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Prognostic Value of the Intensive Care Respiratory Distress Observation Scale on ICU Admission

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BACKGROUND: The association between dyspnea and mortality has not been demonstrated in the ICU setting. We tested the hypothesis that dyspnea (self-reported respiratory discomfort) or its observational correlates (5-item intensive care Respiratory Distress Observation Scale [IC-RDOS]) assessed on ICU admission would be associated with ICU mortality. METHODS: Ancillary analysis of single-center data prospectively collected from 220 communicative ICU subjects allocated to a derivation cohort of 120 subjects and a separate validation cohort of 100 subjects. Dyspnea was assessed dichotomously (yes/no), with a dyspnea visual analog scale (measured in mm), and IC-RDOS was calculated. Multivariate logistic regression was used to identify factors associated with ICU and hospital mortality. RESULTS: Dyspnea was reported by 69 (58%; median 45 [interquartile range [IQR] 32–60] mm) and 47 (47%; 38 [IQR 26–48] mm) subjects in the derivation and validation cohorts, respectively. IC-RDOS was 2.3 (1.2–3.1) and 2.4 (1.3–2.8), respectively. IC-RDOS values were higher in subjects with dyspnea than in subjects without dyspnea in both the derivation cohort (2.6 [2.2–4.6] vs 1.4 [0.9–2.4], $P < .001$) and the validation cohort (2.6 [2.3–4.4] vs 2.2 [1.0–2.8], $P < .001$). On multivariate analysis of the derivation cohort, admission for hemorrhagic shock (odds ratio 13.98), IC-RDOS (odds ratio 1.77), and Simplified Acute Physiology Score II (odds ratio 1.10) was associated with ICU mortality. Areas under the receiving operating characteristic curve of IC-RDOS to predict ICU mortality were 0.785 and 0.794 in the derivation and validation cohorts, respectively. CONCLUSIONS: IC-RDOS, an observational correlate of dyspnea, but not dyspnea itself, was associated with higher mortality in ICU subjects. *Key words: dyspnea; dyspnea observation scale; ICU; multidimensional dyspnea profile; prognosis.* [Respir Care 0;0(0):1–●. © 0 Daedalus Enterprises]

Introduction

Dyspnea, namely the patient's complaint of difficult breathing, is one of the most prominent and distressing experience encountered by critically ill patients.[1] In the ICU setting, dyspnea is frequent (around 50% of patients),[2-5] severe (median rating of 5 on a dyspnea numerical rating scale),[2-5] and associated with anxiety and poorer clinical outcomes such as delayed extubation[3,4] and posttraumatic stress disorders.[6,7] Dyspnea is often linked to modifiable risk factors (eg, ventilator settings)[3] and should prompt caregivers to undertake diagnostic procedures and provide relief of this symptom.[1,8] Dyspnea is also an independent prognostic indicator in numerous clinical settings.[9-13] For example, Stevens et al[10] recently observed that dyspnea on

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hospital admission was associated with mortality, particularly in the absence of underlying chronic cardiorespiratory disease. In contrast, few data are available concerning the prognostic impact of dyspnea in the ICU,[3-5] and apparently no data are available about the impact of being dyspneic at the time of ICU admission. We designed the present study to test the hypothesis that dyspnea on ICU admission constitutes a predictor of mortality.

We evaluated dyspnea using a traditional unidimensional assessment, namely a dyspnea visual analog scale (D-VAS). Because dyspnea is a multidimensional experience,[14] we also evaluated dyspnea using a simplified version of a validated multidimensional tool, the Multidimensional Dyspnea Profile (MDP).[15] Finally, with noncommunicative subjects (ie, subjects unable to reliably report their dyspnea) in mind, we also assessed the prognostic value of the intensive care Respiratory Distress Observation Scale (IC-RDOS).[2,16] IC-RDOS is a 5-item dyspnea correlate considering the need for supplemental oxygen, heart rate, use of neck muscles and abdominal paradox during inspiration, and facial expression of fear.[2,16] This scale has been devised to identify "occult respiratory suffering"[17] in ICU subjects who often cannot self-report their breathing difficulties[18] and in whom caregivers have trouble identifying such difficulties.[4,19,20]

QUICK LOOK

Current knowledge

Dyspnea is a ubiquitous symptom associated with negative emotional response and mortality in various clinical settings. In the ICU, self-reported dyspnea is frequent, severe, and distressing, but its emotional response and its association with mortality have not been demonstrated.

What this paper contributes to our knowledge

Measuring the intensive care Respiratory Distress Observation Scale, a 5-item observational correlate of dyspnea, on ICU admission reveals the prognostic influence of dyspnea in critically ill subjects. Assessing the negative emotional response to dyspnea allows identifying subjects that may suffer the most from being dyspneic during their ICU stay.

Methods

Subjects and Settings

This is an ancillary analysis of a previous single-center prospective study conducted in a 16-bed ICU of a 1,600-bed tertiary university hospital, which described the IC-RDOS and its performance in 2 cohorts of critically ill subjects: a derivation cohort that comprised 120 subjects and a validation cohort that comprised 100 subjects.[2] This study was approved by the Comité de protection des personnes Ile-de-France VI, Paris, France, and all subjects provided their consent to participate. Guidelines for reporting this retrospective study were from the Strengthening the Reporting of Observational Studies in Epidemiology statement. All consecutive patients admitted to the ICU were included except when they refused to participate or were unable to reliably self-report (noncommunicative subjects). The inability to self-report was defined by the presence of at least one of the following criteria: Richmond Agitation-Sedation Scale < -2 or $> +2$, presence of delirium according to the Confusion Assessment Method for the ICU, ongoing sedative drugs, language barrier, and deafness or D-VAS variation > 10 mm between 3 successive measures.

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This study was approved by the Comité de protection des personnes Ile-de-France VI, Paris, France, and all subjects provided their consent to participate.

The data sets analyzed during the current study are available from the corresponding author on reasonable request.

Drs Demoule and Similowski are co-last authors.

Supplementary material related to this paper is available at http://rc.rcjournal.com.

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Dyspnea Assessment in the Derivation Cohort ($n = 120$)

Dyspnea assessment and clinical data were collected during the first 24 h of the ICU stay (on weekdays only), between 8:00–10:00 AM, by a single investigator (RP):

(1) Unidimensional self-reported assessment

The presence of dyspnea was detected by the subject's answers to questions such as "is your breathing difficult?," "is breathing a problem?," and "is your breathing bothering you." At least 2 different phrasings were used, and the answers had to be consistent in order to define the patient as dyspneic.

Subjects with dyspnea were then asked to rate the intensity of their breathing difficulties using a 0–100-mm visual analog scale (D-VAS, from absent to maximal difficulty).

(2) Multidimensional self-reported assessment (sensory and emotional descriptors)

Subjects with dyspnea were asked to:

Rate dyspnea unpleasantness on a 0–100-mm VAS (from no discomfort to maximal imaginable discomfort; analogous to the A1 scale of the MDP);[15]

Choose one or several sensory descriptors from a list of 5 descriptors taken from the sensory descriptors of the MDP[15] (sensory dimension);

Choose one or several emotional descriptors from a list of 5 descriptors taken from the emotional descriptors of the MDP[15] (emotional dimension).

Subjects unable to choose descriptors were labeled unable to report sensations and/or unable to report emotions. Each subject was, therefore, characterized by 12 yes/no answers. Based on our experience in dyspnea self-report assessment and given the expected challenge to elicit self-report in critically ill patients[18] especially when presenting with acute respiratory failure (ARF) and taking into account that applying the full MDP requires at least 2 min of full cooperation,[15] we chose to use a simplified version of the MDP that we believed would be more convenient for ICU patients (e-Table 1, see related supplementary materials at http://www.rc.rcjournal.com).

(3) Observational approach. The components of the IC-RDOS were collected at the same time, and the IC-RDOS score was calculated. The IC-RDOS is a 5-item multidimensional dyspnea observation scale validated for the ICU setting that takes into account the need for oxygen supplementation, the use of neck muscles for inspiration, the paradoxical abdominal motion during inspiration (abdominal paradox), heart rate, and facial expression of fear[2,16] (e-Table 2, see related supplementary materials at http://www.rc.rcjournal.com).

Dyspnea Assessment in the Validation Cohort ($n = 100$)

Only D-VAS and IC-RDOS were collected in this cohort.

Statistical Analysis

Continuous variables were expressed as median (interquartile range), and categorical variables were expressed as absolute and relative frequencies. Continuous variables were compared between 2 groups using a Mann-Whitney test, and categorical variables were analyzed by chi-square or Fisher exact tests as appropriate.

Based on the MDP results, we created an awareness variable by means of hierarchical cluster analysis (HCA) taking into account the 12 yes/no answers collected during the multidimensional assessment (see methods) and using the Euclidean distance and Ward minimum variance method for merging. The number of clusters was determined using the pseudo-F[21] and pseudo-T[22] heuristics. This HCA was used to restrict the number of categories of the MDP,[23,24] assuming that it would give us the smallest number of categories, ideally a dichotomy (self-aware vs not self-aware), that could subsequently be incorporated in multivariate logistic regression analysis.

Multivariate logistic regression was used to identify factors associated with ICU and hospital mortality. Univariate analysis of factors associated with ICU or 90-d mortality was first performed. Factors yielding P values $\leq .20$ or considered clinically relevant were then considered for logistic regression. The awareness variable determined by the cluster analysis was entered in the subject with dyspnea mortality prediction models as well as the 2 additional synthetic variables: at least one sensation reported or at least one emotion reported. Continuous variables were not dichotomized. Prior to multivariate analysis, missing data (3.8%) were imputed using the nearest-neighbor method. The final models were determined using additive stepwise logistic regression. All tests were 2-tailed, and P values $< .05$ were considered statistically significant. The Hosmer-Lemeshow chi-square test was used to check the goodness of fit of the final model. Odds ratios (ORs) and their 95% CI intervals were calculated for factors identified as being significant. The performance of the IC-RDOS to discriminate ICU and hospital survivors and nonsurvivors was tested in the derivation and validation cohorts by generating receiver operating characteristic (ROC) curves, which were compared to the ROC of the Simplified Acute Physiology Score II (SAPS II) assessing the severity of the subjects[25] using bootstrap (2,000 bootstrap samples). As a requirement for prediction tests,[26] we used the derivation/validation cohorts design previously used for the validation of the IC-RDOS.[2] Analyses were performed using MATLAB 9.7.1261785 (R2019b) and its Statistics and Machine Learning Toolbox version 11.6 (MathWorks,

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Table 1. Characteristics, at the Time of Evaluation, of Subjects With Dyspnea and Subjects Without Dyspnea in the Derivation Cohort

Variables	All Subjects $N = 120$	Subjects With Dyspnea $n = 69$	Subjects Without Dyspnea $n = 51$	P
General characteristics				
Age, y	61 [46–70]	62 [48–70]	57 [39–72]	.33
Male gender	72 (60	38 (55)	34 (67)	.26
Admission for ARF	78 (65)	49 (71)	29 (57)	.08
De novo	48 (62)	34 (69)	14 (48)	.02
Acute on chronic	30 (38)	15 (31)	15 (52)	.34
Admission for hemorrhagic shock	9 (8)	3 (4)	6 (12)	.17
Acute infectious pneumonia	18 (15)	15 (22)	3 (6)	.02
Physiological variables and severity				
Heart rate, beats/min	95 [80–120]	99 [85–109]	88 [75–99]	.008
SAPS II	33[21–43]	35 [26–43]	29 [19–43]	.11
Laboratory variables				
P_{aCO_2}, mm Hg	38 [33–46]	39 [32–46]	37 [34–46]	.65
Bicarbonate, mMol/L	25 [21–29]	26 [23–29]	23 [19–28]	.11
Hemoglobin, g/dL	12.0 [9.9–13.4]	11.8 [9.9–13.2]	11.5 [9.6–13.9]	.98
Respiratory clinical features				
Breathing frequency, breaths/min	22 [18–26]	23 [19–27]	20 [17–25]	.043
Paradoxical breathing	4 (3)	4 (6)	0	.14
Use of inspiratory neck muscles	26 (22)	24 (35)	2 (4)	< .001
Facial expression of fear	7 (6)	7 (10)	0	.02
Nonpurposeful movements	2 (2)	1 (1)	1 (2)	.74
Nasal flaring	4 (3)	4 (6)	0	.14
Need for oxygen therapy	80 (67)	57 (83)	23 (45)	< .001
IC-RDOS	2.3 [1.1–3.0]	2.6 [2.2–4.6]	1.4 [0.9–2.4]	< .001
Associated symptoms				
Pain	41 (34)	29 (60)	12 (26)	< .001
Pain intensity on VAS, mm	43 [23–60]	45 [30–60]	35 [20–50]	.20
Anxiety	61 (51)	50 (74)	11 (22)	< .001
Anxiety intensity on VAS	54 [40–80]	58 [41–80]	45 [29–50]	.03
Medication at the time of evaluation				
Anxiolytics	35 (29)	20 (29)	15 (29)	.96
Morphine	28 (23)	13 (21)	15 (29)	.18
Bronchodilators	32 (27)	19 (28)	13 (25)	.80

Continuous variables are expressed as median [interquartile range], and categorical data are expressed as *n* (%).
ARF = acute respiratory failure
SAPS II = Simplified Acute Physiology Score II
IC-RDOS = intensive care Respiratory Distress Observation Scale
VAS = visual analog scale

Natick, Massachusetts) as well as R version 3.6.1 (July 5, 2019) and its ROCR package (R Foundation for Statistical Computing, Vienna, Austria).

Results

Derivation Cohort

Subject characteristics. During the study period, 456 patients were admitted to the ICU and 193 were evaluated. Seventy-three (37%) were noncommunicative (sedation, $n = 49$; delirium, $n = 9$; unable to understand the questions, $n = 6$; and other reasons, $n = 9$). Among the remaining 120 subjects, 69 (57%) had dyspnea and 51 (43%) did not (Table 1). Subjects with dyspnea were more likely to present pneumonia, visible signs of labored breathing, and other distressing symptoms, such as pain and anxiety (Table 1).

Characteristics of dyspnea. Subjects with dyspnea reported dyspnea intensity of 45 [32–60] mm on D-VAS and dyspnea unpleasantness of 52 [31–77] mm. IC-RDOS scores were higher among the 69 subjects with dyspnea (Table 1), and all 5 items, except for abdominal paradox, were significantly more frequent or more intense in subjects with dyspnea (Table 1). Figure 1 depicts the frequency of each sensory and emotional descriptor in these subjects. Fifty-

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Table 2. Characteristics, at the Time of Evaluation, of Self-Aware and Non–Self-Aware Subjects With Dyspnea, as Defined by Hierarchical Cluster Analysis on the 10 Sensory and Emotional Descriptors

Variables	Self-Aware Subjects $n = 37$	Non–Self-Aware Subjects $n = 32$	P
General characteristics			
Age, y	61 [45–70]	63 [51–72]	.40
Male gender	19 (51)	19 (59)	.50
Admission for ARF	29 (78)	22 (69)	.36
Admission for hemorrhagic shock	2 (5)	1 (3)	.77
Acute infectious pneumonia	8 (22)	7 (22)	.94
Physiological variables and severity			
Heart rate, beats/min	102 [86–109]	94 [80–110]	.28
SAPS II	35 [22–43]	37 [26–47]	.77
Respiratory clinical features			
Breathing frequency, breaths/min	24 [21–30]	22 [16–25]	.005
Paradoxical breathing	3 (8)	1 (3)	.78
Use of inspiratory neck muscles	16 (43)	8 (25)	.11
Facial expression of fear	6 (16)	1 (3)	.11
Nonpurposeful movements	1 (3)	0	> .99
Nasal flaring	4 (11)	0	.12
Need for oxygen therapy	33 (89)	24 (75)	.12
IC-RDOS	3.2 [2.4–4.7]	2.4 [1.7–4.1]	.01
Associated symptoms, mm			
Pain intensity on VAS	42 [21–62]	45 [33–60]	.80
Anxiety intensity on VAS	72 [42–82]	52 [36–66]	.14
Dyspnea sensory and emotional descriptors			
VAS dyspnea intensity, mm	55 [42–64]	39 [22–50]	.003
VAS dyspnea unpleasantness intensity, mm	56 [32–81]	31 [11–59]	.009
At least one sensation reported	34 (92)	15 (46)	< .001
Labored breath	23 (62)	5 (16)	< .001
Air hunger	28 (76)	9 (28)	< .001
Constricted chest	21 (57)	2 (6)	< .001
Concentrated breathing	17 (46)	3 (9)	< .001
Heavy/hard breathing	22 (59)	5 (16)	< .001
At least one emotion reported	36 (97)	8 (25)	< .001
Depression	23 (62)	0	< .001
Anxiety	29 (78)	5 (16)	< .001
Frustration	21 (66)	3 (9)	< .001
Anger	19 (51)	0	< .001
Fear	20 (54)	1 (3)	< .001
Medication at the time of evaluation			
Anxiolytics	10 (27)	10 (31)	.81
Morphine	3 (8)	10 (32)	.01
Bronchodilators	10 (27)	9 (28)	.89

Continuous variables are expressed as median [interquartile range], and categorical data are expressed as *n* (%).
ARF = acute respiratory failure
SAPS II = Simplified Acute Physiology Score II
IC-RDOS = intensive care Respiratory Distress Observation Scale
VAS = visual analog scale

nine (86%) subjects were able to choose at least one sensory descriptor ($n = 49$; 2 or more descriptors in 42 cases) or state that none of the descriptors was appropriate ($n = 10$). Ten (14%) subjects were unable to express themselves on this aspect. Fifty-one (74%) subjects were able to choose at least one emotional descriptor ($n = 44$; 2 or more descriptors in 41 cases) or state that none of the descriptors was appropriate ($n = 7$). Eighteen (26%) subjects were unable to express themselves on this aspect.

Hierarchical cluster analysis. Analysis of the 69 subjects with dyspnea identified 2 clusters (e-Fig. 1, see related

RESPIRATORY CARE Paper in Press. Published on April 19, 2022 as DOI: 10.4187/respcare.09601

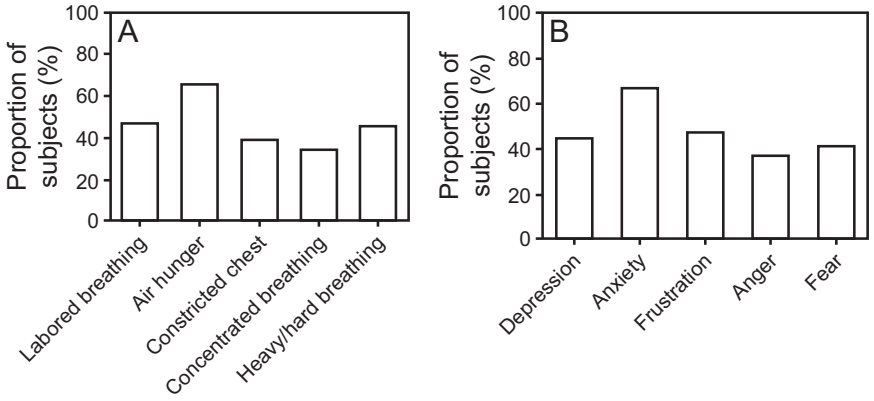

Fig. 1. Sensory (A) and emotional (B) descriptors reported by the 69 subjects with dyspnea on ICU admission.

supplementary materials at http://www.rc.rcjournal.com) composed of (1) 37 (54%) subjects who were able to choose at least one sensory or one affective descriptor (self-aware) and (2) 32 subjects (46%) who were unable to choose any descriptor (non–self-aware). The characteristics of these 2 clusters are compared in Table 2. Self-aware subjects reported more intense dyspnea and were more likely to exhibit visible signs of labored breathing. They were also less frequently treated with morphine than non–self-aware subjects.

Mortality and associated factors. Fourteen subjects were receiving mechanical ventilation at the time of dyspnea assessment, but 54 (45%) subjects received mechanical ventilation at some time during their ICU stay. Mechanical ventilation was more frequently required in subjects with dyspnea than in subjects without dyspnea (43 [62%] vs 21 [51%], $P = .02$), especially noninvasive ventilation (NIV) (29 [42%] vs 9 [18%], $P = .02$). The ICU stay was significantly longer in subjects with dyspnea (3 [2–7] vs 2 [1–3], $P = .001$), but the hospital stay was not significantly longer (13 [7–32] vs 8 [5–18], $P = .08$).

ICU and hospital mortality rates in the derivation cohort ($n = 120$) were 9% and 21%, respectively. ICU and hospital mortality rates were 12% and 25% in subjects with dyspnea versus 6% and 16% subjects without dyspnea ($P = .35$ and .23, respectively). Factors associated with ICU and hospital mortality, identified by univariate analyses, are depicted in Tables 3 and 4, respectively. On multivariate analysis, 2 factors were independently associated with ICU mortality: the need for vasopressors (OR 20.79 [95% CI 1.57–258.71], $P < .001$) and IC-RDOS (OR 2.01 [95% CI 1.34–3.00], $P < .001$). Multivariate analysis identified 3 factors independently associated with hospital mortality: admission for hemorrhagic shock (OR 13.98 [95% CI 2.26–86.96], $P = .004$), IC-RDOS (OR 1.77 [95% CI 1.27–2.51], $P < .001$), and SAPS II (OR 1.10 [95% CI 1.01–1.08], $P = .01$). Higher IC-RDOS scores were associated with higher mortality in both the ICU and hospital mortality prediction models.

When mortality analysis was restricted to the 69 subjects with dyspnea (e-Tables 3 and 4, see related supplementary materials at http://www.rc.rcjournal.com), multivariate analysis showed that IC-RDOS was independently associated with ICU mortality (OR 5.26 [95% CI 1.69–16.67], $P = .003$). Of note, a significant inverse relationship was also observed between the ability to report at least one emotion and ICU mortality (OR 0.01 [95% CI 0–0.25], $P = .006$). Only one factor was identified as an independent predictor of hospital mortality, namely IC-RDOS (OR 2.19 [95% CI 1.42–3.34], $P < .001$).

On univariate analysis, being self-aware according to the HCA analysis was not associated with increased ICU ($P = .46$) or hospital mortality ($P = .62$).

IC-RDOS Performance to Predict Mortality in the Derivation and Validation Cohorts

Figure 2 depicts the area under the ROC of IC-RDOS compared to SAPS II to predict mortality. In the derivation cohort, an IC-RDOS of 2.8 predicted ICU mortality with a sensitivity of 76% and a specificity of 72%.

The characteristics of the subjects included in the validation cohort ($n = 100$) are described in e-Table 5 (see related supplementary materials at http://www.rc.rcjournal.com). Although the hospital mortality rate was significantly lower in the validation cohort (7% vs 21%, $P = .004$), the performance of the IC-RDOS to predict mortality in this cohort was similar to that observed in the derivation cohort, as in the validation cohort ($n = 100$) an IC-RDOS of 2.7 predicted hospital mortality with a sensitivity of 100% and a specificity of 70%.

Discussion

This study, conducted in 2 independent patient cohorts, showed that dyspnea evaluated on ICU admission was not associated with increased ICU or hospital mortality. In

RESPIRATORY CARE Paper in Press. Published on April 19, 2022 as DOI: 10.4187/respcare.09601

Table 3. Univariate Analysis: Factors Associated With ICU Mortality in the Derivation Cohort

Variables	Nonsurvivors $n = 11$	Survivors $n = 109$	P
General characteristics			
Age, y	64 [53–72]	60 [45–70]	.29
Male gender	7 (64)	65 (59)	.80
Admission for hemorrhagic shock	3 (27)	6 (6)	.036
Physiological variables and severity			
Heart rate, beats/min	108 [90–117]	99 [79–104]	.054
SAPS II	36 [26–44]	33 [20–43]	.42
Laboratory variables			
P_{aCO_2}, mm Hg	35 [32–37]	39 [33–46]	.17
Bicarbonate, mMol/L	24 [18–28]	25 [21–29]	.56
Hemoglobin, g/dL	10.1 [8.9–12.9]	11.7 [9.9–13.4]	.46
Respiratory clinical features			
Breathing frequency, breaths/min	25 [23–32]	22 [18–26]	< .001
Paradoxical breathing	2 (18)	2 (2)	.041
Use of neck muscles	7 (64)	19 (17)	.002
Facial expression of fear	3 (27)	4 (4)	.02
Nonpurposeful movements	1 (8)	1 (1)	.18
Nasal flaring	1 (8)	3 (3)	.32
Need for oxygen therapy	10 (91)	70 (64)	.10
IC-RDOS	4.7 [2.7–6.5]	2.3 [1.1–2.7]	.002
Associated symptoms			
Pain	4 (36)	38/83 (46)	.56
Pain intensity on VAS, mm	30 [23–42]	45 [23–60]	.54
Anxiety	7 (64)	54 (50)	.53
Anxiety intensity on VAS, mm	60 [45–86]	54 [40–79]	.54
Dyspnea (yes/no)	8 (73)	61 (56)	.28
VAS dyspnea intensity, mm	55 [44–81]	44 [30–60]	.12
VAS dyspnea unpleasantness intensity, mm	60 [35–65]	50 [30–79]	.79
Medication at the time of evaluation			
Anxiolytics	0	35 (32)	.033
Morphine	0	28 (26)	.065
Bronchodilators	3 (27)	29 (27)	> .99

Continuous variables are expressed as median [interquartile range], and categorical data are expressed as *n* (%).
SAPS II = Simplified Acute Physiology Score II
IC-RDOS = intensive care Respiratory Distress Observation Scale
VAS = visual analog scale

contrast, IC-RDOS, a correlate of dyspnea derived from physical examination, was independently associated with both ICU and hospital mortality.

Data linking dyspnea with mortality in the ICU setting are scarce. Schmidt et al[3] found that dyspnea was associated with prolonged weaning from mechanical ventilation but not with mortality. Haugdahl et al[4] observed similar results when dyspnea was assessed at the end of a spontaneous breathing trial. Dangers et al[5] observed a significant association between mortality and persistent dyspnea after a first NIV session in patients admitted for ARF but not between mortality and dyspnea on admission. In these studies, dyspnea was assessed unidimensionally using VAS or numerical rating scales. Our D-VAS data are in line with these observations.

In contrast with D-VAS, IC-RDOS was independently associated with ICU mortality and hospital mortality in both cohorts. The association was even stronger when the analysis was restricted to the subset of subjects with dyspnea. The difference in prognostic value between D-VAS and IC-RDOS may stem from the integrative nature of IC-RDOS that captures elements related to gas exchange (need for oxygen supplementation), respiratory drive (use of neck muscles for inspiration), respiratory muscle function (abdominal paradox), and neurovegetative (heart rate) and emotional responses (facial expression of fear) to stress. The contrast in terms of the respective prognostic value of D-VAS and IC-RDOS is reminiscent of dyspnea-targeted interventional studies that failed to modify unidimensional dyspnea ratings but successfully improved other

RESPIRATORY CARE Paper in Press. Published on April 19, 2022 as DOI: 10.4187/respcare.09601

Table 4. Univariate Analysis: Factors Associated With Hospital Mortality in the Derivation Cohort

Variables	Nonsurvivors $n = 25$	Survivors $n = 95$	P
General characteristics			
Age, y	62 [53–70]	60 [43–71]	.51
Male gender	17 (68)	55 (58)	.36
Admission for hemorrhagic shock	5 (20)	4 (4)	.01
Physiological variables and severity			
Heart rate, beats/min	102 [95–118]	90 [77–102]	< .001
SAPS II	40 [30–52]	31 [19–43]	.008
Laboratory variables			
P_{aCO_2}, mm Hg	33 [31–37]	39 [35–48]	.009
Bicarbonate, mMol/L	23 [18–26]	26 [22–30]	.09
Hemoglobin, g/dL	10.1 [8.8–13.0]	11.7 [10.1–13.5]	.12
Respiratory clinical features			
Breathing frequency, breaths/min	26 [23–30]	20 [17–24]	< .001
Paradoxical breathing	3 (12)	1 (1)	.03
Use of neck muscles	12 (48)	14 (15)	< .001
Facial expression of fear	4 (16)	3 (3)	.034
Nonpurposeful movements	1 (4)	1 (1)	.38
Nasal flaring	3 (12)	1 (1)	.03
Need for oxygen therapy	20 (80)	60 (63)	.11
IC-RDOS	2.91 [2.22–5.20]	2.25 [1.07–2.62]	< .001
Associated symptoms			
Pain	11/21 (52)	31/73 (42)	.42
Pain intensity on VAS, mm	35 [28–60]	45 [20–51]	.89
Anxiety	17 (68)	44 (46)	.054
Anxiety intensity on VAS, mm	78 [50–82]	51 [30–71]	.067
Dyspnea (yes/no)	17 (68)	52 (55)	.16
VAS dyspnea intensity, mm	50 [42–71]	42 [30–59]	.09
VAS dyspnea unpleasantness intensity, mm	69 [52–83]	40 [29–65]	.066
Medication at the time of evaluation			
Anxiolytics	6 (24)	29 (31)	.63
Morphine	3 (12)	25 (26)	.19
Bronchodilators	3 (12)	29 (31)	.08

Continuous variables are expressed as median [interquartile range], and categorical data are expressed as number (%).
SAPS II = Simplified Acute Physiology Score II
IC-RDOS = intensive care Respiratory Distress Observation Scale
VAS = visual analog scale

patient-related outcomes. Likewise, Messika et al[27] studied the effects of musical intervention in subjects undergoing NIV. They did not observe any relief of dyspnea but reported a statistically significant reduction in blood pressure and the Peritraumatic Distress Inventory, a measure of acute stress that is predictive of posttraumatic stress disorders.[27] These findings have led to the hypothesis that dyspnea-targeted intervention should be evaluated by means of multidimensional rather than unidimensional indicators.[28,29] Our observations suggest that IC-RDOS could provide a multidimensional assessment of dyspnea, but this remains to be demonstrated by specifically designed studies.

The absence of association between dyspnea and prognosis observed in previous studies[3-5] could result from a bias due to high proportions of noncommunicative subjects in the corresponding populations (up to 50%[2,18]). However, this was not the case in our study, which only included communicative subjects and which also concluded on the absence of a D-VAS/mortality association. Of note, it is unlikely that the prognostic value of IC-RDOS is simply due to an overlap of its constituent variables with variables of the SAPS II. Only one variable is common to IC-RDOS and SAPS II (heart rate), and in our study, IC-RDOS performed as well or better than SAPS II to predict ICU and hospital mortalities.

In line with previous MDP clinical studies, air hunger and anxiety dominate the description of dyspnea on ICU admission,[23,30,31] confirming the interplay between anxiety and dyspnea.[32,33] Subjects in the non–self-aware subgroup had lower IC-RDOS scores and reported 2-fold lower

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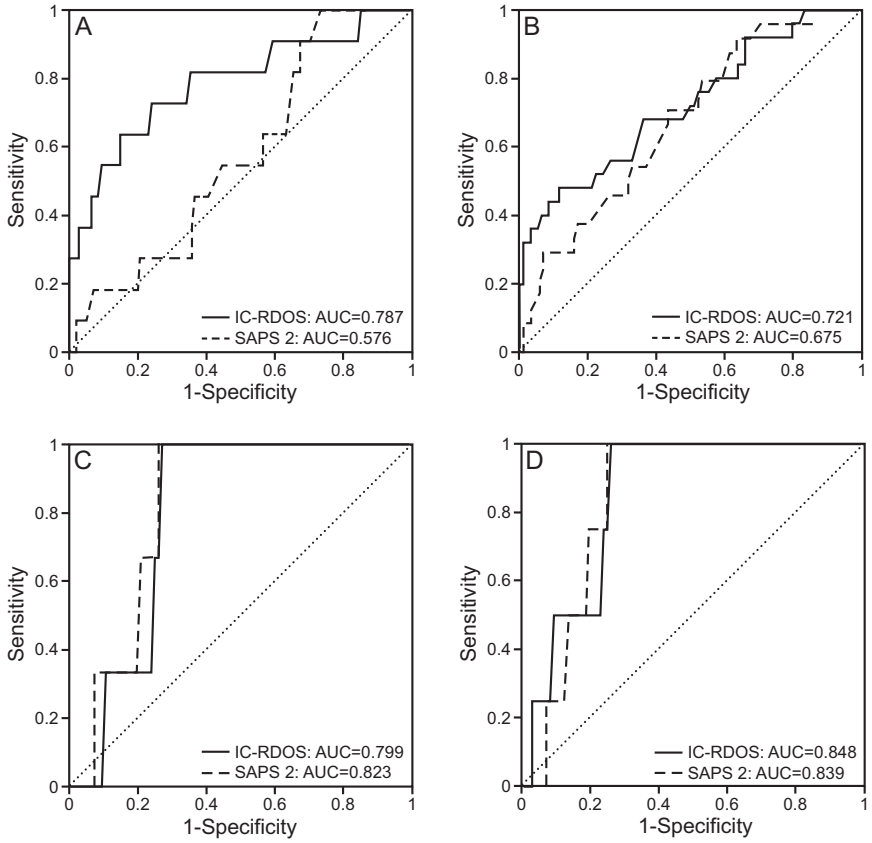

Fig. 2. Comparisons of the area under the receiver operating curve (AUC) of the Simplified Acute Physiology Score (SAPS) II and the intensive care Respiratory Distress Observation Scale (IC-RDOS) to predict ICU and hospital mortality in the derivation ($n = 120$) and validation ($n = 100$) cohorts. A: Derivation cohort, ICU mortality. B: Derivation cohort, hospital mortality. C: Validation cohort, ICU mortality. D: Validation cohort, hospital mortality.

dyspnea intensity and dyspnea unpleasantness than self-aware subjects. However, non–self-aware subjects more frequently received morphine than self-aware subjects at the time of dyspnea assessment. Morphine, regardless of its indication, may, therefore, have blunted dyspnea in non–self-aware subjects.[34] The inability to report at least one emotion was associated with higher mortality, in line with recent data showing that hospitalized subjects unable to self-report their symptoms (dyspnea, pain, or anxiety) are at increased risk of mortality than subjects who are able to self-report.[10]

This study has a number of limitations. First, the verbal multidimensional assessment of dyspnea was based on a nonvalidated rough simplification of the MDP. Second, this assessment was only performed in the derivation cohort and not in the validation cohort. Third, because of the study design requiring subjects be communicative in order to participate, only 14 subjects (12%) of the derivation cohort were intubated; and the overall mortality was low, in line with this moderate disease severity, limiting the generalizability of the results. A corroborative study of the prognostic value of IC-RDOS in unselected ICU subjects is, therefore, needed. Finally, the study was not powered to identify the components of the IC-RDOS that drive its prognostic value. However, some of these items taken independently have been associated with prognosis (eg, alterations in breathing pattern[35] and modifications of facial expression[36]).

Conclusions

With all due caution in view of the above limitations, our results support the idea that measuring IC-RDOS in communicative patients on ICU admission can provide valuable prognostic information and, therefore, complements the clinically actionable information provided by unidimensional or multidimensional assessment of dyspnea. Our results also support further evaluation of the prognostic value of IC-RDOS in noncommunicative subjects, corresponding to the population for which this scale was developed in order to alleviate unrecognized respiratory suffering.[37]

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