Lung function testing in the COVID-19 endemic

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For the **classification of AGP** see https://www.gov.uk/government/publications/covid-19-personal-protective-equipment-use-for-aerosol-generating-procedures

For the **ERS statement** see https://ers.app.box.com/s/zs1uu88wy51monr0ewd990itoz4tsn2h

For **ARTP guidance** see https://www.artp.org.uk/COVID19

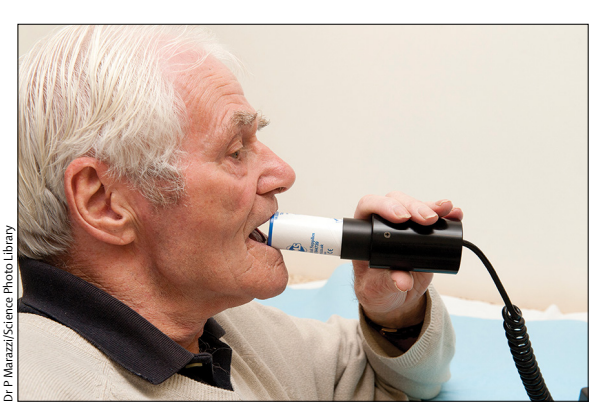
For more on **clinical findings** see **Articles** *Lancet Infect Dis* 2020; **20:** 425–34 and *N Engl J Med* 2020; published online May 21. DOI:10.1056/NEJMoa2015432

For the **paper by Mo and colleagues** see *Eur Respir J* 2020; **55:** 2001217

The COVID-19 pandemic has presented considerable challenges to global health services and dictates almost every aspect of medical practice and policy. Across Europe, a surge phase in acute caseload, led to a sudden curtailment of non-COVID-19 medical care, with immediate implications for routine diagnostic and surveillance investigations.

As COVID-19-related hospital admissions subside, many lung function services have started to reconsider how best to operate, within the constraints dictated by a COVID-19 endemic scenario. Central to planning in this phase are the precautions needed to protect lung function staff, and to minimise cross-infection risk, given an ongoing need to test vulnerable patient groups—eg, immunocompromised or individuals with long-term conditions. Clear and definitive guidance is urgently required for all clinicians planning on undertaking lung function testing (LFT)—particularly spirometry, which is performed widely and in a variety of settings. This procedure requires patients to repeatedly undertake forced exhalatory manoeuvres and as such frequently precipitates coughing and the production of sputum. It also requires clinicians and patients to be in close proximity and thus, even with the use of device filters, in a COVID endemic phase, enhanced infection prevention and control is crucial.

In the UK, discussions regarding the use of personal protective equipment (PPE) largely centre on the classification of any medical intervention or assessment being termed an aerosol generating procedure (AGP)—ie, one in which small particles (<5 micron) are released into the immediate environment and in the respirable range. Classification as an AGP by public health authorities automatically mandates that the highest level of PPE is provided; including eye protection, a full gown (ie, covering the shoulders and lower arms), and the use of a high specification facemask (ie, FFP3 or ventilated hood). Few data confirm or refute whether spirometry represents an AGP; however, a European Respiratory Society expert group statement (from Group 9·1) indicates that full PPE should be worn and that LFT should only be done when absolutely essential. Similarly, the UK body, responsible for clinical respiratory physiology, the Association for Respiratory Technology and Physiology (ARTP) has published guidance indicating that while Public Health England doesn't currently regard LFT to be an AGP, full PPE is recommended and should include the use of a visor and FFP3 (or equivalent) facemask for all those undertaking spirometry. This guidance has immediate implications, not only for the provision of PPE, but also for testing protocols and procedures, including strict recommendations for air circulation times and room cleaning requirements; acting to substantially impede testing capability of physiology services wherever they are performed.



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Yet, simultaneously, it is likely that clinicians will actually require increased and immediate access to LFTs, to help inform the management of patients recovering from COVID-19-related pulmonary disorders. The clinical–radiological pattern most frequently encountered with moderate to severe COVID-19 pulmonary disease indicates change in the airspace and interstitial regions. Increasingly, publications indicate that infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is also associated with a high prevalence of thrombotic events and pulmonary vascular damage. Thus, it seems likely that LFT focussed on interrogating the integrity of the pulmonary–vascular interface will be most rewarding in terms of providing clinicians with physiological insight to inform disease surveillance. Early reports from a series of hospitalised patients with COVID-19 appear to support this supposition with Mo and colleagues, reporting that impairment of gas transfer (TL_{CO} <80% predicted) was the most common finding, evident in approximately half of patients (and present in 80% of those recovering from severe disease), whereas distinct spirometric defects were only found in approximately one in ten. Moving forward, additional value might be provided from more detailed surveillance of the alveolar–capillary interface (eg, with TL_{NO} and assessment of membrane conductance or pulmonary capillary blood volume).

Moreover, testing an individual's respiratory performance under conditions of physiological stress (eg, exercise) will enable more detailed characterisation of any functional impediment and the cardiorespiratory impact of prior SARS-CoV-2 infection. In this respect, cardiopulmonary exercise testing has proven value in the assessment of pulmonary vascular dysregulation and ventilation–perfusion inequality. For example, by revealing a widening of the alveolar to arterial O_2 difference at peak exercise and elevated dead space markers (such as

raised Ve/VCO_2 slope, V_D/V_T and arterial to end-tidal CO_2 difference).

It is also possible that cardiopulmonary exercise testing, if employed in this context, could act to identify other important causes of ongoing breathlessness following SARS-CoV-2 infection, including breathing pattern dysregulation disorder and indeed, in some cases, might act to reassure an individual that their cardiopulmonary performance was normal. This acknowledged, the ability to provide cardiopulmonary exercise testing in a COVID-19 endemic scenario faces the same challenges as general LFTs and thus testing capability will be limited.

It is currently unknown how SARS-CoV-2 infection affects patients with pre-existing respiratory disease or potentially alters the longitudinal lung function trajectory, but this is an important issue and will present both clinical and research demands on lung function services. Although the British Thoracic Society has provided recent guidance regarding a pathway of post-COVID follow-up care, the capability to perform LFT on a large number of individuals recovering from COVID-19 respiratory illness will present a considerable challenge to physiology departments. Moreover, it is likely that the timing of LFT is delicate; anecdotal evidence from respiratory physiologists who had routinely tested their lung function before having COVID-19 found LFT to be painful and difficult to perform reliably without coughing. It is also important that patients have undergone appropriate risk stratification before being referred for LFT—ie, it is crucial that prior to testing occult cardiac or pulmonary vascular problems are considered.

The pandemic does, however, present new opportunities. As with other aspects of clinical practise, the current restrictions present an opportunity to encourage clinicians to review and improve their physiological diagnostic and surveillance pathways. Moreover, it focuses on the need for respiratory teams to engage and explore innovative methods of patient assessment. This is epitomised in the shielded population, where remote and novel means of undertaking physiological assessment will be needed. In this context, non-volitional measures (eg, capnography or structured light plethysmography) might prove valuable. Already, some services have moved to remote applications for doing assessments; for example, using phone-based applications to conduct 6-min walking tests with oximetry monitoring. It seems highly likely that the pandemic will accelerate this type of innovation, the use of diagnostic hubs, and the rapid utilisation of novel diagnostic techniques. As with every aspect of health care, today's challenges are tomorrow's opportunities and lung physiology services will need to embrace these challenges safely, expeditiously, and wisely.

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For **BTS guidance** see https://www.brit-thoracic.org.uk/about-us/covid-19-information-for-the-respiratory-community

For more on **structured light plethysmography** see *Acta Paediatrica* 2019; **108:** 1398–405

For more on **remote 6-min walking test** see *JMIR Mhealth Uhealth* 2020; **8:** e13756

Patient perspectives

Positivity and pulmonary rehabilitation: antidotes to chronic lung conditions

Leslie Sullivan has a positive outlook, always has. He is living with several chronic lung conditions that have changed his life completely; from the diagnosis of chronic obstructive pulmonary disease (COPD) over a decade ago, and then more recently, bronchiectasis and asthma, but this positive attitude has never wavered. "I fight rather than flight, I'm not a worrier. Yes, it can get you down, but not for long because I accept if I can't do something, I can't do it. Acceptance makes it easier." Positivity is definitely Leslie's antidote to all the frustrations and fears that come with his respiratory illness. And he is also immensely grateful to the Adult Cardiorespiratory Enhanced and Responsive Service team (ACERs) who support patients based in the London boroughs City and Hackney, where Leslie lives, in the UK. "Everyday things were harder to do—a lot harder. The support I got from ACERs has made living with these lung conditions a lot more bearable. They are a wonderful team."

So who are ACERs and why have they made such a difference to Leslie? In 2009, ACERs was set up in response to growing evidence obtained from the Hospital at Home Scheme, a community-driven scheme set up to empower patients, to meet the particular needs of City and Hackney residents. Initially, ACERs managed patients at home and provided respiratory physiotherapy, and they also managed patients' pulmonary rehabilitation, which was hospital-based. Since then, more patients with COPD are being admitted to Homerton hospital for short stays due to exacerbations and are dying outside of hospital.

Leslie Sullivan

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