Remote Monitoring in Idiopathic Pulmonary Fibrosis: Home Is Where the Bluetooth-enabled Spirometer Is

In the midst of a global pandemic, the medical world has scrambled to find alternative ways of providing clinical care. There are specific challenges for respiratory patients given that access to pulmonary function testing (PFT) and diagnostic imaging is largely restricted, and virtual clinic visits have replaced in-person appointments. There are unique considerations for patients with interstitial lung disease (ILD) (1). They are frequently older, have impaired lung function, and may be systemically immune suppressed, all reasons to minimize potential exposures to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). However, as we are learning, it is difficult to evaluate a patient's clinical status without PFTs, chest imaging, or physical examination. Although we long for the glory days of usual care, there are also important limitations to intermittent clinic visits. Hospital-based PFTs require patients to travel to the clinic and provide only a cross-sectional snapshot of disease. Furthermore, the typical clinic data obtained every 3–6 months may not capture the impact of disease on the whole person.

Home-monitoring programs and medical mobile applications are increasingly available to remotely track everything from blood pressure to migraine to mood. Within pulmonary medicine, hand-held spirometry has been used to monitor sarcoidosis and lung function post-transplant (2, 3). Mobile health tools have been proposed as useful for patients with idiopathic pulmonary fibrosis (IPF) given the complex progressive nature of disease and challenges associated with clinical trials of therapeutics. Beyond simple spirometry, home monitoring in IPF has extended to include measures of physical activity, symptoms, quality of life, and medication tolerability (4–7).

In this issue of the *Journal*, Moor and colleagues (pp. 393–401) build on their previous work with data from a multicenter randomized controlled trial of home monitoring in patients with IPF (8). Through patient collaboration, the authors built a secured personal platform that integrates hand-held spirometry with patient-reported outcome measures, symptom scores, medication side effects, an information library, and access to electronic consultations. Ninety patients were randomized at antifibrotic treatment initiation (46 to home monitoring and 44 to standard care), with between-group change in the King's Brief ILD score as the primary outcome. From baseline to 24 weeks, the King's Brief ILD score improved by 2.70 (SD = 9.5) points in the home-monitoring group versus 0.03 (SD = 10.4) in the standard care group, with higher scores indicating improvement. The between-group difference was 2.67 (95% confidence interval, −1.85 to 7.17; $P = 0.24$), whereas the minimal clinically important difference is estimated to be 3.9 points. The psychological domain increased by 5.12 points (SD = 15.8) in the home spirometry arm versus −0.48 (SD = 3.3) with standard care, a between-group difference of 5.6 points (95% confidence interval, −1.13 to 12.3; $P = 0.10$). Patients in the home-monitoring arm reported greater general well-being than those receiving standard care. There were no differences in cough, dyspnea, or fatigue. Interestingly there were more medication changes and dose adjustments in the home-monitoring group versus the standard care group (mean, 1 vs. 0.3 per patient) despite similar rates of side effects and self-reported medication satisfaction. In the home-monitoring group, there were numerically higher hospitalizations (6 vs. 4) and additional appointments with healthcare providers (13 vs. 10).

Most exceptional about this paper is the program of patient-centered home monitoring that has been developed by this group in the Netherlands. Their collaborative approach involving key stakeholders (i.e., patients) is reflected in compliance and satisfaction measures. The mean adherence to daily home spirometry was 97% over 24 weeks, whereas the overall mean adherence to the intervention was 93%. Nearly all patients would recommend this home-monitoring program to others, and 89% believed it provided better insights into their disease course without being burdensome. Consistent with prior reports, home FVC was highly correlated with hospital-based FVC measures in this study from start through 24 weeks. These data support the feasibility and utility of such a platform.

There are four major applications for home monitoring in patients with IPF. The first is to provide an alternative to hospital- or clinic-based care, which minimizes travel and inconvenience for patients. This is particularly important for patients of older age or with advanced disease whose oxygen supplies may run out during travel. It is also important for those with long-distance commutes to ILD specialty clinics in rural or geographically remote locations. Second, home monitoring allows for increased frequency of assessments, with daily or weekly testing, compared with the usual every 3–6 months. More data points allow for a more precise estimate of change to delineate clinical trajectory and may allow for earlier intervention and prognostication (9, 10). The granularity of remotely collected data extends to symptoms, quality of life, and physical activity levels, providing a comprehensive patient-centered evaluation. Third, home monitoring should be empowering for patients with IPF. Lung function data should be unblinded and accessible in real time for disease monitoring and management while providing reassurance or medical follow-up as clinically indicated. The devices must be user-friendly and not burdensome while providing accurate measures to inform disease status. Fourth, a driving impetus for home-monitoring platforms in IPF has been to facilitate clinical trials of therapeutics. There is an ongoing need to optimize trial efficiency and minimize visits while maximizing enrollment, and creative trial designs are needed. Beyond FVC, home monitoring allows for frequent symptom, activity, and quality-of-life

Originally Published in Press as DOI: 10.1164/rccm.202005-1532ED on May 13, 2020

measurements, all potential parts of a meaningful composite endpoint.

In an age of social distancing and virtual visits, are platforms such as this the future for clinical follow-up? Perhaps. But the results of Moor and colleagues may not be generalizable to other clinical or research programs without paying heed to the key considerations outlined above. To date, there have been successes and less-than-successful applications of home monitoring in IPF, and it recently proved challenging for implementation in a large clinical trial (11). An invested coordination team is critical to provide training and troubleshoot technical issues so that data acquisition is optimized and patients are supported. Future work should evaluate the cost effectiveness of such platforms considering both the clinic and patient perspectives. Such tools should also be viewed through a lens of accessibility with a goal of reducing disparate access to ILD specialist care. For successful implementation of such home-monitoring platforms, clinicians and trialists should emulate Moor and colleagues' patient-centered approach. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

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Occupational Exposures and Lung Cancer

Despite decreases in the incidence of certain cancers and associated mortality, cancer remains highly lethal and very common. About 41% of Americans will develop some form of cancer (including nonmelanoma skin cancer) in their lifetimes. One-fifth of Americans will die of cancer. Notwithstanding important progress made in the reduction of lung cancer in the United States with antismoking campaigns, it still tops the list for the most common cause of cancer death in the United States, as well as the world. Lung cancer is a global public health problem. There were an estimated 2.1 million lung cancer cases and 1.8 million deaths in 2018 worldwide. Incidence and mortality rates vary 20-fold between regions, mainly because of variation in carcinogen exposure such as tobacco smoking. However, if tobacco smoking were removed altogether, lung cancer would still be in the top 10 cancers worldwide (1). There are a number of well-known lung carcinogens to which exposure occurs mainly in the workplace. But studies of lung cancer in occupational populations are often hampered by small sample size and inability to control for, or assess interactions with, tobacco smoking. It is critical to understand the risks posed by exposures to occupational lung carcinogens to develop effective control programs for this deadly disease.

In this issue of the *Journal*, two papers by Ge and colleagues (pp. 402–411 and pp. 412–421) address major issues related to occupational lung cancer (2, 3). One critical feature in this published

Originally Published in Press as DOI: 10.1164/rccm.202004-1404ED on May 12, 2020