Brief Methodological Report

Validity, Reliability, and Diagnostic Accuracy of the Respiratory Distress Observation Scale for Assessment of Dyspnea in Adult Palliative Care Patients

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Abstract

Background. The prevalence and severity of dyspnea increase at the end of life. Many of these patients have difficulty in reporting their symptoms. Accurate surrogate measures are needed for appropriate assessment and treatment. The Respiratory Distress Observation Scale (RDOS) is proposed as a possible scale although more external validation is needed. We set out to validate the RDOS in the context of palliative care patients near the end of life.

Measures. We prospectively studied 122 palliative care patients in a tertiary hospital in Singapore. Prior RDOS training was done using a standardized instructional video. Dyspnea was assessed by RDOS, Dyspnea Numerical Rating Scale, and Dyspnea Categorical Scale. Pain was assessed by Pain Numerical Rating Scale. We measured RDOS inter-rater reliability, convergent validity, and divergent validity. We used area under receiver operating characteristics curve (AUC) analysis to examine the discriminant properties of RDOS using dyspnea self-report as benchmark.

Results. RDOS had good inter-rater reliability with an intraclass correlation of 0.947 (95% CI 0.919−0.976). It showed moderate-to-strong correlation with Dyspnea Numerical Rating Scale ($r = 0.702$) and Dyspnea Categorical Scale ($r = 0.677$) and negligible correlation to Pain Numerical Rating Scale ($r = 0.080$). It showed good discriminant properties of identifying patients with moderate and severe dyspnea with an AUC of 0.874 (95% CI 0.812−0.936). RDOS ≥ 4 predicted patients with moderate and severe dyspnea with a sensitivity of 76.6%, specificity of 86.2%, positive predictive value of 86.0%, and negative predictive value of 76.9%.

Conclusions. The RDOS shows promise and clinical utility as an observational dyspnea assessment tool. Further studies in uncommunicative patients are needed to determine clinical usefulness and generalizability of results.   J Pain Symptom Manage 2019;57:304−310. © 2018 American Academy of Hospice and Palliative Medicine. Published by Elsevier Inc. All rights reserved.

Key Words
Respiratory Distress Observation Scale, palliative care, dyspnea, scale validation, reliability, receiver operating characteristics curve analysis

Background

The prevalence and severity of dyspnea increase rapidly at the end of life.[1,2] At the same time, patients experience difficulties with providing self-report of their dyspnea symptom.[3] As the gold standard for dyspnea assessment is self-reporting of symptoms, an alternative needs to be sought for in this group of patients.[4]

Proxy assessments of symptom severity are carried out by health care teams in clinical practice. However, accuracy of such subjective assessments may be poor. Studies in advanced cancer and intensive care populations

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show proxy assessments by physicians and nurses to be significantly lower and poorly correlating to patient self-report. As the assessments of symptom severity influence treatment decisions, there is a need for a better method to assess dyspnea in nonverbal patients.[5−7]

The Respiratory Distress Observation Scale (RDOS) is an eight-item ordinal scale designed to measure the presence and intensity of respiratory distress in adults (Fig. 1). This scale was developed from a biobehavioral framework by Dr. Margaret L. Campbell.[8,9] It is the first and only symptom assessment tool for dyspnea developed thus far, intended for assessing presence and intensity of respiratory distress in nonverbal patients.

Psychometric properties have been previously examined by the original scale developer. The internal consistency (α) across studies ranged from 0.64 to 0.84. Inter-rater reliability was perfect, but this was conducted on only five patients ($r = 1.0$).[10,11] Convergent validity was established through comparison of RDOS against dyspnea self-report ($r = 0.38 - 0.74$) in various populations. Although strong correlation ($r = 0.74$)

was found in a combined population of healthy volunteers, patients with postoperative pain, and dyspneic chronic obstructive pulmonary disease (COPD) patients, within-group correlation was poor in dyspneic COPD patients ($r = 0.38$).[10−12] Discriminant validity was established with comparisons of RDOS scores in dyspneic COPD patients against patients with acute pain.[10] Area under receiver operating characteristic curve (AUC) analysis determined RDOS scores of $0 - 2$ to suggest little or no respiratory distress, whereas a score of ≥ 3 signified moderate-to-severe distress (AUC 0.795).[12] Further intensity cutpoints for none, mild, moderate, and severe respiratory distress have been suggested, benchmarked against surrogate ratings by nurse practitioners.[13]

Following development of the original scale, there remains a paucity of independent studies validating the RDOS, none substantiating the cutoff point of RDOS ≥ 3, and none examining inter-rater reliability with an adequate sample size.[14,15] The RDOS shows potential but requires further examination of its

Variable	0 Points	1 Point	2 Points	Total
Heart rate per minute	< 90 beats	90 - 109 beats	$\geq$ 110 beats	
Respiratory rate per minute	$\leq$ 18 breaths	19 - 30 breaths	> 30 breaths	
Restlessness: nonpurposeful movements	None	Occasional, slight movements	Frequent movements	
Paradoxical breathing pattern: abdomen moves in during inspiration	None		Present	
Accessory muscle use: rise in clavicle during inspiration	None	Slight rise	Pronounced rise	
Grunting at end-expiration: guttural sound	None		Present	
Nasal flaring: involuntary movement of nares	None		Present	
Look of fear	None		Eyes wide open, facial muscles tense, brow furrowed, mouth open, teeth together	
Total				

Instruction for use:
1. RDOS is not a substitute for patient self-report if able.
2. RDOS is an adult assessment tool.
3. RDOS cannot be used when the patient is paralyzed with a neuromuscular blocking agent.
4. RDOS is not valid in bulbar ALS or quadriplegia.
5. Count respiratory and heart rates for one minute; auscultate if necessary.
6. Grunting may be audible with intubated patients on auscultation.
7. Fearful facial expressions:

Fig. 1. The Respiratory Distress Observation Scale (RDOS) was developed by Dr. Margaret L. Campbell as an observational tool to measure respiratory distress in patients. The above scale is reproduced in full with written permission given by the original scale developer.

statistical and clinical validity before widespread use can be recommended.[16] We thus set out to evaluate its reliability and validity within our palliative care setting and examine its diagnostic properties in identifying patients with moderate-to-severe dyspnea.

First, we hypothesize that an appropriate RDOS score cutoff will discriminate between none/mild dyspnea and moderate/severe dyspnea with an AUC of at least 0.75. This would provide clinical relevance and utility in identifying patients requiring further symptom managment.[17,18]

Second, we hypothesize that RDOS will have strong reliability by demonstrating concurrent inter-rater reliability. We also hypothesize that RDOS will have moderate convergent and divergent validity against self-reported dyspnea and pain, respectively.

Materials and Methods

Study Setting

The study was conducted prospectively in Singapore General Hospital (SGH), a 1597-bed tertiary hospital with a dedicated palliative care team that provides palliative consultation services.

Study Population

Although the intended population for RDOS is cognitively impaired patients unable to report respiratory distress, to establish preliminary psychometric data, it is necessary to use cognitively intact patients. This allowed us to use symptom self-report as a gold-standard benchmark.

Ethics Approval

Approval to conduct the study was granted by the SingHealth Institutional Review Board (CIRB Ref No: 2017/3126) with waiver of written informed consent as the study presented minimal risk of harm to participants.

Participants

We screened all consecutive inpatients referred to our palliative consultation service from 25th June 2018 till 1st September 2018. All patients who met our inclusion/exclusion criteria were approached for consent and recruited into the study once verbal consent was obtained.

We included patients with age ≥ 21 years, at risk of dyspnea (but not referred for management of dyspnea) with one of these diagnoses: lung or pleural malignancies, end-stage renal failure, heart failure, and COPD. We also included patients referred specifically for management of dyspnea. Inclusion criteria were purposefully designed to obtain a sample of patients with a spread of dyspnea severity from none to severe.

We excluded patients who were unable to provide consent or refused to participate. RDOS is not valid if the patient is quadriplegic or has bulbar amyotrophic lateral sclerosis, and thus these patients were excluded.[11]

Sample Size

We established, a priori, that a sample size of 113 was needed to detect a difference of 0.15 between the null hypothesis of AUC = 0.60 and the alternative hypothesis of AUC = 0.75 with 80% power at 5% two-sided type 1 error. An AUC of 0.75 would establish the RDOS to have clinically acceptable discriminating properties. An assumption was made that the proportion of moderate and severe dyspnea would be 40% of the total included patients based on a retrospective audit of prior palliative care referrals over two months.

Measures

Patient demographics included age, gender, race, primary diagnosis, and Palliative Performance Scale, version 2, (PPS).[19]

The scale to be evaluated is RDOS (Fig.1)—an 8-item ordinal scale to measure the presence and intensity of respiratory distress. Each parameter is scored from 0 to 2 points, and the points are summed. Scale scores range from 0 signifying no distress to 16 signifying the most severe distress.[11]

The reference standard for dyspnea measurement is self-report. We use two single-item verbal report scales to assess current dyspnea severity. The Dyspnea Numeric Rating Scale (Dyspnea-NRS) is a widely used and a valid scale to measure dyspnea severity. It is scored from 0 to 10, labeled with verbal anchors (e.g., "nothing at all" to "maximal").[20] The Dyspnea Categorical Verbal Descriptor Scale (Dyspnea-Cat) is a four-level categorical scale to describe severity of dyspnea (none, mild, moderate, and severe). It has been shown to have strong correlation to the Dyspnea-NRS.[21]

The reference standard for pain measurement is self-report. We use the Pain Numeric Rating Scale (Pain-NRS), which is widely used and validated to measure pain severity. It is scored from 0 to 10, labeled with verbal anchors "nothing at all" to "maximal."[22]

Procedure

Two raters were trained in the use of RDOS with the aid of an instructional video obtained from the original scale developer. These 2 raters were a palliative physician (Rater 1) and an advanced practitioner nurse (Rater 2) with 10 years of clinical experience. This was followed by practice scoring of RDOS on real patients until a score difference of ≤1 was obtained. We decided, a priori, that a score difference of ≤1 would be deemed clinically acceptable.

Inpatient referrals to the palliative care team were screened daily by Rater 1, and patients whom met the inclusion criteria were identified. After obtaining verbal consent, rater/s would first proceed to administer the RDOS. This would be followed by obtaining patient self-report on dyspnea and pain.

To assess inter-rater reliability, 50 patients were recruited via convenience sampling. Raters 1 and 2 would conduct simultaneous blinded scoring of the RDOS. The sample size of 50 was decided a priori, giving a 95% confidence interval width of 0.2 for intraclass correlation (ICC).

Statistical Analyses

Inter-rater reliability was examined with the Analysis of Variance (ANOVA) estimator of ICC and limits of agreement by the Bland-Altman plot. Convergent and divergent validity was ascertained by using Spearman's rank-order correlations to examine association of RDOS with Dyspnea-NRS, Dyspnea-Cat, and Pain-NRS.

Kruskal-Wallis Test was used to assess difference between RDOS scores of patients across categories of dyspnea severity (none, mild, moderate, and severe). We used box and whisker plots to illustrate RDOS median and interquartile range against dyspnea self-report ratings. AUC analysis was used to illustrate the diagnostic ability of the RDOS in identifying patients with moderate and severe dyspnea. We calculated the sensitivity, specificity, positive predictive value, and negative predictive value for various RDOS cutoff points and used the Youden Index to detect the optimal RDOS score cutoff for our sample. This was compared with the original cutoff of RDOS $\geq$ 3 proposed by Dr. Campbell.[12]

Statistical analyses were carried out using IBM SPSS Statistics, version 25, software.

Results

We screened 472 referrals, and a total of 132 inpatients who fulfilled the inclusion/exclusion criteria were approached during the study interval. In all, 10 patients refused participation because of fatigue ($n = 4$) or gave no reason ($n = 6$). Patient characteristics are summarized in Table 1.

Of the 122 participants, mean age was 67.9 (standard deviation = 12.9) years, 43.4% were female and more than 80% were of Chinese ethnicity. Eighty-seven (71.3%) participants had a primary cancer diagnosis, whereas the rest were noncancer diagnosis. Seventy-one (58.1%) participants were chair/bed bound with a PPS of $\leq$50, and 28 (23%) were completely bedfast requiring total care with a PPS of $\leq$30.

Median Dyspnea-NRS score was 5 with a range from 0 to 10. Twenty-two (18.0%) patients had no dyspnea, 36 (29.5%) had mild dyspnea, 45 (36.9%) had

Table 1
Baseline Characteristics of Study Participants

Variable	$N = 122$
Age (years), mean (SD)	67.9 (12.9)
Gender, *n* (%)	
Male	69 (56.6)
Female	53 (43.4)
Race, *n* (%)	
Chinese	99 (81.1)
Malay	14 (11.5)
Indian	9 (7.4)
Others	0 (0)
Primary diagnosis, *n* (%)	
Lung or pleural malignancies	41 (33.6)
End-stage renal failure	12 (9.8)
Heart failure	17 (13.9)
Chronic obstructive pulmonary disease	5 (4.1)
Others	47 (38.5)
Others ($N = 47$)	
Cancer diagnosis	46
Noncancer diagnosis	1
Palliative Performance Scale, *n* (%)	
100	0 (0)
90	1 (0.8)
80	6 (4.9)
70	19 (15.6)
60	25 (20.5)
50	28 (23.0)
40	15 (12.3)
30	15 (12.3)
20	13 (10.7)
10	0 (0)
Median RDOS score, (range)[a]	3 (0−10)
Dyspnea-NRS[b]	
Mean (SD)	4.19 (2.71)
Median (range)	5 (0−10)
Dyspnea-Cat, *n* (%)[c]	
None	22 (18.0)
Mild	36 (29.5)
Moderate	45 (36.9)
Severe	19 (15.6)
Pain-NRS[d]	
Mean (SD)	1.11 (2.45)
Median (range)	0 (0−10)

[a]RDOS: Respiratory Distress Observation Scale measures respiratory distress on a scale of 0 to 16.
[b]Dyspnea-NRS: Dyspnea Numeric Rating Scale measures dyspnea severity on a scale of 0 to 10.
[c]Dyspnea-Cat: Dyspnea Categorical Verbal Descriptor Scale is a four-level categorical scale to describe severity of dyspnea.
[d]Pain-NRS: Pain Numeric Rating Scale measures pain severity on a scale of 0 to 10.

moderate dyspnea, and 19 (15.6%) had severe dyspnea. Very few of these patients (19.7%) had concurrent pain symptoms with a median pain score of 0 (0−10).

RDOS scores ranged from 0 to 10 with a median score of 3. There was high positive correlation between RDOS and Dyspnea-NRS ($r = 0.702$) and moderate positive correlation between RDOS and Dyspnea-Cat ($r = 0.677$). There was negligible correlation between RDOS and Pain-NRS ($r = 0.08$; all $P < 0.01$).[23]

Figure 2 shows the distribution of RDOS scores across dyspnea severity categories. It shows a trend of increasing median RDOS scores as dyspnea severity increases. Fifty-eight (47.5%) participants had none or
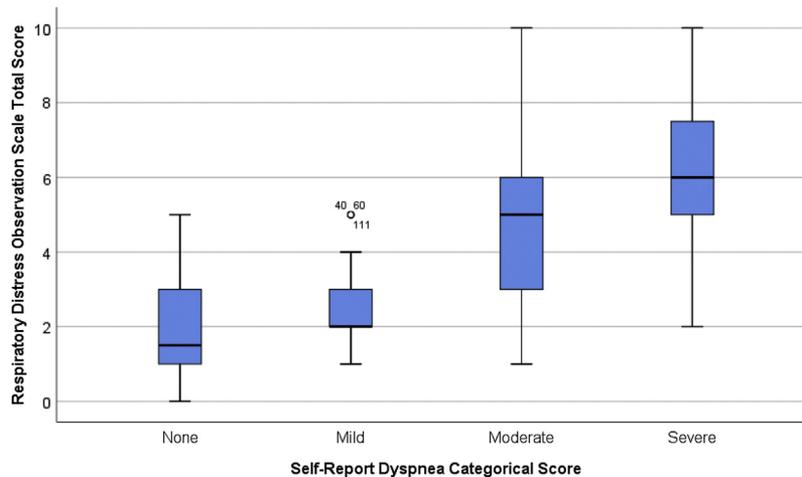
Fig. 2. Box and whisker plot of median RDOS scores against dyspnea categorical score.

mild dyspnea, and they had a median RDOS score of 2 with a range from 0 to 5. Sixty-four (52.5%) participants had moderate or severe dyspnea, and they had a median RDOS score of 5 with a range from 1 to 10. Median RDOS scores across patient groups with none, mild, moderate, and severe dyspnea were significantly different using Kruskal-Wallis Test ($P < 0.05$).

Figure 3 shows receiver operating characteristic curve analysis. The RDOS had clinically significant ability to discriminate patients with moderate-to-severe dyspnea from none to mild dyspnea with an AUC of 0.874 (0.812−0.936). Table 2 shows diagnostic values of varying RDOS cutoff points. We use Youden's Index to propose the optimal cutoff point for our population.[24] Our proposed cutoff value of RDOS ≥ 4 has
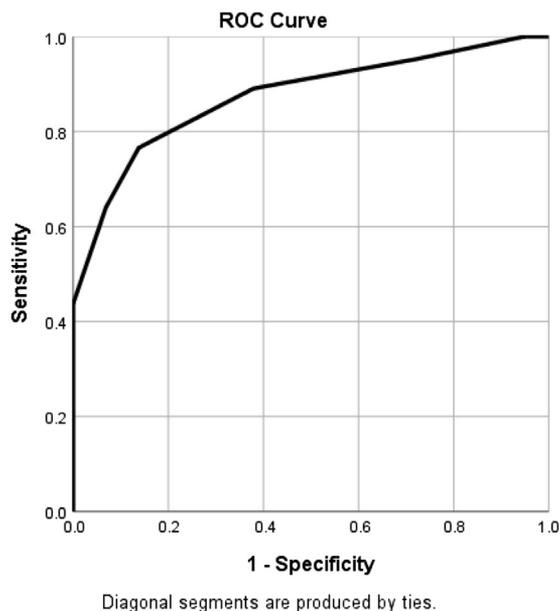
the highest Youden Index of 0.628, with a sensitivity of 76.6%, specificity of 86.2%, positive predictive value of 86.0%, and negative predictive value of 76.9% in identifying patients who have moderate-to-severe dyspnea.

There was strong inter-rater reliability of the RDOS between two trained raters (a nurse and a doctor) with an ICC of 0.947 (95% CI 0.919 to 0.976). Figure 4 shows the limits of agreement using the Bland-Altman Plot. There is a mean RDOS score difference of 0 (standard deviation = .74), and 47 (94%) ratings had an absolute score difference of ≤1, which was clinically acceptable.

Discussion

Standardized, well-developed, and clinically useful tools for dyspnea assessment are needed for nonverbal palliative care patients. The RDOS appear promising, and we seek to further explore its statistical and clinical validity within our population. The results of our study demonstrate moderate-to-strong convergent validity, divergent validity, acceptable diagnostic properties, and strong inter-rater reliability.

First, the RDOS demonstrates a moderate-to-strong relationship with dyspnea self-report, establishing convergent validity with standard dyspnea severity scales. We also show no relationship of RDOS with pain self-report, which establishes divergent validity.

Diagonal segments are produced by ties.

Fig. 3. Results of the receiver operating characteristic curve analysis.

Table 2
RDOS Score Cutoff to Identify Patients With Moderate and Severe Dyspnea

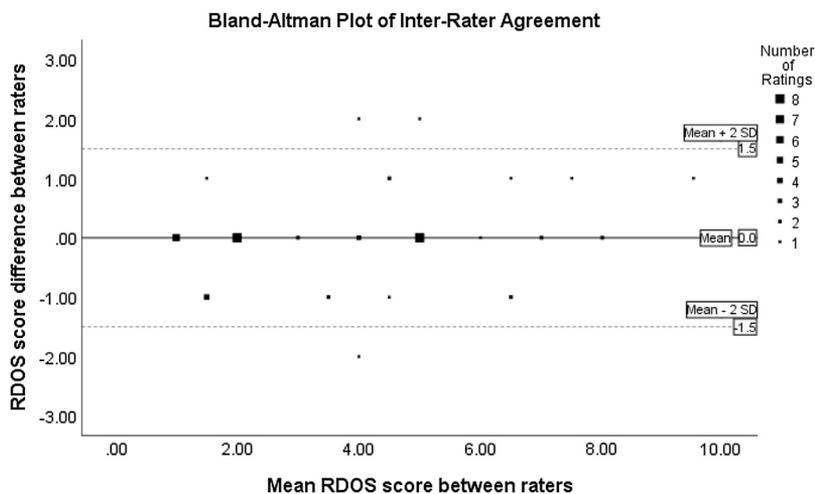| RDOS Score Cutoff	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Youden's Index
≥2	95.3	27.6	59.2	84.2	0.229
≥3	89.1	62.1	72.2	83.7	0.512
≥4	76.6	86.2	86.0	76.9	0.628
≥5	64.1	93.1	91.1	70.1	0.572

Fig. 4. Bland-Altman plot of inter-rater agreement.

Our findings comport with Dr. Campbell's initial findings, further establishing generalizability.[10–12, 23]

Second, we showed significant difference in RDOS scores among patients with varying dyspnea severities. The discriminant capability of this tool is clinically significant (as determined a priori), and our proposed new cutoff of ≥4 provided the best sensitivity and specificity tradeoffs. This is in contrast to the previous proposed cutoff of ≥3, which we felt did not demonstrate sufficiently high specificity (62.1%) within our population.[12] The increased number of false positives due to a lower cutoff score may result in overtreatment of these vulnerable patients who are cognitively impaired. Further external validation of RDOS cutoff is needed.[25]

Third, our study shows that the RDOS can be administered reliably after standardized training is given. The larger sample size provides better precision for the estimation of inter-rater reliability. A prior unpublished study using this tool in Singapore had shown significant inter-rater variability, and results were hypothesized to be due to lack of standardized training. The original scale developer had shown perfect inter-rater reliability but only on a small sample size of five patients.[11]

Our study had a few limitations. We were unable to completely blind Rater 1 to patient's clinical information as Rater 1 was involved in patient screening. This could possibly bias RDOS scoring. We tried to reduce bias by ensuring only information relevant for trial screening was accessed. Rater 2 was completely blinded to patient's prior clinical information. Given that we achieved good score agreement between both Raters 1 and 2 without unidirectional bias during disagreements (Fig. 4), we suggest that the impact of such a bias may be limited.[26]

Raters had no knowledge of prior dyspnea scores as dyspnea self-report was collected only after RDOS scores were finalized. However, this could bias the dyspnea self-report scoring. There should be no prior knowledge of RDOS scores in an ideal situation. We tried to reduce bias by training our raters to follow a standard script during scale administration.

RDOS was designed to measure respiratory distress in nonverbal patients, which is a common situation near the end of life. However, we needed to use cognitively intact patients so that we could benchmark against gold standard (symptom self-report). This limits generalization of our results although a majority of our patients were possibly near the end of life as they had low PPS scores.[27] Ninety-six (78.7%) participants had a PPS of ≤60, whereas 28 (23.0%) had a PPS of ≤30, which gave a predicted median survival of 43 days and 19 days, respectively.[28]

An important aspect of the RDOS not measured in this study would be its responsiveness and sensitivity to change. Assessment of its ability to detect clinically relevant changes in dyspnea symptoms over time provides additional valuable insight into the discrimination properties of a clinical tool.[29] We have plans for future studies in nonverbal palliative care patients to further substantiate clinical validity and utility.

Conclusions

The RDOS shows strong concurrent inter-rater reliability, convergent validity, and divergent validity, suggesting its reliability and validity as a potential observational tool in dyspnea assessment for palliative care patients. More importantly, it shows clinical utility by demonstrating good discriminant properties in detecting patients with moderate and severe dyspnea. We propose new RDOS cutoff of ≥4, which provides a sensitivity of 76.6% and specificity of 86.2%. Further studies in uncommunicative palliative care patients are needed to determine clinical usefulness and generalizability of results.

Disclosures and Acknowledgments

References

1. Currow DC, Smith J, Davidson PM, Newton PJ, Agar MR, Abernethy AP. Do the trajectories of dyspnea differ in prevalence and intensity by diagnosis at the end of life? A consecutive cohort study. J Pain Symptom Manage 2010;39:680−690.

2. Campbell ML, Kiernan JM, Strandmark J, Yarandi HN. Trajectory of dyspnea and respiratory distress among patients in the Last Month of life. J Palliat Med 2018;21:194−199.

3. Campbell ML, Templin T, Walch J. Patients who are near death are frequently unable to self-report dyspnea. J Palliat Med 2009;12:881−884.

4. 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;185:435−452.

5. Nekolaichuk CL, Bruera E, Spachynski K, MacEachern T, Hanson J, Maguire TO. A comparison of patient and proxy symptom assessments in advanced cancer patients. Palliat Med 1999;13:311−323.

6. Puntillo KA, Neuhaus J, Arai S, et al. Challenge of assessing symptoms in seriously ill intensive care unit patients: can proxy reporters help? Crit Care Med 2012;40:2760−2767.

7. Binks AP, Desjardin S, Riker R. ICU Clinicians Underestimate Breathing Discomfort in Ventilated Subjects. Respir Care 2017;62:150−155.

8. Campbell ML. Fear and pulmonary stress behaviors to an asphyxial threat across cognitive states. Res Nurs Health 2007;30:572−583.

9. Campbell ML. Respiratory distress: a model of responses and behaviors to an asphyxial threat for patients who are unable to self-report. Heart Lung J Crit Care 2008;37:54−60.

10. Campbell ML. Psychometric testing of a respiratory distress observation scale. J Palliat Med 2008;11:44−50.

11. Campbell ML, Templin T, Walch J. A Respiratory Distress Observation Scale for patients unable to self-report dyspnea. J Palliat Med 2010;13:285−290.

12. Campbell ML, Templin TN. Intensity cut-points for the respiratory distress observation scale. Palliat Med 2015;29:436−442.

13. Campbell ML, Kero KK, Templin TN. Mild, moderate, and severe intensity cut-points for the respiratory distress observation scale. Heart Lung J Crit Care 2017;46:14−17.

14. Persichini R, Gay F, Schmidt M, et al. Diagnostic accuracy of respiratory distress observation scales as surrogates of dyspnea self-report in intensive care Unit patients. Anesthesiology 2015;123:830−837.

15. Chan Y-H, Wu H-S, Yen C-C, Campbell ML. Psychometric evaluation of the Chinese respiratory distress observation scale on Critically ill patients with Cardiopulmonary Diseases. J Nurs Res 2018;26:340−347.

16. Altman DG, Royston P. What do we mean by validating a prognostic model? Stat Med 2000;19:453−473.

17. Gomutbutra P, O'Riordan DL, Pantilat SZ. Management of moderate-to-severe dyspnea in hospitalized patients receiving palliative care. J Pain Symptom Manage 2013;45:885−891.

18. Figarska SM, Boezen HM, Vonk JM. Dyspnea severity, changes in dyspnea status and mortality in the general population: the Vlagtwedde/Vlaardingen study. Eur J Epidemiol 2012;27:867−876.

19. Anderson F, Downing GM, Hill J, Casorso L, Lerch N. Palliative performance scale (PPS): a new tool. J Palliat Care 1996;12:5−11.

20. Gift AG, Narsavage G. Validity of the numeric rating scale as a measure of dyspnea. Am J Crit Care 1998;7:200−204.

21. Wysham NG, Miriovsky BJ, Currow DC, et al. Practical dyspnea assessment: relationship between the 0-10 Numerical rating scale and the four-level categorical verbal Descriptor scale of dyspnea intensity. J Pain Symptom Manage 2015;50:480−487.

22. Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. Pain 1986;27:117−126.

23. Mukaka M. A guide to appropriate use of Correlation coefficient in medical research. Malawi Med J 2012;24:69−71.

24. Fluss R, Faraggi D, Reiser B. Estimation of the Youden Index and its associated cutoff point. Biom J Biom Z 2005;47:458−472.

25. Šimundić A-M. Measures of diagnostic accuracy: Basic Definitions. EJIFCC 2009;19:203−211.

26. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet Lond Engl 1986;1:307−310.

27. Baik D, Russell D, Jordan L, Dooley F, Bowles KH, Masterson Creber RM. Using the palliative performance scale to estimate survival for patients at the end of life: a Systematic Review of the Literature. J Palliat Med 2018;21:1651−1661.

28. Mei AHY, Jin WLC, Hwang MKY, Meng YC, Seng LC, Yaw WH. Value of the Palliative Performance Scale in the prognostication of advanced cancer patients in a tertiary care setting. J Palliat Med 2013;16:887−893.

29. Fava GA, Tomba E, Sonino N. Clinimetrics: the science of clinical measurements. Int J Clin Pract 2012;66:11−15.