Pulmonary function testing during the COVID-19 pandemic

INTRODUCTION

The COVID-19 pandemic caused by the highly infectious SARS-CoV-2 has affected over 15.9 million people across 200 countries and caused more than 643,000 deaths.[1] As on July 27, 2020, India has ~14.5 lakh cases of COVID-19 and the number is still increasing.[2] The coronavirus is a highly infectious virus and spreads through droplets generated during coughing, sneezing, talking, and even breathing. Indirect contact via contaminated surfaces is another possible cause of infection.[3] The virus may remain viable on plastic (polypropylene) and stainless steel for up to 3 days but does not survive on cardboard for >1 day or on copper for >4 h. The virus is inactivated by soap, which destabilizes its lipid bilayer.[4]

Screening of patients with non-COVID respiratory disease poses special problems at the triage and fever clinics of the hospital, as it would be difficult if not impossible to rule out COVID. Transmission risks during pulmonary function testing (PFT) for COVID-19 are unknown at present as data available are sparse, but the prevalence of the virus in the community, old age, severity of lung disease, and presence of immunosuppression are significant risk factors determining the risk of infection.

PFT is a valuable tool in the assessment of respiratory disease. Spirometry is the key diagnostic test for airway diseases such as asthma and chronic obstructive pulmonary disease (COPD), and is the most commonly performed test. The other tests include lung volumes and diffusing capacity measurement, impulse oscillometry (IOS), bronchoprovocation, and exercise physiology tests.

Spirometry is an effort-dependent test wherein the patient takes a deep inhalation and blows forcefully into the spirometer flow sensor for at least 6 s. Many patients often cough during spirometry. Blowing forcefully and coughing are known to produce aerosol droplets that may contain millions of viruses from the respiratory tract, thereby significantly increasing the risk of transmitting SARS-CoV-2 viruses not only to people present in and around the spirometry room but also to other patients who subsequently perform the test in the same room. It is, therefore, important to avoid and postpone all spirometry tests as well as other PFTs unless it is absolutely necessary.

Decisions regarding the conduct of PFTs need to balance the potential risks against the benefits from the test in making decisions. Several professional societies have advised to defer PFT still after the COVID-19 pandemic.[5-8] We concur with this recommendation and would recommend avoiding spirometry and other PFTs, during the COVID-19 pandemic. Physicians will have to rely more on taking a good history and, wherever possible, using validated diagnostic/screening questionnaires to arrive at a diagnosis and limit testing to the minimum required. In the following section, we have outlined the assessment of the need for testing, the precautions to be taken, and suggested approach to the clinical management of common respiratory conditions, without lung function testing.

TESTS PERFORMED IN PULMONARY FUNCTION TESTING LABORATORIES

Commonly performed tests in the PFT lab are as follows:

1. Spirometry
2. Diffusion capacity measurement
3. Lung volume measurement: using body plethysmography/multi-breath helium dilution/ nitrogen washout
4. IOS
5. Bronchial challenge testing
6. Cardiopulmonary exercise testing (CPET)
7. Six-min walk test
8. Exhaled nitric oxide measurement.

TESTS TO BE AVOIDED DURING THE COVID-19 OUTBREAK

Investigations most likely to carry higher risk for SARS-CoV-2 transmission and thus avoided as far as possible include:

a. Spirometry
b. Diffusion studies
c. Body plethysmography
d. CPET
e. Bronchial provocation tests
f. Sputum induction.

TESTS WITH LESS RISK FOR TRANSMISSION OF INFECTION

IOS being a largely passive procedure, the risk associated with this investigative modality may be lower. Where available, IOS may be recommended, However, this is not as widely available nor as well evidenced as conventional spirometry or diffusion studies.[9]

Fractional exhaled nitric oxide (FENO) measurements do not cause significant risk of aerosolization and may be permissible, again keeping in mind the risk–benefit ratio.[10] Use of appropriate viral filters would improve the safety of health-care personnel.

ALTERNATE METHODS OF DIAGNOSIS TO REDUCE/AVOID LABORATORY-BASED LUNG FUNCTION TESTS

Wherever possible, it is recommended that safer alternatives to standard lung function testing be considered, in combination with a good clinical assessment, the options include:

1. Handheld spirometers at home
2. Personal peak flow meters
3. Validated questionnaires such as the Asthma Control Test (ACT) or Asthma Control Questionnaire (ACQ) or COPD assessment test (CAT).

RECOMMENDATIONS FOR LUNG FUNCTION TESTING

Broadly, recommendations for PFT can be made based on the prevalence of the infection in the community. We anticipate the following phases:

a. Pandemic phase when there is high community prevalence
b. Declining phase when the community prevalence is low
c. Postpandemic phase when the disease transmission is controlled.

During pandemic phase when there is high community prevalence

Administrative measures

a. Postpone all routine PFTs unless it is absolutely necessary
b. Patients diagnosed with COVID or those with COVID-19/influenza-like symptoms should not be tested for 30 days
c. When deemed essential, COVID test may be done, if possible before proceeding to test
d. A day before the scheduled date, screening is done for COVID-19/influenza-like symptoms. If present, follow step "b" or "c."
e. Avoid overcrowding in the waiting area and maintain physical distance of at least 2 m. Patient attendants should not be allowed or restricted to one if required, wearing a mask
f. Ideally designate testing rooms into separate inpatient and outpatient test areas
g. Immunocompromised non-COVID patients should be scheduled for testing at the start of day, before other patients arrive.

Recommendations for protection of staff

a. Use of personal protective equipment (PPE) as per local hospital policy
b. We recommend mandatory use of N95 or filtering face-piece (FFP) 3 or FFP2, along with eye protection – goggles or face shield
c. Proper training of staff should be done regarding donning and doffing of PPE
d. Staff should not move outside the area without removing the PPE
e. Disposable gloves should be used during testing and discarded after each patient and after cleaning of the surfaces
f. Hand sanitizers should be readily available for implementation of the hygiene protocols for patients and staff as per local policy, and before and after glove use.

Laboratory-infection control and cleaning protocols

Equipment

- Manufacturer recommendations for cleaning and disinfection of equipment should be followed
- To the extent possible, only single-use consumables, for example, nose clips and rubber mouthpieces should be used. Disposal of these items should also be done with care
- Reusable items should be carefully cleaned as recommended by the local infection control policy
- The testing room with negative pressure is preferred when high-risk and infected patients are tested; alternatively, testing using telemedicine could be tried
- There should be at least a 15-min gap between two patients
- If testing is not done under a negative-pressure facility, windows and doors should be kept open to ensure free ventilation, and the direction of wind flow should be away from the health-care providers performing the test
- High-specification disposable in-line bacterial and viral filter (with minimum proven efficiency for high expiratory flow of 600–700 L/min) should be used in the spirometer while conducting the test.

Cleaning and infection control

- All patients should be provided a surgical mask to be used during their stay in the laboratory. Attendants should also wearing masks while in the laboratory at all times
- Hand sanitizers should be readily available in the department and the PFT laboratory, and the staff and the patient should use this before handling the equipment
- Regular wiping of all countertops and wet mopping of the floors with 1% sodium hypochlorite should be done
- Local cleaning protocol should be adopted
- Proper disposal of biological waste should be ensured
- Ultraviolet light and ozone are other modes that could be considered for decontamination of rooms.

During the declining phase when community prevalence is low

- All testing procedures can be reintroduced with extra

precautions, such as with full PPE and policy guided by local health bodies
- Exercise testing, nebulization, bronchial challenge tests, and other aerosol-generating procedures should be limited to specific equipment and testing rooms, and filters should be connected to the expiration ports
- Continue the use of viral filters while conducting spirometry
- Reserve separate equipment for testing patients who have a history of COVID infection
- Single-use consumables such as nose clips and rubber mouthpieces should be used and disposed carefully at the end of procedure.

During postpandemic phase when disease is controlled

- Return to pre-COVID-19 standards for the delivery of lung function services.
- For more details about air borne infection control, design and construction of health care facilities we refer you two sources.[11,12]

DIAGNOSIS AND MANAGEMENT OF COMMON RESPIRATORY CONDITIONS WHEN REQUIRED WITHOUT TESTING

Asthma

Diagnosis

While spirometry should be employed only if necessary, alternate modes of arriving at a diagnosis could be explored. However, if spirometry is deemed necessary, adequate infection control measures must be adhered to (see above). A diagnosis of asthma can be arrived at in the absence of spirometry based on various clinical features depicted in Table 1.[13] Peak expiratory flowmetry may be useful in arriving at a diagnosis in the absence of spirometry, but it is not as reliable as routine spirometry.

Table 1: Asthma likelihood

	Asthma likelihood (not fully diagnostic nor excluding asthma)	
	More likely	**Less likely**
Symptoms and Signs:	Combined dyspnoea and wheeze (highest sensitivity and specificity) Any combination of wheeze, cough, breathlessness and chest tightness (at least 2) Widespread polyphonic wheezes	Cough without wheeze or breathlessness No wheeze despite symptoms being present Cough with purulent sputum and /or haemoptysis Associated symptoms suggestive of hyperventilation
Symptom Pattern	Worse at night or early morning Worse in some seasons Recurrent Aggravated by known allergen, exercise, cold air, vital infections, inhaled irritants beta-blockers, aspirin or NSAIDs Relieved partially or completely by SABAs	Later onset of symptoms, especially in smokers/ those with exposure to noxious fumes/ gases No immediate response to SABAs
Background of:	Past or Family history of allergies/ asthma Childhood onset	Long smoking history No response to previous asthma treatment
Peak flow variability:	24 hour variability in PEF (measured on personal peak flow meter) of > 10% (adults) and > 13% (children)	Normal PEF when symptomatic No PEF variability or < 10% (adults) -13%(Children)

Monitoring

Asthma symptom control should be assessed on a routine basis. Simple screening tools to Categorical and Numerical symptom control tools have been recommended in the GINA 2020 document. However, numerical "asthma control" tools such as the ACT and ACQ-6 are more sensitive to change in symptom control compared to the categorical tools. There is no evidence to differentiate a worsening of symptoms caused by SARS-CoV-2 or other respiratory viruses.

a. Spirometry and peak flowmetry should be avoided in the health-care setting, if there is evidence of SARS-CoV-2 transmission in the community, unless there is an urgent need. If spirometry is urgently needed, see instructions above.

Home peak flowmetry may be undertaken, and the results may be used for patient care. Personal peak flow reading should also be taken with utmost precautions. Patients should preferably be alone in a well-ventilated room and no one should enter the room for about 15 min after the test has been performed. Appropriate hand hygiene and sanitization of the peak flow meter should be followed. Peak flow meters should never be shared. Short-term peak flow monitoring may be used to assess response to symptoms, evaluate triggers for worsening symptoms, or to establish the baseline for proposed action plans.

Handheld home spirometers may be useful devices for monitoring asthma in future:

a. FENO may be used when available, as the risk of transmission is lower. However, the risk–benefit ratio must be carefully considered.

Chronic obstructive pulmonary disease

Patients with COPD are among the worst affected by COVID-19 and suffer a high risk for more severe disease and mortality.[14] COPD was found to be significantly associated with severe COVID-19 (odds ratio: 5.69 (95: confidence interval: 2.49–13.00).[15] The overall case fatality rate (CFR) in COPD was 6.3% compared to a CFR of 2.3% in the overall population.[16]

Diagnosis

The diagnosis of COPD is based on a history of exposure to risk factors and a demonstration by spirometry of persistent airflow obstruction. However, in the current pandemic situation, when most professional bodies have recommended that spirometry should not be done except where essential, alternative diagnostic tools are needed. The use of a questionnaire combined with a handheld spirometer (using a forced expiratory volume 1 s (FEV1)/forced vital capacity [FVC] [or FEV6]) has been suggested as a method of reaching a diagnosis of COPD. A questionnaire alone combined with the clinical assessment may be adequate to reach a diagnosis.

Questionnaires such as the International Primary Care Airways Group questionnaire, the COPD Population Screener questionnaire, and the Lung Function Questionnaire all seem to have a reasonable predictive value.[17,18]

Monitoring

Once a diagnosis of COPD is confirmed, the treatment plan is based on a combination of symptom assessment (modified Medical Research Council [mMRC] grading of breathlessness or CAT) and the history of exacerbations. These may also be used to monitor the course of COPD. The mMRC is simpler and easier to remember, while the CAT with more items ideally needs a printed or online form but offers greater detail. Also useful in assessing the overall self-management ability is the Chronic Respiratory Disease Questionnaire Mastery Score (Global Initiative for Chronic Obstructive Lung Disease 2020). More widely used is the Clinical COPD questionnaire (CCQ) which is available in many languages including Indian languages (https://ccq.nl/?wpsc-product = ccq-uk-english-24 h-version). Handheld spirometers are a useful tool to monitor serial changes in spirometry which can be used by the patient at home. The peak flow meter is not usually used in COPD monitoring, but in a COVID situation may deserve closer attention.[19,20]

Interstitial lung diseases

Lung function tests including spirometry (mainly FVC and DLCO) are not essential for the diagnosis of interstitial lung disease. They are important in prognostication and for recording response to drug treatment. A baseline spirometry with adequate attention to infection control may be undertaken at the initial evaluation to have a baseline assessment for future comparison, among patients with low preprocedure risk of COVID. Risk assessment should be performed as per local hospital guidelines.

Follow-up lung function can be delayed to an annual assessment of FVC/DLCO and should be resorted to once it is deemed safe to perform the procedure. Follow-up handheld spirometry performed at home may be an acceptable alternative if feasible, with attention to infection control practices as above. Patients should be trained to perform home-based spirometry via noncontact modes of communication such as videos or telemedicine (https://www.youtube.com/watch?v = bdkyrngFhho). In-person training should be avoided.

Monitoring of the disease may be performed by 6-min walk distance and imaging studies timed as per defined protocols.

We recognize that the concepts are evolving and may require change as new evidence is forthcoming.

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