts for a smaller percentage of machine learning studies, and given its high prevalence, most of these have focused on asthma. With the continued development of AI, more pediatric respiratory diseases have been incorporated into ML, which also deserve discussion.

In cystic fibrosis (CF) patients aged 10 years or older hospitalized for exacerbations requiring intravenous antibiotic treatment, an ML model demonstrated that they could be grouped into two symptom severity groups. Compared with the low-symptom group, high-symptom patients experienced a greater symptom burden during hospitalization despite treatment, longer hospital stays, greater oxygen requirements, and persistent symptoms after treatment completion [1]. ML with symptom scores of exacerbations in CF has made it possible to design predictive models of poor response to treatment or risk of not recovering lung function [2]. The strategy of home monitoring for patients with CF has been increasing in recent years. AI-guided home stethoscopes are tools being incorporated into home monitoring of CF. A recent study demonstrated that incorporating AI-guided stethoscopes increases the accuracy of predicting exacerbations compared to standard self-assessment [3]. AI has also made it possible to demonstrate clinical clusters of severity that could be useful in monitoring the progression of CF in children and adolescents [4]. ML has also proven useful in predicting the intensity of physical activity that can be performed by children and adolescents with CF [5].

Primary ciliary dyskinesia (PCD) is a chronic pediatric respiratory disease whose confirmation is complex. Data obtained by analyzing ciliary movement in respiratory cells by video-electron microscopy from patients with genetic confirmation of PCD, which have been incorporated into ML models, have managed to predict with 95 to 97% accuracy the differences with samples obtained from healthy patients and patients with CF [6]. Another way to use AI is through the use of International Classification of Diseases (ICD) codes. A study conducted in the United States used ML to integrate data from the PCD Foundation Registry with ICD codes for diagnoses, procedures, and treatments obtained from medical insurance claims and PCD-related ICD codes, six months after undergoing electron microscopy. The data were from patients under 18 years of age, and data privacy was ensured through the use of anonymous tokens. This study demonstrated that integrating all the data yielded moderate sensitivity or positive predictive value for PCD, and a prevalence very similar to that estimated for the entire population [7].

AI has also been applied to pediatric respiratory sleep medicine. U-Sleep is a polysomnography (PSG) data interpretation model using an AI neural network that has reduced the time and variability in PSG interpretation in adults. A recent study conducted in Denmark validated U-Sleep in a healthy pediatric population aged 6 to 17 years, including those with chronic illnesses. Moderate to high

correlations and agreement were found between manual and automated reports, suggesting that U-Sleep is a valid and effective tool for PSG interpretation in children and adolescents [8]. In children and adolescents with obesity, different algorithms based on ML were shown to be able to precede with a high level of accuracy for the diagnosis of obstructive sleep apnea [9].

A study conducted in children and adolescents demonstrated that recording forced expiratory respiratory sounds using mobile phones allows for the creation of ML models with good agreement with classic parameters of pulmonary function. This opens a path for home-based pulmonary function monitoring in children with chronic illnesses who have physical limitations or are unable to travel far to hospitals [10].

This selection of studies shows encouraging results and is just one example of the rapid progress that AI is making in the field of pediatric pulmonology. However, we cannot fail to mention the difficulties that AI has in advancing pediatric medicine and that still limit its widespread use. One of these is the high cost of maintaining ML, which could be a significant barrier to the equitable distribution of this technology, maintaining or deepening inequalities in access to the latest advances in health between high-income countries and those with medium or low economic levels, as well as between regions within the same country. Another important limitation is the veracity of the data sources for the creation of learning models and algorithms, which, if unreliable, could lead to errors in medical decision-making. Security and privacy in the protection of medical information are a problem for the development of AI, a topic of great importance in the treatment of minors. Furthermore, AI does not allow the introduction into the models of the ethical and moral values associated with the medical diagnosis and treatment process, and it is the duty of the healthcare professional to ensure that these are not violated. With all these considerations, it is necessary for each government to design an appropriate regulatory framework that allows the use of this technology for the benefit of patients.

Despite current limitations, the future evolution of AI will likely increase benefits in pediatric respiratory medicine, reducing diagnosis times, improving the monitoring of chronic disease progression, and enabling better prediction of exacerbations and responses to different treatments. This will allow healthcare professionals reduce errors and save valuable time that could be dedicated to other activities. Similarly, healthcare institutions will be able to increase their productivity, and patients will also benefit from fewer unnecessary diagnostic tests and treatments.

Currently, ML is a support or complement that is increasingly being considered in pediatric respiratory medicine, but it does not replace clinical judgment and medical decision-making, which will always be necessary in medical practice. ML in pediatric respiratory medicine is a wave that has just begun and is gaining momentum. Pediatric pulmonologists should learn to *ride the wave*; otherwise, we will watch it pass us by.

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