




Challenges of evaluating lung function as part of cancer care during the COVID-19 pandemic

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The COVID-19 pandemic and the necessity for social isolation are ushering in a new era of remote clinical evaluation. Modifications of CT imaging and processing in chest medicine yield both anatomical and functional information in a safe environment. <https://bit.ly/2Np3Dyz>

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a newly identified agent foisted upon humanity and responsible for the contagious affliction, coronavirus disease 2019 (COVID-19) [1] that has rapidly evolved into a pandemic testing to the limits, and sometimes beyond, the capacity to respond of healthcare systems across the world [2]. Management is purely supportive and social isolation crucial to containment [3]. Enforced reallocation of hospital resources and personnel to cope with the increasing numbers requiring hospital admission and intensive care [4] in the most trying of conditions has been at the expense of many hospital departments, among them those offering diagnostic and support services for lung cancer [5–7].

Evaluation of lung physiology is an essential preliminary to potentially curative treatments, surgical resection, chemotherapy and radiotherapy [8]. The risks to patients and staff associated with exposure to aerosols generated by forced expiratory manoeuvres in conventional testing has led to several societies issuing advice against their use [9, 10]: formal evidence-based guidance has yet to be published. Our institution is, however, adapting to less hazardous procedures and technologies, for example virtual clinical assessments.

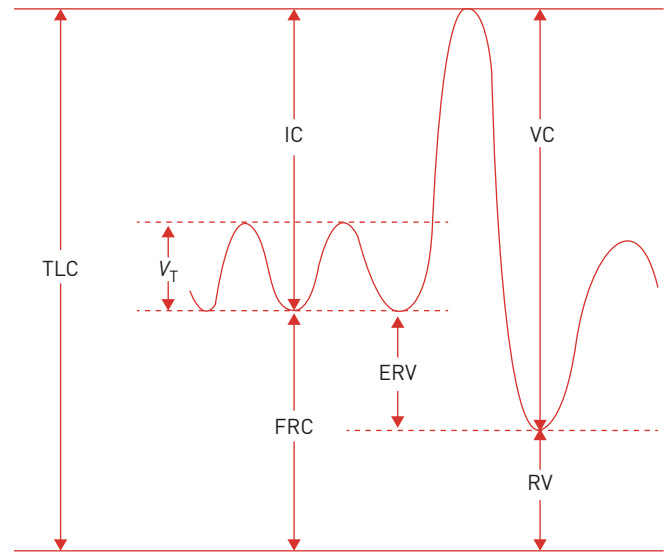
Spirometry is the most feared aerosol generating procedure and we are looking into provision of peak expiratory flow meters to be used as an alternative in the home environment [11]. Remote monitoring of cystic fibrosis patients with portable wireless transmission spirometers such as NuvoAir has revolutionised their outpatient management, and minimising interpersonal contact, has the potential for transforming the care of cancer patients during the current “lockdown” period [12]. Use of either device can be supervised *via* a secure telemedicine link to ensure optimal technique and valid measurements and provide convenient, operationally and financially advantageous continuing surveillance of these patients, particularly post-operatively.

A promising alternative approach to evaluating lung function is that of quantitative computed tomography (qCT) imaging [13]; whilst this is currently a research tool, it has the potential for transforming clinical

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FIGURE 1 Subdivisions of plethysmography-derived lung volumes. ERV: expiratory reserve volume; FRC: functional residual capacity; IC: inspiratory capacity; RV: residual volume; TLC: total lung capacity; VC: vital capacity; V_T : tidal volume.



practice. Fractionation of conventional CT scans on a scale of attenuation has been used to determine the relative contributions of pathologies. SHROEDER *et al.* [14], in 2013, examining more than 4000 CT scans made in expiration of individuals who were smokers, with and without COPD, correlated air trapping (areas of low attenuation equal to or less than -856 Hounsfield units, HU) with physiological measures of airway obstruction. Their estimations of forced expiratory volume in 1 s (FEV_1) compared favourably with those of spirometry. Wu *et al.* [15], in 2002, categorising the pre-operative scans of 44 of their lung cancer patients, applied dual thresholds of attenuation distinguishing the contributions of tumour and atelectasis (greater than -500 HU), emphysema (less than -910 HU), and normal functioning parenchyma (-500 to -910 HU) and making accurate predictions of post-operative FEV_1 . The authors, observing the small sample size, exercised caution in those patients with a qCT-predicted $FEV_1 < 40\%$ who have a higher risk of post-operative morbidity and mortality, and advised the addition of perfusion scintigraphy and exercise testing for comprehensive evaluation. Functional respiratory imaging, combining high-resolution CT and post-processing computational fluid dynamics, can be used to assess airway volume and resistance at a lobar level and is more sensitive to pharmacologically induced changes than routine lung function tests [16]. Total lung capacity and residual volumes, estimated on CT scans respectively made in maximum inspiration and expiration have also been shown to correlate well with plethysmography derived measurements (figure 1) [17]. In the absence of a local qCT software platform, a number of commercial companies offer such an imaging service simply requiring uploading of an anonymised CT scan to a secure cloud-based service for analysis: the report is emailed within 24 h.

Dual-energy phase CT [18] and single photon emission tomography CT [19] imaging enable evaluation of lobar perfusion, which is necessary, for example, prior to surgery. Furthermore, CT chest images acquired without electrocardiographic gating for non-cardiac indications have nevertheless proved serviceable for detecting coronary artery calcification [20, 21] and quantifying epicardial and thoracic fat [22].

The COVID-19 pandemic and the necessity for social isolation is ushering in a new era of remote clinical evaluation. Modifications of CT imaging and processing in chest medicine yield both anatomical and functional information in a safe environment. They are not expected to appreciably add to the radiation exposure of current use, nor are they likely to be especially time-consuming [23, 24]. This approach could be transferable to other fields of medicine. The advent of serological testing for SARS-CoV-2 should help to restore some functionality to the health services, but a rethinking of current infrastructure and adaptation to the demands of changing global circumstances confronting us is called for.

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