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## LETTER TO THE EDITOR

### Response to the Letter to the Editor

We appreciate the opportunity to respond to the Letter to the Editor. While endurance tests of the inspiratory muscles have limitations, they are not inadequate.

We agree with Drs. Powell and Williams that some of the endurance tests cited in our systematic review require a high degree of cooperation and that it might be difficult to establish whether it is impairment or lack of effort that contributes to a poor outcome. However, patient effort and motivation are key components of motor performance. Considering their role in muscle endurance tests will enhance our understanding of how our evaluative measures relate to improvements in a patient's daily life.

Several of the inspiratory muscle endurance tests establish the point that a participant can no longer continue, also termed "task failure." We prefer not to use the term fatigue because of the broader connotations it implies when used in the context of neuromuscular or cognitive fatigue. In such instances, the participant may be able to perform a task while experiencing various types of fatigue.

We do not agree that "...direct function of the respiratory muscles can only be truly measured invasively." This statement is not supported by the NHLBI Working Group report<sup>1</sup> nor authors, like those included in our systematic review, who perform clinical research and perceive these tests to be estimates of respiratory muscle endurance. Review of the broader literature on limb muscles demonstrates that many clinical tests of muscle performance are used to estimate muscle endurance and are not restricted to invasive measures.<sup>2–4</sup>

The inspiratory muscles in different respiratory conditions may undergo relentless loading, however, these loads are not constant. Levels of ventilation, blood flow distribution, and energy supply will vary throughout the day and lifetime of these individuals dependent on physical demands, progression of disease, and the presence of superimposed acute illness or exacerbation.

Without a doubt, the inability to sustain a steady-state submaximal load might be attributed to a different combination of factors than those that limit an incremental, progressive threshold loading test of the respiratory muscles. We are not aware of any data to support the clinical utility of one measure over the other but are aware of the practical considerations of performing tests on

patients. It would appear that respiratory muscle tests are selected based on whether they can estimate the desired outcome, are straightforward to perform, are not unduly challenging, and are accessible, reliable, and preferably non-invasive.

We agree that endurance testing of the inspiratory muscles should be standardized and that new technologies could provide better information to formulate a diagnosis and exercise prescription. Despite the above-described limitations of the inspiratory muscle endurance tests, our rigorous review showed significant improvements in inspiratory muscle strength, exercise performance, decreased dyspnea and improved quality of life. Given the low-risk nature of this type of training, careful consideration of its potential effectiveness in the management plan of each of our patients is warranted.

### References

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