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Short communication

Respiratory function assessment at the time of a new respiratory virus pandemic

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ABSTRACT

We must be aware that new respiratory virus pandemic can happen frequently. Standard lung function tests should keep their crucial role to assist the clinicians in the decision-making process, but they are at risk for the spread of infection because of the generated droplets. We used opto-electronic plethysmography to investigate the post-COVID-19 syndrome on 12 patients after ICU. We found normal ventilatory pattern at rest, a restrictive pattern (Fig. 1). We firstly tested both groups during 6 min of quiet breathing in seated and supine position, finding no differences in the ventilatory pattern (Fig. 1). We investigated the effects of post-COVID-19 syndrome on 12 patients who were admitted to ICU for a median time of 14 days (interquartile range 12–18.7 days), as a consequence of the progressive deterioration of respiratory functionalities. This group of patients was composed by 9 males (median age: 59 years old) and 3 females (46 years old). A control group of COVID-19 naïve healthy subjects with the same sex and age distribution was also evaluated with the same protocol.

To the editor.

In February 2020, COVID-19 invaded Lombardy, that soon became the epicentre of the COVID-19 outbreak in Italy while representing also the beginning of epidemic in Europe and then worldwide. The clinicians had to face new unexpected stressful challenges, while dealing with the infected subjects who experienced the most severe and critical aspects of this new particularly severe disease. In the worst scenario, it evolves in severe interstitial pneumonia, acute respiratory distress syndrome and multi-organ dysfunction, requiring the admission in intensive care unit (ICU) [1–3]. At the end of the first pandemic wave, Lombardy was left with one of the highest crude mortality rate (167.6/100 k) [4] and with patients experiencing unexpected post-COVID-19 syndrome [5], now known as long COVID-19 [6], with a variety of symptoms and organ-related injuries to be investigated. Assessing pulmonary functions in post-COVID-19 syndrome was therefore a crucial part of the healing process of the patients and for the clinicians to manage the disease. However, standard lung function tests (spirometry, static lung volumes assessment and diffusion capacity of the lungs for carbon monoxide tests) generate aerosols in the form of droplets, due to coughing and/or the generation of high flow rates, and they all require tube circuits attached to a mouthpiece. These features posed the tests at considerable risk for the spread of infection to operators and patients, even the asymptomatic ones. For this reason, at the beginning of the pandemic, a document of the European Respiratory Society recommended no patients with COVID-19 or flu-like symptoms to be tested under any circumstances for a minimum of 30 days after the infection [7]. Pandemic had therefore enormously impacted and limited the widespread application of spirometry, while prompting much attention on hygienic procedures and on noncontact spirometers [8]. In June 2020, therefore at the end of the first dramatic wave in Lombardy, we implemented dedicated security procedures for opto-electronic plethysmography (OEP), a non-invasive, motion analysis system capable to quantify respiratory volume variations without the use of mouthpiece [9,10]. We investigated the effects of post-COVID-19 syndrome on 12 patients who were admitted to ICU for a median time of 14 days (interquartile range 12–18.7 days), as a consequence of the progressive deterioration of respiratory functionalities. This group of patients was composed by 9 males (median age: 59 years old) and 3 females (46 years old). A control group of COVID-19 naïve healthy subjects with the same sex and age distribution was also evaluated with the same protocol.

We firstly tested both groups during 6 min of quiet breathing in seated and supine position, finding no differences in the ventilatory pattern (Fig. 1). OEP does not require mouth instrumentation and therefore the impact of surgical mask on the ventilatory pattern at rest could be tested. In seated position, the surgical mask made patients increase their minute ventilation (11.8 ± 10.8 L min⁻¹) because of shorter total breath duration due to reduced expiratory time (Fig. 1).

Because no standard lung function tests could be performed at that time [7], chest wall and thoraco-abdominal volumes were measured also.
Firstly, the results showed the importance of developing mouthpiece-free systems to assess pulmonary function [11], unique and carry out important considerations. (Fig. 1).

After more than one year of pandemic, it is still crucially important to significantly lower in patients because of reduced inspiratory capacity, with during vital capacity (VC) manoeuvre. In both postures, VC was significantly lower in patients than in controls, confirming the presence of fibrotic tissue and the stiffness impact on the overall VC while limiting only the maximal inspiratory phase. These conclusions were somewhat theoretically expected, considering the severe pneumonia, but they resulted from a radiation-free technique and without the use of mouthpiece, underlining also the importance to investigate thoraco-abdominal volumes.

Thirdly, the results showed that the most severe form of the disease, once resolved, does not impact on the ventilatory pattern at rest. This result seems in line with the clinical unpublished consideration that the CT-scans of the lung of these patients were better than expected (considering the acute episodes of pneumonia), suggesting different cellular fibrotic mechanisms of COVID-19 (to be investigated).

Lastly, the results underlined that surgical mask impacts on the ventilatory pattern of patients in seated position. Considering that at the end of the protocol they reported a dyspnoea BORG scale of 0 (interquartile range 0–0.5), we wonder if the mask-induced altered pattern was mostly like to be consequence of some psychological aspects [14,15] rather than to specific ventilatory drive alterations.

The limits of the results are intrinsically linked to the protocol itself and they were unavoidable: 1) the lack of standard lung function assessment, banned at that period [7]; 2) the lack of evaluation during some exercise task, due to patients suffering from important unexpected locomotor impairments [16–18], that were the primary question of the clinicians; 3) the low number of patients, due to the delicate period to gather people in a research laboratory, that was re-opened for that purpose at the end of a rigid national lockdown [19].

To conclude, although we are experiencing an extraordinary event, we must be aware that new respiratory virus pandemic can happen more frequently than expected [20]. Respiratory function assessment should keep its crucial role in the diagnosis, treatment and follow-up, particularly during the most severe pandemic wave, to assist the clinicians in their delicate decision-making process to heal patients. The attention on unconventional respiratory function tests should be therefore increased and sponsored for the important information they can provide as shown by the present dataset.

**Statements.**

**Contributorship**

All authors designed the study, discussed the results, contributed to and agreed on the final manuscript.; ALM and FG: acquired the data; ALM analysed the data and draft the manuscript.

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**Competing interests**

Nothing to declare.

**Exclusive license**

Nothing to declare.

**Ethics statement**

The study was registered by the local ethical committee of Ospedale...
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