

Special Edition  
"Recent Advances in Pulmonary  
Rehabilitation"

## Review

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# Recent Advances in Assessment of Dyspnea

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### ABSTRACT

As pulmonary rehabilitation can provide various benefits on managing the symptoms of dyspnea, alleviating dyspnea represents a major goal in pulmonary rehabilitation. Dyspnea appears not to be just a single sensation, as it includes the three sensory quality of dyspnea; work/effort, air-hunger and chest tightness. In addition to sensation of dyspnea, complex emotions including anxiety, attention and fear can involve through processing of the limbic system. Recent studies emphasized the multidimensional nature of dyspnea in the sensory-perceptual (intensity and quality), affective distress and impact domains. This review focused on the underlying mechanism of dyspnea and recent advances in assessment in pulmonary rehabilitation in chronic obstructive pulmonary disease (COPD).

**KEY WORDS:** Dyspnea; Air-hunger; Chest tightness; Multidimensional approach.

**ABBREVIATIONS:** COPD: Chronic Obstructive Pulmonary Disease; FEV<sub>1</sub>: Forced Expiratory Volume in 1 s; BDI: Baseline Dyspnea Index; TDI: Transition Dyspnea Index; MDP: Multidimensional Dyspnea Profile.

### INTRODUCTION

Dyspnea generally decreases functional status and psychological health in diverse respiratory disease who require the pulmonary rehabilitation. Specifically, in chronic obstructive pulmonary disease (COPD), dyspnea has been shown to be better predictor of 5-year survival than forced expiratory volume in 1 s (FEV<sub>1</sub>).<sup>1</sup> Since it is well-known that pulmonary rehabilitation can provide help to manage the symptoms of dyspnea<sup>2</sup>; therefore, alleviating dyspnea represents a major goal in pulmonary rehabilitation. This review focused on the underlying mechanism of dyspnea and assessments in pulmonary rehabilitation in COPD.

### THE DEFINITION AND SENSORY QUALITY OF DYSPNEA

On the American thoracic society/European respiratory society (ATS/ERS) statement, dyspnea can be defined as "subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity".<sup>3</sup> As this statement concludes,<sup>3</sup> dyspnea appears not to be a single sensation. At least, there would be three distinct sensations of dyspnea; 1) work/effort ("breathing takes work or effort"); 2) tightness ("chest is constricted, chest feels tight"); 3) air hunger (unsatisfied inspiration, urge to breathe and starved for air).<sup>3</sup> There are solid evidences showing that these respiratory sensations may consist of qualitatively distinct neurophysiological mechanisms.<sup>4</sup>

Work/effort may be originated from increased respiratory motor command. In addition, it has been reported that air hunger may derive from increased central chemoreceptors that are stimulated by hypercapnia.<sup>5,6</sup> On the other hand, activation of C-fiber receptors or rapidly adapting stretch receptors induced by bronchoconstriction may play key role in the production of sensation of chest tightness.<sup>7</sup> The peripheral afferent inputs involved in these above sensa-

tions are thought to convey each cortical pathway, pathway parallel to respiratory somatic sensation or limbic system.<sup>8,9</sup> Thus, the variety on these neurophysiological mechanisms is thought to lead to the distinct treatment for the perceptions. However, despite no single sensation, only labeled dyspnea during physical exercise has been mainly focused in most pulmonary rehabilitation research or practice.

#### THE UNDERLYING MECHANISM ABOUT DYSPNEA IN COPD

In COPD, peripheral airway obstruction during expiration can result in expiratory flow limitation that reduce the tidal expiration but not inspiration, which causes the dynamic lung hyperinflation. In clinical settings, the dynamic hyperinflation is generally represented by the decreased inspiratory capacity (IC). Excessive inspiratory muscle effort occurs as a result of increased elastic loading induced by abnormal dynamic mechanics during restrictive IC situation.<sup>10</sup> Actually, on the S-shaped pressure-volume curves of the respiratory system, a high lung volume can force to breathe with a high respiratory pressure. Based on the changes in respiratory mechanics, the augmented efferent ventilatory drive to the respiratory muscles may reflect in the central neural pathway for the production of the sensation of work/effort.

In peripheral organs, afferents from muscle spindles and tendon organs in respiratory musculature appears as the sensing mechanism of ventilation.<sup>10</sup> In addition to this sensing system, the nasal Transient Receptor Potential Melastatin-8 (TRPM8) channel are thought to play key role in monitoring the airflow.<sup>11</sup> On the other hand, increased central and peripheral chemo-stimulation may arise from alveolar ventilation/perfusion abnormalities, arterial oxygen desaturation, early embolic acidosis and ergo- and metabo-receptors in skeletal muscle.<sup>10</sup> The insufficient respiratory afferent inputs in response to efferent ventilatory motor output (neuro-mechanical uncoupling) might evoke not only work/effort but also air hunger. Furthermore, the bronchospasm during exercise may induce the chest tightness. Taken together, dyspnea during daily physical activities may often occur as a result of the integration of these sensory qualities based on distinct mechanisms, we have to pay more attention to evaluate the sensory quality of dyspnea in COPD in clinical practice.

#### MULTIDIMENSIONAL APPROACHES TO ASSESS DYSPNEA

Sensation of dyspnea and such complex emotions including anxiety, attention and fear, can evolve through processing of the limbic system. Accumulating evidences indicate that dyspnea, like pain perception, consists of “sensory quality” and “affective” components. For example, this study showed that unpleasantness of dyspnea during inspiratory resistive breathing can vary independently from perceived intensity.<sup>12</sup> In addition to this finding, air hunger and work/effort do not evoke the same unpleasant or affective dimension: air hunger is usually associated

with greater unpleasantness and emotional response than work/effort.<sup>12</sup> Therefore, recent studies emphasized that multidimensional nature of dyspnea in the sensory-perceptual (intensity and quality) are effective against distress and impact domains.<sup>4</sup>

In multidimensional ratings to measure dyspnea, there are currently three available methods that consist of Multidimensional Dyspnea Profile (MDP),<sup>13</sup> Dyspnea-12 (D-12)<sup>14</sup> and Cancer Dyspnea Scale.<sup>15</sup> The MDP evaluates dyspnea during a specific time or a particular activity and is designed to examine individual items. Other multidimensional dyspnea scale assess recalled recent dyspnea over a period of days using aggregate score.<sup>12</sup> These multidimensional approaches to assess dyspnea may contribute to the treatment based on the underlying mechanisms, but would require over 1-2 min. Thus, there is no consensus as to the best approach concerning the measuring the multidimensional component of dyspnea during exercise challenging. However, it is still clarified whether both sensory and affective dimensions on dyspnea during exercise can accurately be evaluated in elderly patients with COPD in clinical setting.

#### THE INDIRECT ASSESSMENTS OF DYSPNEA

Dyspnea generally can be assessed by direct and indirect evaluation in pulmonary rehabilitation practice. Indirect assessment of dyspnea was often recorded by the Modified MRC Scale or New York Heart Association Functional Class. Since the components of these measurements have to request the intensity for dyspnea in daily activities with yes-or-no question, it is common that the degree of experienced dyspnea using these scales is dependent on the uncertain intensity of physical exercise. Therefore, needless to say, they seems to be not suitable for investigating the details about the effect of pulmonary rehabilitation program on exertional dyspnea.

Other indirect assessments of dyspnea include baseline dyspnea index (BDI) and transition dyspnea index (TDI).<sup>16</sup> The BDI index developed by Mahler et al<sup>16</sup> evaluates dyspnea based on three components that evoke dyspnea in activities of daily living, in symptomatic individuals. TDI measures changes in dyspnea severity from the baseline as established by the BDI.<sup>16</sup> The limitation is few specific instructions included in the instrument.

#### THE DIRECT ASSESSMENTS OF DYSPNEA

The modified 10-point Borg scale or visual analog scale for dyspnea in response to the cycling and walking protocols are often used as the direct approach for the assessment of dyspnea.<sup>17,18</sup> However, there are no well-designed exercise protocol from the viewpoint of evaluating the effect of pulmonary rehabilitation on exertional dyspnea.

Six-minute walking test is a self-paced walking test, and represents the most commonly used field test in diverse

respiratory diseases. Although, this test is the most appropriate evaluation of functional exercise capacity in respiratory disease, due to lack of control of the exercise stimulus, it is not optimally designed to evaluate the effects of pulmonary rehabilitation on exertional dyspnea.

On the other hand, constant work load and the endurance shuttle walking test are usually conducted up to symptom limitation for leg fatigue or dyspnea with the purpose of quantifying exercise duration. However, since therapeutic intervention may alter the exercise duration, those tests could not evaluate the effects of pulmonary rehabilitation on dyspnea and on exercise. There are similar limitations on the incremental exercise testing including the incremental shuttle walking test. However, the measurement of dyspnea ratings at a standardized submaximal time or load (iso-time/loads) during above exercise tests is thought to be able to evaluate the effect of pulmonary rehabilitation on exertional dyspnea.

#### CONFLICTS OF INTEREST

The author declare that they have no conflicts of interest.

#### REFERENCES

- Nishimura K, Izumi T, Tsukino M, Oga T. Dyspnea is a better predictor of 5-year survival than airway obstruction in patients with COPD. *Chest*. 2002; 121(5): 1434-1440. doi: [10.1378/chest.121.5.1434](https://doi.org/10.1378/chest.121.5.1434)
- Rochester CL, Vogiatzis I, Holland AE, et al. An official American thoracic society/European respiratory society policy statement: Enhancing implementation, use, and delivery of pulmonary rehabilitation. *Am J Respir Crit Care Med*. 2015; 192(11): 1373-1386. doi: [10.1164/rccm.201510-1966ST](https://doi.org/10.1164/rccm.201510-1966ST)
- Parshall MB, Schwartzstein RM, Adams L, et al. An official American thoracic society statement: Update on the mechanisms, assessment, and management of dyspnea. *Am J Respir Crit Care Med*. 2012; 185(4): 435-452. doi: [10.1164/rccm.201111-2042ST](https://doi.org/10.1164/rccm.201111-2042ST)
- Lavolette L, Laveneziana P, Faculty ERSRS. Dyspnoea: A multidimensional and multidisciplinary approach. *Eur Respir J*. 2014; 43(6): 1750-1762. doi: [10.1183/09031936.00092613](https://doi.org/10.1183/09031936.00092613)
- Banzett RB, Lansing RW, Evans KC, Shea SA. Stimulus-response characteristics of CO<sub>2</sub>-induced air hunger in normal subjects. *Respir Physiol*. 1996; 103(1): 19-31. doi: [10.1016/0034-5687\(95\)00050-X](https://doi.org/10.1016/0034-5687(95)00050-X)
- Bloch-Salisbury E, Shea SA, Brown R, Evans K, Banzett RB. Air hunger induced by acute increase in PCO<sub>2</sub> adapts to chronic elevation of PCO<sub>2</sub> in ventilated humans. *J Appl Physiol (1985)*. 1996; 81(2): 949-956.
- Moy ML, Woodrow Weiss J, Sparrow D, Israel E, Schwartzstein RM. Quality of dyspnea in bronchoconstriction differs from external resistive loads. *Am J Respir Crit Care Med*. 2000; 162(2 Pt 1): 451-455. doi: [10.1164/ajrccm.162.2.9907138](https://doi.org/10.1164/ajrccm.162.2.9907138)
- von Leupoldt A, Sommer T, Kegat S, et al. The unpleasantness of perceived dyspnea is processed in the anterior insula and amygdala. *Am J Respir Crit Care Med*. 2008; 177(9): 1026-1032. doi: [10.1164/rccm.200712-1821OC](https://doi.org/10.1164/rccm.200712-1821OC)
- Peiffer C, Costes N, Herve P, Garcia-Larrea L. Relief of dyspnea involves a characteristic brain activation and a specific quality of sensation. *Am J Respir Crit Care Med*. 2008; 177(4): 440-449. doi: [10.1164/rccm.200612-1774OC](https://doi.org/10.1164/rccm.200612-1774OC)
- O'Donnell DE, Elbehairy AF, Faisal A, Webb KA, Neder JA, Mahler DA. Exertional dyspnoea in COPD: The clinical utility of cardiopulmonary exercise testing. *Eur Respir Rev*. 2016; 25(141): 333-347. doi: [10.1183/16000617.0054-2016](https://doi.org/10.1183/16000617.0054-2016)
- Kanezaki M, Ebihara S. Effect of the cooling sensation induced by olfactory stimulation by L-menthol on dyspnoea: A pilot study. *Eur Respir J*. 2017; 49(4): 1601823. doi: [10.1183/13993003.01823-2016](https://doi.org/10.1183/13993003.01823-2016)
- von Leupoldt A, Dahme B. Differentiation between the sensory and affective dimension of dyspnea during resistive load breathing in normal subjects. *Chest*. 2005; 128(5): 3345-3349. doi: [10.1378/chest.128.5.3345](https://doi.org/10.1378/chest.128.5.3345)
- Banzett RB, O'Donnell CR, Guilfoyle TE, et al. Multidimensional dyspnea Profile: An instrument for clinical and laboratory research. *Eur Respir J*. 2015; 45(6): 1681-1691. doi: [10.1183/09031936.00038914](https://doi.org/10.1183/09031936.00038914)
- Yorke J, Moosavi SH, Shulldham C, Jones PW. Quantification of dyspnoea using descriptors: Development and initial testing of the Dyspnoea-12. *Thorax*. 2010; 65(1): 21-26. doi: [10.1136/thx.2009.118521](https://doi.org/10.1136/thx.2009.118521)
- Tanaka K, Akechi T, Okuyama T, Nishiwaki Y, Uchitomi Y. Development and validation of the cancer dyspnoea scale: A multidimensional, brief, self-rating scale. *Br J Cancer*. 2000; 82(4): 800-805. doi: [10.1054/bjoc.1999.1002](https://doi.org/10.1054/bjoc.1999.1002)
- Mahler DA, Weinberg DH, Wells CK, Feinstein AR. The measurement of dyspnea. Contents, interobserver agreement, and physiologic correlates of two new clinical indexes. *Chest*. 1984; 85(6): 751-758. doi: [10.1378/chest.85.6.751](https://doi.org/10.1378/chest.85.6.751)
- Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc*. 1982; 14(5): 377-381.
- Bausewein C, Farquhar M, Booth S, Gysels M, Higginson IJ. Measurement of breathlessness in advanced disease: A systematic review. *Respir Med*. 2007; 101(3): 399-410. doi: [10.1016/j.rmed.2006.07.003](https://doi.org/10.1016/j.rmed.2006.07.003)