This study demonstrates that ML models have translational potential for improving spirometry quality assurance. Linear regression models using decision trees, random forest, and extreme gradient boosting (XGBoost) were trained on CT images to estimate forced expiratory volume in 1 second (FEV1pp) as measured by pulmonary function tests (PFTs). Individuals with CT and PFT data were included in this ML model by including clinical data and demographic characteristics. We included 153 participants with cystic fibrosis (PwCF) because of chronic inflammation of lung parenchyma [1]. Although pulmonary function tests (PFTs) are the gold standard for monitoring lung disease, some studies have demonstrated that CT-based radiology scores can detect changes earlier than PFT, suggesting CT sensitivity in CF [2], but obtaining radiology scores is time consuming and subjective. Lung parenchymal biomarkers derived from CT image processing are quick and reproducible and have been demonstrated to quantify parenchymal abnormalities [3]. Our central hypothesis was that imaging biomarkers would have translational applications in CF. To test this hypothesis, we developed a machine learning (ML) model to estimate percentage predicted forced expiratory volume in 1 second (FEV1pp) in PwCF using CT-derived lung parenchymal measures alone.

Methods: Lung parenchymal biomarkers describing different components of CT attenuation distribution were derived using an in-house-developed automated program and pyradiomics [4]. Individuals with CT and PFTs within 3 months from our CF center were included. We trained ML regression models using decision trees, random forest, and extreme gradient boosting (XGBoost) to estimate FEV1pp measured using PFTs. The XGBoost regression model performed best in estimating FEV1pp (RMSE 6.4%).

Results: We included 153 PwCF (age 14.3 ± 3.6; 59 male/94 female; FEV1pp as measured by PFT: 82.8 ± 22.8%). Ten-fold cross-validation was used to find the best hyperparameters for each model. Root mean squared error (RMSE) was used to assess ML model performance. The ML model error in FEV1pp is on the same order of magnitude as the disease, but it is unclear whether the quality and accuracy of home spirometry are comparable with those of in-clinic spirometry [1-3]. This study aimed to evaluate the feasibility and measurement quality of telehealth spirometry assessments for people with CF.

Conclusions: Home-based telehealth spirometry is feasible in people with CF and can support the CF team in ongoing outpatient monitoring.

References