'Every Breath You Take I'll Be Watching You': Measuring Exercise Kinetics during 6-Min Walking Test in COPD

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Exercise limitation is one of the major characteristics of everyday life for COPD patients and has been shown to be related to increased exacerbation risk [1], poor health-related quality of life and increased mortality [2–4]. The main symptoms that limit exercise in most COPD patients are dyspnea and fatigue, both of which result from ventilatory parameters, pulmonary gas exchange abnormalities, peripheral muscle dysfunction, cardiac decompensation, or any combination of the above [5].

An analysis of the factors which limit exercise tolerance in COPD may uncover hidden exercise-related issues, including hypoxemia, dysrhythmias and cardiac ischemia [5]. Cardiovascular deconditioning is very common in COPD patients and a substantial amount of the increase in exercise tolerance following cardiopulmonary rehabilitation also reflects improvements in cardiovascular function, besides the well-established muscular enhancement [6, 7]. Clarification of the underlying cause of exercise intolerance in COPD would ideally be the major determinant of therapeutic interventions.

In a recent issue of *Respiration* van Gestel et al. [8] used a portable cardiopulmonary monitoring device in order to quantify oxygen exchange kinetics during the 6-min walking test (6MWT). With this setting, the authors were able to record in a 'breath by breath' manner several pa-

rameters, including pulse rate, oxygen saturation (SpO₂), oxygen uptake (VO₂), carbon dioxide output (VCO₂), total volume, and breathing frequency, and to quantify VO₂ kinetics in real time. After carefully excluding patients with inaccurate mean response time (MRT) estimation, the authors observed that patients with more severe airflow limitation (patients with severe and very severe COPD) had worse corrected work MRT (wMRT) and oxygen uptake at steady state (VO_{2ss}). The distance walked in 6 min (6MWD) is used as the main outcome of the 6MWT [9]. In the study of van Gestel et al., wMRT was associated both with the 6MWD and the VO_{2ss}, providing evidence that the result of such a simple test, combined with the use of a portable device, may be used as a marker of exercise tolerance instead of the complicated and demanding cardiopulmonary exercise testing.

Although the 6MWT is mainly considered as a test of submaximal exercise testing [10], it is important to state that during the study over 80% of patients reached the criteria for maximal exercise. This observation is of great importance, since the results of the present study suggest that a simple 6MWT may reflect the overall exercise capacity in the majority of COPD patients, which can then be translated to important information regarding disease severity and outcomes.

The great majority of patients in the study of van Gestel et al. [8] suffered from severe and very severe COPD (GOLD stages III and IV) and most of them experienced exercise limitations due to ventilatory factors and gas exchange. This is in accordance with previous data supporting the hypothesis that patients with severe airway obstruction usually experience exercise limitations due to intense dyspnea which is the result of an imbalance between ventilatory demands and capacity and, to a lesser extent, leg discomfort resulting from inadequate energy supply to locomotor muscles of the lower extremities [5]. The dynamic hyperinflation which occurs during exercise leads to respiratory discomfort and exercise limitations, which have also been observed in patients with moderate airway obstruction (GOLD stage II) [5].

Interestingly, only 12.5% of the study participants experienced cardiocirculatory limitation during exercise. However, the fact that wMRT is known to be mostly de-

pendant on the rate of increase of pulmonary blood flow [11], combined with the association between wMRT and disease severity in the current study, probably supports the view that exercise tolerance in more severe COPD is also limited by cardiocirculatory parameters. This finding suggests that the optimal management of exercise limitation may need to include the optimization of the cardiocirculatory status of COPD patients. This needs to be addressed in future studies.

Overall, the quantification of VO_2 kinetics in real time during 6MWT may be a simple but precise and thorough approach to evaluate the causes of exercise limitation in patients with COPD. Such interventions may lead to more targeted management of exercise limitation in COPD, involving effective bronchodilation, the optimization of cardiocirculatory status and/or the improvement of physical deconditioning, to the extent that each of these parameters needs to be refined.

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