CHEST

Original Research

SIGNS AND SYMPTOMS OF CHEST DISEASES

Reliability and Validity of the Multidimensional Dyspnea Profile

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Background: **Most measures of dyspnea assess a single aspect (intensity or distress) of the symptom. We developed the Multidimensional Dyspnea Profile (MDP) to measure qualities and intensities of the sensory dimension and components of the affective dimension. The MDP is not indexed to a particular activity and can be applied at rest, during exertion, or during clinical care. We report on the development and testing of the MDP in patients with a variety of acute and chronic cardiopulmonary conditions.**

Methods: **One hundred fifty-one adults admitted to the ED with breathing symptoms completed the MDP three times in the ED, twice at least 1 h apart (T1, T2), and near discharge from the ED (T3). Measures were repeated in 68 patients twice in a follow-up session 4 to 6 weeks later (T4-T5). The ED sample was 56% men with a mean age of 53 ± 15 years; the follow-up sample was similar.**

Results: **Factor analysis resulted in a two-factor solution with a total explained variance of 63%, 74%, and 72% at T1, T2, and T3, respectively. One domain related to primary sensory qualities and immediate unpleasantness, and the second encompassed emotional response. For the two domains, Cronbach α ranged from 0.82 to 0.95, and the intraclass correlation coefficient ranged from 0.91 to 0.98. Repeated-measures analysis was significant for change (T1, T3, T4), showing responsiveness to change in MDP domains with treatment ($F_{[2,66]} = 19.67$, $P > .001$).**

Conclusions: **These analyses support the reliability, validity, and responsiveness to clinical change of the MDP with two domains in an acute care and follow-up setting.**

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Abbreviations: BSI = Brief Symptom Inventory; ICC = intraclass correlation coefficient; MDP = Multidimensional Dyspnea Profile; MMSE = Mini-Mental State Examination; MRC = Medical Research Council; PFSDQ-M = modified Pulmonary Function Status Dyspnea Questionnaire

Mechanoreceptors, chemoreceptors, and awareness of motor output continuously convey information about breathing to the cerebral cortex and contribute to producing a variety of specific sensory perceptions.[1] Perceived threats to respiratory homeostasis are unpleasant and are accompanied by emotional responses.[2] Dyspnea has been defined as "a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity," and the experience "derives from interactions among multiple physiologic, psychologic, social, and environmental factors."[1] Although this definition recognizes the complexity of dyspnea perception, commonly used dyspnea measures do not adequately assess this complexity.

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Dyspnea research is currently hampered by the lack of a single instrument to measure different aspects of respiratory discomfort in a variety of settings. A number of clinical dyspnea instruments provide indirect measurement of several aspects of patients' experience of dyspnea.[3,4] Most clinical questionnaires rely on patient recall to assess daily activities and do not directly scale sensation. Single-dimension scales (eg, visual analog, Borg, number) are widely used to measure dyspnea, especially in experimental settings.[4,5] The rating of the perceptual dimension often is poorly defined in published reports,[6] and the meaning can vary across studies (eg, a laboratory subject breathing against a resistive load and rating the intensity of effort, a patient in an ED rating emotional distress). Specifically, the original descriptor list developed by Simon et al[7,8] has been used by several investigators in the exploration of how individuals would describe breathlessness in various conditions and settings.[9-11] However, others have modified the list such that comparison across investigations is difficult.[12,13]

The Multidimensional Dyspnea Profile (MDP) is a comprehensive instrument designed to measure sensory and affective dimensions of dyspnea. The conceptual model we proposed for dyspnea asserts that each item in the MDP has the potential to vary separately from the others under some circumstances.[14] Our approach in developing this instrument was based on the multidimensional model of pain.[15-20] Intensity (strength of sensation), quality, unpleasantness, and emotion are distinct aspects of pain perception, with evidence accumulating that these dimensions are also relevant to dyspnea perception.[8,13,14,21-23] Advances in the ability to understand and measure the several dimensions of dyspnea could facilitate comparison of different laboratory models and different disease states based on quantifiable data rather than on intuition and argument; thus, it can lead to better experimental design and clinical practice.

Data thus far support the model concept that the component items can vary with some independence. An earlier laboratory experiment confirmed that the sensory quality of work/effort can vary independently from the sensory quality of air hunger and showed that sensory intensity can vary independently from immediate unpleasantness.[24] Another laboratory investigation confirmed that the MDP is responsive to treatment with morphine.[25] The MDP is rooted in these findings and the model because it is designed to measure sensory and affective dimensions of dyspnea while supporting the relative independence of these dimensions. The purpose of this study was to provide initial reliability and validity estimates of the MDP when administered to the same individuals in two settings: during an ED visit and at an outpatient follow-up visit 4 to 6 weeks later.

Materials and Methods

Instrument Development and Content Validity

The MDP was developed from existing instruments for pain and dyspnea and subsequently refined through laboratory work.[14] It comprises 12 items (Fig 1): an immediate sensory intensity item, an immediate unpleasantness item, five items addressing sensory qualities (eg, tightness, muscle work), and five emotional response items (eg, frustration, anxiety). Sensory qualities of dyspnea were reduced from a list of 19 descriptors[8] to five descriptor groups based on previous factor analysis in patients[26,27] and laboratory use in healthy subjects and patients. The emotional response items were adapted from pain research.[28,29]

All items were measured on a rating scale of 0 to 10, with higher scores indicating greater intensity, unpleasantness, or distress. For overall intensity and unpleasantness, scaling words were used that accorded with the aspect being rated (ie, none, moderate, maximum, overall intensity vs neutral, annoying, unbearable unpleasantness). For the sensory quality items, subjects rated the intensity of the five descriptors, with 0 signifying "does not apply" and 10 signifying "as intense as I can imagine." Subjects were instructed to rate each emotional response item on a scale labeled "none" to the "most severe imaginable." See e-Appendix 1 for a detail script for first-time use.

This investigation used a longitudinal design that allowed serial determination of internal consistency, temporal stability, and responsiveness of the MDP to clinical change over time. We recruited individuals presenting to the ED with a breathing complaint. Patients with acute coronary syndromes or malignant neoplasms of the head, neck, thorax, or abdomen were excluded. The study had ethical approval from the University of New Mexico Human Research Review Committee (HRRC #07-062).

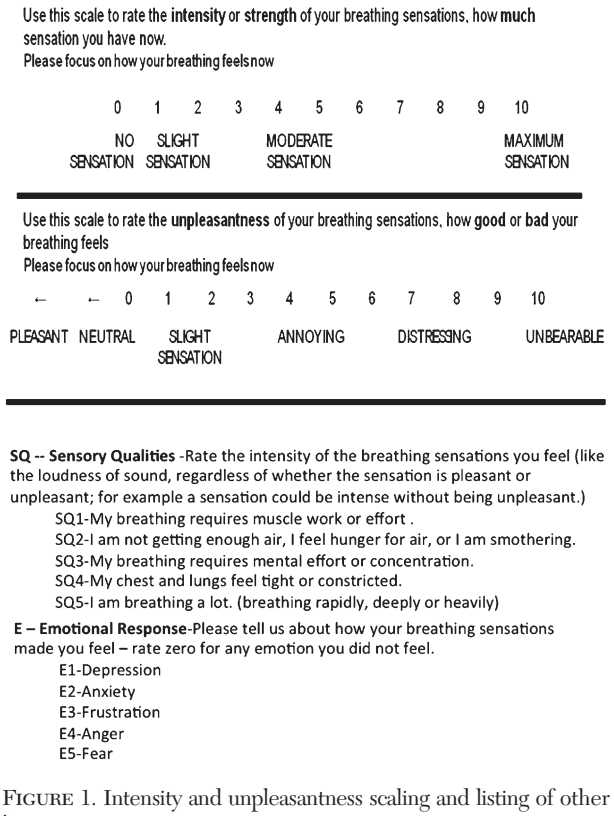

Figure 1. Intensity and unpleasantness scaling and listing of other items.

After informed consent in the ED, we administered the MDP (T1), followed by a second administration ~60 min later (T2), which served as a stability check (test-retest reliability), with the assumption that dyspnea might change but not resolve completely. At least 1 h after the second administration, the MDP was completed a third time (T3) to assess responsiveness to clinical change.

The MDP was administered a fourth and fifth time (T4, T5) at follow-up 4 to 6 weeks after discharge, with spirometry, pulse oximetry, and additional questionnaire data obtained for construct validity testing. Following completion of those additional measures, the MDP was administered again for the second time in the follow-up group (T5) as another stability check. Spirometry testing was done using a MicroLoop spirometer (CareFusion Corporation), according to guidelines established by the American Thoracic Society and European Respiratory Society,[30] using National Health and Nutrition Examination Survey III predicted values.

Additional questionnaires included the Mini-Mental State Examination (MMSE),[31] Brief Symptom Inventory (BSI),[32] the modified Pulmonary Function Status Dyspnea Questionnaire (PFSDQ-M),[33] and the Medical Research Council (MRC) dyspnea scale.[34] The MMSE is a cognitive screening tool with scores ranging from 0 to 30; scores of ≥ 24 are normal. The BSI uses 18 items from the Symptom Checklist-90-R,[35] having three subscales (somatization, depression, and anxiety) normed with T scores. The PFSDQ-M measures dyspnea and fatigue, with higher scores indicating greater intensity.[31] Two items that ask about levels on most days and today were used. The MRC estimates dyspnea by grading breathing difficulty with daily activities.[36] Scores range from grade 1 to 5, with satisfactory reliability[37] and validity[38] reported.

Analysis

Analysis began with exploratory principal components analysis using a varimax rotation, using T1 data to determine the underlying factorial structure of the MDP.[39] Details of the factor analysis procedures, factor selection, and item retentions are available in e-Appendix 1. The same analysis was run with data from T2 and T3 to assess the temporal stability of the MDP proposed domain structure. A separate factor analysis was not conducted at T4 because of the substantially smaller sample size.

After determining the proposed domain structure of the MDP through the factor analysis,[40] we calculated Cronbach α for each domain at each administration and intraclass correlation coefficients (ICCs) for the domains and individual items across successive administrations. ICCs were used for test-retest reliability because unlike conventional correlation coefficients, ICCs account for error variance attributable to discrepancy over time.[41] ICCs for domains were calculated using a two-way mixed-model analysis of variance for consistency of average measures and a two-way mixed model for absolute agreement for single items.[42,43] Calculation of domain and item ICCs provided support for use of the stability of individual items or domains, depending on the proposed MDP use. Construct validity was assessed by correlations of the MDP domains with the additional questionnaire, spirometry, and pulse oximetry data obtained at T4. We used repeated-measures analysis of variance of the MDP domains and items using T1, T3, and T4 scores to determine responsiveness to change in patient condition. Analyses were conducted using SPSS version 18 (SPSS, Inc) statistical software.

Results

Sample

A total of 151 adults with cardiac or respiratory disease who came to the ED with breathing complaints completed the MDP at T1, with 146 completing the tool at T2 and 131 at T3. Sixty-eight of these subjects completed the MDP again 4 to 6 weeks after the ED visit (T4, T5). The majority of individuals took between 2 and 5 min to complete the MDP, regardless of setting. The sample at T1 was 56% men with a mean ± SD age of 53 ± 15 years. Most participants had asthma, COPD, pneumonia, or congestive heart failure (Table 1). The follow-up sample at T4 was similar in composition, although slightly older (59 ± 14 years) and with more men (62%). The entire sample was heterogeneous, encompassing a variety of individuals who sought urgent care because of breathing difficulty (Table 1).

Factor Analysis and Reliability

Exploratory factor analysis identified two factors at T1 that explained 66% of total variance in the set of items (Table 2). Factor 1 included overall intensity and unpleasantness of breathing along with the five sensory quality items and was labeled "immediate perception." Factor 2 comprised all five of the emotion items and was labeled "emotional response." Factor analysis applied to T2 and T3 data identified the same two factors with strong (>0.66) primary item loadings on a single factor at each time point (Table 2). Immediate perception and emotional response remained

Table 1—*Basic Demographic Characteristics of Time 1 and 4 Samples*

Demographic Characteristic	Time 1 (n = 151)	Time 4 (n = 68)
Age, y	53.2 ± 15.8	58.5 ± 13.5
Male sex	85 (56)	42 (62)
Race		
White	118 (78)	60 (88)
Black	10 (7)	2 (3)
Native American	8 (5)	4 (6)
Other	15 (10)	2 (3)
Ethnicity		
Hispanic	38 (25)	16 (24)
Diagnosis		
Asthma	43 (29)	15 (22)
COPD	41 (27)	24 (35)
Congestive heart failure	19 (13)	5 (7)
Pneumonia	28 (19)	12 (18)
Other	20 (13)	12 (18)
Spirometry[a]		
FEV_1, L	…	2.22 ± 0.94
FEV_1 % predicted normal value	…	70.7 (25.1)
FVC, L	…	2.95 ± 1.10
FVC % predicted normal value	…	73.3 (21.3)
FEV_1/FVC	…	74.0 (15.6)
Years of education	…	13.7 ± 2.9
Number in household	…	2.2 ± 1.9
Time to follow-up, wk	…	5.6 ± 2.7

Data are presented as mean ± SD or No. (%).
[a]Sample size dropped to n = 65.

Table 2—*Factor Loadings at Time 1, 2, and 3*

Items and Proposed Item Categories	Item	Time 1 (n = 151) Factor 1	Time 1 (n = 151) Factor 2	Time 2 (n = 146) Factor 1	Time 2 (n = 146) Factor 2	Time 3 (n = 131) Factor 1	Time 3 (n = 131) Factor 2
My breathing requires muscle work or effort	SQ-1	0.840[a]	0.306	0.890[a]	0.239	0.845	0.239
I am breathing a lot (breathing rapidly, deeply, or heavily)	SQ-5	0.839	0.198	0.824	0.324	0.824	0.324
My chest and lungs feel tight or constricted	SQ-4	0.805	0.325	0.870	0.244	0.845	0.244
I am not getting enough air, I feel hunger for air, or I am smothering	SQ-2	0.793	0.269	0.863	0.308	0.846	0.308
My breathing requires mental effort or concentration	SQ-3	0.791	0.204	0.797	0.326	0.805	0.326
Unpleasantness of breathing		0.775	0.254	0.835	0.306	0.874[a]	0.306
Intensity of breathing		0.704	0.268	0.804	0.245	0.826	0.245
Angry	E-4	0.099	0.826[a]	0.162	0.758	0.162	0.758
Frustrated	E-3	0.365	0.776	0.285	0.825[a]	0.285	0.825[a]
Anxious	E-2	0.387	0.692	0.342	0.687	0.342	0.687
Afraid	E-5	0.295	0.667	0.352	0.745	0.352	0.745
Depressed	E-1	0.183	0.663	0.198	0.732	0.198	0.732

E = emotional response (1-5 item instrument order); SQ = sensory quality (1-5 item instrument order).
[a]Indicates highest loading within factor at each time point.

relatively constant, with some variations in the loading across time (Table 2). The total explained variance was 74% at T2 and 72% at T3, demonstrating a stable factor structure across all three time points and defining two MDP domains.[40,41] These factors (underlying dimensions) were labeled "domains" similar to the use of this term in the St. George Respiratory Questionnaire.[44]

The reliability (Cronbach α and ICC) estimates for the immediate perception and emotional response domains are shown in Table 3. Both domains had a Cronbach α values >0.80 at all time points and ICC values >0.90 for the T1 to T2 and T4 to T5 intervals. ICCs for individual items across the same time intervals were acceptable (>0.60), with the exception of the overall intensity and unpleasantness of breathing items (Table 3). The two domains were summed to allow for subscale assessment, but a total summated score was not calculated.

Construct Validity

Correlations with other measures at T4 were analyzed to assess convergent and discriminant validity of the two MDP domains. There was a significant correlation between the self-reported frequency of breathlessness per day with the immediate perception domain but not with the emotional response domain. The MRC correlated approximately equally with both MDP domains. Correlations with the PFSDQ-M questions of shortness of breath today and fatigue today were stronger for MDP immediate perception than for emotional response (Table 4). The correlations with BSI domains were significant, with the strongest correlations found between the BSI anxiety and depression domains and emotional response and between BSI somatization and immediate perception (Table 4), supporting the construct validity of the two MDP domains. There were no significant correlations with spirometry measures, MMSE, BMI, or resting pulse oximetry levels for either domain, which was consistent with the literature.[45,46]

Responsiveness

The median time from arrival to T1 (enrollment) was ~6.5 h, and the median time from T1 to T3 was ~2 h. The median time to follow-up (T1-T4) was 36 days. A significant main effect of time ($F_{[2,66]} \geq 19.67$, $P < .001$) was identified for the two domain scores of the MDP from T1, T3, and T4 (Fig 2). In addition, all items were found to have a significant change over time. ($F_{[2,66]} \geq 5.51$, $P \geq .01$) and suitable individual effect sizes (η^2, 0.15-0.38) (e-Appendix 1).

Discussion

The results show that the MDP is internally consistent, has a stable factor structure, and has subject ratings that are reliable over time. In the ED, the test-retest interval was short to assess stability in an acute, rapidly changing clinical setting. Test-retest reliability was assessed during the follow-up interval as well, with the results again supporting stability. We presented evidence of the construct and structural validity of the MDP using factor analysis at three different time periods, and of the correlation of the MDP with established questionnaires.

Table 3—*Reliability Estimates by Items and Subscales Across Time*

Subscales/Items	ED				Follow-up		
	T1 (n = 151)	T2 (n = 146)	T3 (n = 131)	T1-T2	T4 (n = 68)	T5 (n = 68)	T4-T5
Immediate perception domain	α = 0.93	α = 0.96	α = 0.96	…	α = 0.94	α = 0.97	…
	30.6 ± 18.6	24.8 ± 18.8	25.1 ± 18.6	0.96 (96-0.97)	15.7 ± 14.1	13.5 ± 14.8	0.98 (97-0.98)
Unpleasantness of breathing	5.1 ± 2.6	4.5 ± 2.7	4.4 ± 2.6	0.47 (35-0.58)	3.7 ± 2.5	2.4 ± 2.3	0.67 (53-0.77)
Intensity of breathing	4.9 ± 2.9	4.0 ± 2.8	4.0 ± 3.7	0.58 (47-0.67)	2.5 ± 2.4	2.1 ± 2.3	0.79 (69-0.86)
SQ-1	4.4 ± 3.2	3.5 ± 2.1	3.5 ± 3.0	0.73 (64-0.80)	2.2 ± 2.3	1.9 ± 2.3	0.81 (71-0.88)
SQ-2	3.8 ± 3.3	3.2 ± 3.2	3.4 ± 3.0	0.77 (69-0.83)	1.6 ± 2.1	1.7 ± 2.2	0.86 (78-0.91)
SQ-3	3.4 ± 3.3	2.9 ± 3.1	2.9 ± 3.0	0.76 (68-0.82)	1.7 ± 2.5	1.9 ± 2.5	0.91 (86-0.95)
SQ-4	4.5 ± 3.3	3.5 ± 3.2	3.5 ± 3.1	0.76 (69-0.82)	2.2 ± 2.3	1.9 ± 2.3	0.87 (80-0.92)
SQ-5	4.4 ± 3.4	3.3 ± 3.1	3.0 ± 3.4	0.66 (56-0.75)	1.8 ± 2.2	1.6 ± 2.3	0.83 (74-0.94)
Emotional response domain	α = 0.84	α = 0.86	α = 0.86	…	α = 0.92	α = 0.94	…
	18.5 ± 13.5	15.4 ± 13.0	13.5 ± 12.3	0.91 (88-0.93)	9.7 ± 11.7	7.7 ± 10.9	0.96 (94-0.97)
E-1	2.9 ± 3.1	2.4 ± 3.2	1.9 ± 2.7	0.71 (62-0.77)	2.0 ± 2.9	1.6 ± 2.5	0.88 (81-0.92)
E-2	4.1 ± 3.4	3.5 ± 3.0	3.4 ± 3.1	0.61 (50-0.69)	2.2 ± 2.8	1.6 ± 2.4	0.80 (70-0.86)
E-3	4.9 ± 3.5	4.0 ± 3.4	3.4 ± 3.2	0.63 (53-0.71)	2.3 ± 2.8	1.9 ± 2.6	0.83 (75-0.89)
E-4	2.8 ± 3.4	2.2 ± 3.1	1.8 ± 2.9	0.62 (52-0.70)	1.4 ± 2.4	1.3 ± 2.2	0.85 (78-0.90)
E-5	3.8 ± 3.7	3.4 ± 3.5	3.1 ± 3.4	0.75 (67-0.81)	1.8 ± 2.9	1.3 ± 2.5	0.82 (73-0.88)

Data are presented as Cronbach α, mean ± SD, or intraclass correlation coefficient (95% CI). See Figure 1 for description of sensory qualities and emotional responses. See Table 2 legend for expansion of abbreviations.

In this clinical sample, factor analysis determined two domains that explained a substantial total item variance and maintained structural validity over time. Given that the factor analysis extracted two comparatively separate domains, a single total score is not appropriate. The results of this analysis support the two-domain structure as valid, relatively independent, and stable over time.

The present conceptual model proposes separable components of the dyspnea experience: immediate sensory response, immediate unpleasantness, and resultant emotional response.[14] The present factor analysis results are consistent with a degree of independence between the resultant emotional response and the more immediate aspects of dyspnea. The study, however, fails to show independence between immediate sensory intensity and immediate unpleasantness. In these patients in the ED, sensations of intensity, unpleasantness, and quality were grouped together as an immediate experience of breathing discomfort. Laboratory studies have separated the immediate intensity from immediate unpleasantness of dyspnea, but even in these studies, a number of individuals found it difficult to separate these two aspects.[25] The separation of immediate intensity from immediate unpleasantness is probably difficult

Table 4—*Spirometry, Oximetry, BMI, and Questionnaire Scores and Bivariate Correlations With the Immediate Perception and Emotional Response Domains of the MDP at Follow-up*

Other Time 4 Measures	Mean ± SD	Correlation With	
		Immediate Perception	Emotional Response
FEV_1 % predicted (n = 65)	70.1 ± 25.1	−0.131	0.027
FVC % predicted (n = 65)	73.3 ± 21.3	−0.138	−0.017
Mini-Mental Status Examination (n = 65)	28.4 ± 1.9	0.137	0.028
BMI	30.0 ± 6.9	−0.003	0.069
Resting Sa_{O_2}	94 ± 2.5	−0.053	−0.121
Medical Research Council dyspnea scale	2.5 ± 1.3	0.337[a]	0.347[a]
PFSDQ-M SOB on most days	4.0 ± 2.5	0.470[a]	0.320[a]
PFSDQ-M SOB today	3.1 ± 2.5	0.765[a]	0.605[a]
PFSDQ-M fatigue on most days	4.7 ± 2.7	0.571[a]	0.473[a]
PFSDQ-M fatigue today	3.6 ± 2.8	0.700[a]	0.560[a]
BSI somatization	62.0 ± 11.1	0.551[a]	0.451[a]
BSI depression	55.0 ± 11.2	0.535[a]	0.572[a]
BSI anxiety	55.6 ± 11.3	0.662[a]	0.678[a]

BSI = Brief Symptom Inventory T score; MDP = Multidimensional Dyspnea Profile; PFSDQ-M = modified Pulmonary Functional Status and Dyspnea Questionnaire; Sa_{O_2} = arterial oxygen saturation; SOB = shortness of breath.
[a]Significant at the .01 level.

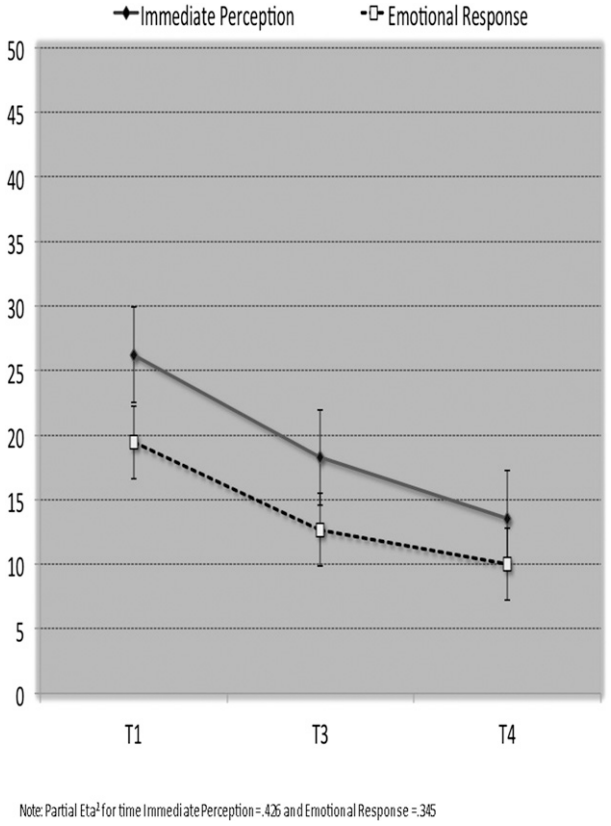

FIGURE 2. Multidimensional Dyspnea Profile immediate perception and emotional response domain score change at admission to the ED (T1), discharge from the ED (T3), and follow-up (T4).

for patients in the ED, whereas emotions that individuals have long experienced appear to be more readily distinguished from the immediate experience.[14] Furthermore, the quality of the sensations experienced by patients (eg, air hunger), in contrast to those used in laboratory experiments (eg, effort/work of breathing), may further account for the difficulty in distinguishing intensity and unpleasantness. The breathing qualities and emotional response items used in the MDP have also demonstrated stability and responsiveness over time (Table 3) and could be used independently to describe changes in qualities or emotions.

The two domains of the MDP revealed by the current study demonstrated adequate responsiveness to change in clinical condition, corresponding to nonspecific effects of ED and subsequent treatment. To our knowledge, this is the first multidimensional dyspnea measure that has been used in both an ED and a stable outpatient follow-up setting with the same subjects. We know of only one other dyspnea measure with a similar factor structure,[47-50] but that tool proposes a total score, has only been tested in outpatients, and, thus far, has not been tested for responsiveness to change in condition.

Limitations of this study include the use of a convenience sample and the exclusion of patients who were too ill to complete self-report measures, who did not speak and understand English, and who were unwilling to participate in an observational study in which there was no expectation of immediate benefit. Even so, the sample size was adequate for conducting factor analysis (13 subjects per questionnaire item compared with 10 subjects per item recommended by Nunnally and Bernstein[39]). We have demonstrated that the MDP is comprehensible to a heterogeneous sample of patients with acute and chronic cardiopulmonary conditions in both an acute care and a stable follow-up setting.

There is a need for reliable, valid, and responsive patient-reported outcome measures to judge how patients are responding to clinical treatments, changes in qualities of breathing sensations, and as an end point in clinical trials intended to improve breathlessness.[51,52] Although more testing of the MDP is indicated and ongoing, these initial results in a relatively large and diagnostically heterogeneous clinical sample suggest that the MDP shows promise of being useful in both acute care and stable follow-up settings.

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Dr Meek: contributed to the final development of the MDP, study concept and design, analysis and interpretation of data, psychometric and statistical analysis, drafting the manuscript, and critical revision of the manuscript for important intellectual content.
Dr Banzett: contributed to the original and final development of the MDP, study concept and design, analysis and interpretation of data, statistical analysis, and critical revision of the manuscript for important intellectual content.
Dr Parshall: contributed to the final development of the MDP, study concept and design, analysis and interpretation of data, psychometric and statistical analysis, drafting of the manuscript, and critical revision of the manuscript for important intellectual content.
Dr Gracely: contributed to the original development of the MDP and critical revision of the manuscript for important intellectual content.
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Additional information: The e-Appendix can be found in the "Supplemental Materials" area of the online aricle.

References

1. American Thoracic Society. Dyspnea. Mechanisms, assessment, and management: a consensus statement. *Am J Respir Crit Care Med*. 1999;159(1):321-340.
2. Liotti M, Brannan S, Egan G, et al. Brain responses associated with consciousness of breathlessness (air hunger). *Proc Natl Acad Sci U S A*. 2001;98(4):2035-2040.
3. Meek PM. Measurement of dyspnea in chronic obstructive pulmonary disease: what is the tool telling you? *Chron Respir Dis*. 2004;1(1):29-37.
4. Dorman S, Byrne A, Edwards A. Which measurement scales should we use to measure breathlessness in palliative care? A systematic review. *Palliat Med*. 2007;21(3):177-191.
5. Lansing R, Banzett R. Psychophysical methods in the study of respiratory sensation. In Adams L, Guz A. eds. *Respiratory Sensation*. New York, NY: Marcel Dekker; 1996:69-100.
6. Clark WC, Yang JC, Tsui S-L, Ng K-F, Bennett Clark S. Unidimensional pain rating scales: a multidimensional affect and pain survey (MAPS) analysis of what they really measure. *Pain*. 2002;98(3):241-247.
7. Simon PM, Schwartzstein RM, Weiss JW, et al. Distinguishable sensations of breathlessness induced in normal volunteers. *Am Rev Respir Dis*. 1989;140(4):1021-1027.
8. Simon PM, Schwartzstein RM, Weiss JW, Fencl V, Teghtsoonian M, Weinberger SE. Distinguishable types of dyspnea in patients with shortness of breath. *Am Rev Respir Dis*. 1990;142(5):1009-1014.
9. Williams M, Cafarella P, Olds T, Petkov J, Frith P. Affective descriptors of the sensation of breathlessness are more highly associated with severity of impairment than physical descriptors in people with COPD. *Chest*. 2010;138(2):315-322.
10. Petersen S, Morenings M, von Leupoldt A, Ritz T. Affective evaluation and cognitive structure of respiratory sensations in healthy individuals. *Br J Health Psychol*. 2009;14(pt 4): 751-765.
11. Mahler DA, Harver A, Lentine T, Scott JA, Beck K, Schwartzstein RM. Descriptors of breathlessness in cardiorespiratory diseases. *Am J Respir Crit Care Med*. 1996; 154(5):1357-1363.
12. Smith J, Albert P, Bertella E, Lester J, Jack S, Calverley P. Qualitative aspects of breathlessness in health and disease. *Thorax*. 2009;64(8):713-718.
13. Han J, Zhu Y, Li S, et al. The language of medically unexplained dyspnea. *Chest*. 2008;133(4):961-968.
14. Lansing RW, Gracely RH, Banzett RB. The multiple dimensions of dyspnea: review and hypotheses. *Respir Physiol Neurobiol*. 2009;167(1):53-60.
15. Melzack R, Torgerson WS. On the language of pain. *Anesthesiology*. 1971;34(1):50-59.
16. Price D. *Psychological Mechanisms of Pain and Analgesia*. Seattle, WA: IASP Press; 1999.
17. Gracely RH. Evaluation of multi-dimensional pain scales. *Pain*. 1992;48(3):297-300.
18. Price DD, Harkins SW, Baker C. Sensory-affective relationships among different types of clinical and experimental pain. *Pain*. 1987;28(3):297-307.
19. Gracely RH. Affective dimensions of pain: How many and how measured? *APS Journal*. 1992;l(4):243-247.
20. Gracely RH. Evaluation of multi-dimensional pain scales. *Pain*. 1992;48(3):297-300.
21. Wilson RC, Jones PW. Differentiation between the intensity of breathlessness and the distress it evokes in normal subjects during exercise. *Clin Sci (Lond)*. 1991;80(1):65-70.
22. Carrieri-Kohlman V, Gormley JM, Douglas MK, Paul SM, Stulbarg MS. Exercise training decreases dyspnea and the distress and anxiety associated with it. Monitoring alone may be as effective as coaching. *Chest*. 1996;110(6):1526-1535.
23. Harver A, Mahler DA, Schwartzstein RM, Baird JC. Descriptors of breathlessness in healthy individuals: distinct and separable constructs. *Chest*. 2000;118(3):679-690.
24. Banzett RB, Pedersen SH, Schwartzstein RM, Lansing RW. The affective dimension of laboratory dyspnea: air hunger is more unpleasant than work/effort. *Am J Respir Crit Care Med*. 2008;177(12):1384-1390.
25. Banzett RB, Adams L, O'Donnell CR, Gilman SA, Lansing RW, Schwartzstein RM. Using laboratory models to test treatment: morphine reduces dyspnea and hypercapnic ventilatory response. *Am J Respir Crit Care Med*. 2011;184(8): 920-927.
26. Parshall MB. Psychometric characteristics of dyspnea descriptor ratings in emergency department patients with exacerbated chronic obstructive pulmonary disease. *Res Nurs Health*. 2002;25(5):331-344.
27. Parshall MB, Carle AC, Ice U, Taylor R, Powers J. Validation of a three-factor measurement model of dyspnea in hospitalized adults with heart failure. *Heart Lung*. 2012; 41(1): 44-56.
28. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. *Pain*. 1983;17(1):45-56.
29. Wade JB, Dougherty LM, Archer CR, Price DD. Assessing the stages of pain processing: a multivariate analytical approach. *Pain*. 1996;68(1):157-167.
30. Miller MR, Hankinson J, Brusasco V, et al; ATS/ERS Task Force. Standardisation of spirometry. *Eur Respir J*. 2005; 26(2):319-338.
31. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189-198.
32. Derogatis LR, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med*. 1983;13(3):595-605.
33. Lareau SC, Meek PM, Roos PJ. Development and testing of the modified version of the Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ-M). *Heart Lung*. 1998;27(3):159-168.
34. Mahler DA, Wells CK. Evaluation of clinical methods for rating dyspnea. *Chest*. 1988;93(3):580-586.
35. Derogatis LR, Rickels K, Rock AF. The SCL-90 and the MMPI: a step in the validation of a new self-report scale. *Br J Psychiatry*. 1976;128:280-289.
36. Fletcher CM. The clinical diagnosis of pulmonary emphysema; an experimental study. *Proc R Soc Med*. 1952;45(9): 577-584.
37. van der Lende R, van der Meulen GG, Wever-Hess J. Investigation into observer and seasonal variation of the prevalence of respiratory symptoms at Schiermonnikoog. *Int J Epidemiol*. 1972;1(1):47-50.
38. Fairbairn AS, Wood CH, Fletcher CM. Variability in answers to a questionnaire on respiratory symptoms. *Br J Prev Soc Med*. 1959;13:175-193.
39. Nunnally JC, Bernstein IH. *Psychometric Theory*. 3rd ed. New York, NY: McGraw Hill; 1994.
40. Devillis RF. *Scale Development: Theory and Application*. 2nd ed. Thousand Oaks, CA: Sage Publications; 2003.
41. Streiner DL, Norman GR. *Health Measurement Scales: A Practical Guide to Their Development and Use*. Oxford, England: Oxford University Press; 2008.

42. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull*. 1979;86(2):420-428.
43. McGraw KO, Wong SP. Forming inferences about some intraclass correlation coefficients. *Psychol Methods*. 1996;1(1): 30-46.
44. Jones PW, Quirk FH, Baveystock CM, Littlejohns P. A self-complete measure of health status for chronic airflow limitation. The St. George's Respiratory Questionnaire. *Am Rev Respir Dis*. 1992;145(6):1321-1327.
45. Wolkove N, Dajczman E, Colacone A, Kreisman H. The relationship between pulmonary function and dyspnea in obstructive lung disease. *Chest*. 1989;96(6):1247-1251.
46. Moosavi SH, Golestanian E, Binks AP, Lansing RW, Brown R, Banzett RB. Hypoxic and hypercapnic drives to breathe generate equivalent levels of air hunger in humans. *J Appl Physiol*. 2003;94(1):141-154.
47. Yorke J, Moosavi SH, Shuldham C, Jones PW. Quantification of dyspnoea using descriptors: development and initial testing of the Dyspnoea-12. *Thorax*. 2010;65(1):21-26.
48. Swigris JJ, Yorke J, Sprunger DB, et al. Assessing dyspnea and its impact on patients with connective tissue disease-related interstitial lung disease. *Respir Med*. 2010;104(9): 1350-1355.
49. Yorke J, Russell A-M, Swigris J, et al. Assessment of dyspnea in asthma: validation of The Dyspnea-12. *J Asthma*. 2011;48(6):602-608.
50. Yorke J, Swigris J, Russell A-M, et al. Dyspnea-12 is a valid and reliable measure of breathlessness in patients with interstitial lung disease. *Chest*. 2011;139(1):159-164.
51. Mebazaa A, Pang PS, Tavares M, et al. The impact of early standard therapy on dyspnoea in patients with acute heart failure: the URGENT-dyspnoea study. *Eur Heart J*. 2010;31(7):832-841.
52. Pang PS, Cleland JGF, Teerlink JR, et al; Acute Heart Failure Syndromes International Working Group. A proposal to standardize dyspnoea measurement in clinical trials of acute heart failure syndromes: the need for a uniform approach. *Eur Heart J*. 2008;29(6):816-824.