Artificial intelligence in computed tomography for quantifying lung changes in the era of CFTR modulators

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Shareable abstract (@ERSpublications)
Artificial intelligence allows a fully automated volumetric scoring system of lung structural abnormalities in CF using computed tomography. It could be used as a robust quantitative outcome to assess disease changes in the era of CFTR modulators. https://bit.ly/3hlXmnc

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Abstract

Background Chest computed tomography (CT) remains the imaging standard for demonstrating cystic fibrosis (CF) airway structural disease *in vivo*. However, visual scoring systems as an outcome measure are time consuming, require training and lack high reproducibility. Our objective was to validate a fully automated artificial intelligence (AI)-driven scoring system of CF lung disease severity.

Methods Data were retrospectively collected in three CF reference centres, between 2008 and 2020, in 184 patients aged 4–54 years. An algorithm using three 2D convolutional neural networks was trained with 78 patients' CT scans (23 530 CT slices) for the semantic labelling of bronchiectasis, peribronchial thickening, bronchial mucus, bronchiolar mucus and collapse/consolidation. 36 patients' CT scans (11 435 CT slices) were used for testing *versus* ground-truth labels. The method's clinical validity was assessed in an independent group of 70 patients with or without lumacaftor/ivacaftor treatment (n=10 and n=60, respectively) with repeat examinations. Similarity and reproducibility were assessed using the Dice coefficient, correlations using the Spearman test, and paired comparisons using the Wilcoxon rank test.

Results The overall pixelwise similarity of AI-driven *versus* ground-truth labels was good (Dice 0.71). All AI-driven volumetric quantifications had moderate to very good correlations to a visual imaging scoring ($p<0.001$) and fair to good correlations to forced expiratory volume in 1 s % predicted at pulmonary function tests ($p<0.001$). Significant decreases in peribronchial thickening ($p=0.005$), bronchial mucus ($p=0.005$) and bronchiolar mucus ($p=0.007$) volumes were measured in patients with lumacaftor/ivacaftor. Conversely, bronchiectasis ($p=0.002$) and peribronchial thickening ($p=0.008$) volumes increased in patients without lumacaftor/ivacaftor. The reproducibility was almost perfect (Dice >0.99).

Conclusion AI allows fully automated volumetric quantification of CF-related modifications over an entire lung. The novel scoring system could provide a robust disease outcome in the era of effective CF transmembrane conductance regulator modulator therapy.