Inspiratory Capacity: The Key to Home Monitoring Patients with COPD

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The focus of this editorial may seem counter-intuitive to many. Chronic Obstructive Pulmonary Disease (COPD) is by definition a disease that obstructs the airways, which seems best monitored by frequent measurements of airflow obstruction. The tool that has been the mainstay of monitoring COPD patients at home is a spirometer and its measurements of Peak Expiratory Flow (PEFR), Forced Expiratory Volume in 1 second (FEV1) and Forced Vital Capacity (FVC). Yet the scientific data suggests that the volume measurements collected during slow vital capacity maneuvers such as Inspiratory Capacity (IC) and Slow Vital Capacity (SVC) inform the most as to COPD patients' response to treatment, forecasting exacerbations, and predicting mortality.

Periodic exacerbations of symptoms are the major cause of morbidity, mortality and health care costs in patients with COPD and one-third of patients with an exacerbation are re-hospitalized at 90 days. Effective treatment of COPD exacerbations, which reduce rehospitalizations, results in significant increases in Forced Expiratory Volume in 1 second (FEV1), Mid-Expiratory Flow (FEF25-75), Peak Expiratory Flow (PEF) and IC with associated reductions in the Borg Dyspnea Score. Yetkin, et al, found that the increase in IC was more significantly correlated with the improvement in the Borg Score than the FEV1.[1]

Tantucci, et al, recruited 222 patients with mild-to-moderate COPD with an average follow-up for 5 years.[2] They studied the stable condition relationships of respiratory mortality and morbidity with measurements of FEV1, FEV1/FVC, IC, PaO2, PaCO2 and Body Mass Index (BMI). All these variables were associated with mortality at the univariate analysis. However, in a multivariate regression analysis for mortality, IC and PaO2 remained the only significant, independent predictors. Inspiratory Capacity, FEV1/FVC, and PaO2 were also significantly related to morbidity, as independent predictors of hospital admissions because of exacerbations. They concluded

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that Inspiratory Capacity is a powerful functional predictor of all-cause of respiratory mortality and of exacerbation-related hospital admissions in COPD patients.

Cassanova, et al, followed 689 COPD outpatients with a wide range of airflow obstruction every six months with measurements of lung function, exercise capacity and dyspnea indices up to 5 years with a median period of 34 months.[4] They reported that IC/TLC may better reflect the overall impact of disease severity, and could have a great potential impact on the multidimensional evaluation of COPD. They concluded that resting hyperinflation measured as IC/TLC is an independent predictor of respiratory and all-causes mortality in COPD with a significant threshold IC/TLC value of <25%. Similar results were reported by French et al, with a statistical association of an IC/TLC <25% with mortality.[5] They emphasized that the IC/TLC ratio or inspiratory fraction should be considered in addition to other lung function parameters in the proper assessment of patients with COPD.

The volume of air that can be inhaled from the resting end-tidal expiratory level (FRC) to total lung capacity (TLC) is the inspiratory capacity and any structural change that increases FRC will encroach upon and reduce the IC. In COPD, these changes are primarily the result of either air trapping that results from airway closure during exhalation that precludes emptying of the alveolar, or from losses in elastic recoil of the lung parenchyma that shifts the end-tidal mechanical zero point to a higher lung volume. In either case, a reduction in IC has significant negative physiologic implications for ventilatory capacity with increased respiratory muscle load and increased respiratory neural drive. These changes clearly explain the findings of reduced exercise capacity and its associated findings of reduced muscle mass in COPD patients and evidence of treatment failure, exacerbation and hospitalization. What we now know is that the progression of hyperinflation that is associated with frequent exacerbations and a faster decline in FEV1 requires better monitoring of changes in Inspiratory Capacity, and that IC monitoring of exacerbation recovery enables tracking of the improvements in symptoms and physical activity that are associated with reductions in lung hyperinflation.

Knowing what to monitor in patients with COPD is only one critical element of effective monitoring, with the other being patient adherence to performing the test. If patients don't perform the test, just the availability of monitoring will have no

impact on outcomes. In a study by Cushen et al of COPD patients at home, they found that adequate forced spirometry testing was only completed by 70% of their subjects, while 90% were able to adequately perform the slow spirometry measurement.[3] There is a message in these results that should not be lost on us. Not only do we need to monitor the right parameters, but that we need to pick ones that patients are best able to perform.

While the medical community has to some extent been appropriately monitoring the airway function of patients with COPD with forced spirometry, it has now been shown that it has been perhaps missing the as important or more important home monitoring of IC in these patients. We should not miss the use of such a simple monitoring test to follow our patients' status. As respiratory care practitioners, it is critical that we use our influence to introduce this concept into the home monitoring programs we participate in or manage if we are to improve the outcomes in the COPD patients in our care.

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