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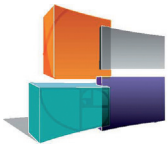

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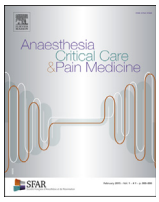

Original article

Assessment of dyspnoea in the emergency department by numeric and visual scales: A pilot study

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ABSTRACT

Objective(s): Dyspnoea is a common and often debilitating symptom that affects up to 50% of patients admitted to acute tertiary care hospitals. The primary purpose of this study was to compare the numeric rating scale (NRS) and the visual analogue scale (VAS) for dyspnoea evaluation in the ED setting.
Study design and patients: This was a cohort study of patients admitted to the ED in a university hospital, with dyspnoea as the chief complaint.
Methods: The agreement of the two dyspnoea scales was assessed using the intraclass correlation coefficient (ICC).
Results: One hundred and seventeen patients were included in this analysis. The median age for the whole study population was 67 years and 42% of patients were male. The aetiology of dyspnoea was acute heart failure (AHF) in 35% of patients. There was good agreement between the two scores (ICC = 0.795; 95% CI = 0.717–0.853; $P < 0.001$).
Conclusions: This pilot study demonstrated that numerical rating and visual analogue scales agree well when assessing the severity of dyspnoea in the ED. Further studies with larger cohorts of patients are needed to confirm these preliminary results.

1. Introduction

Dyspnoea is a common and often debilitating symptom that affects up to 50% of patients admitted to acute, tertiary care hospitals [1,2]. There is increasing research and clinical interest in improving the accuracy of assessment of this complex symptom to help evaluate available interventions, including drug therapy [3]. Consequently, a number of tools to determine a given patient's subjective assessment of dyspnoea have been developed [4]. Unfortunately, a validated instrument that is accurate, reliable, reproducible among observers and with a uniform methodology or set of conditions under which dyspnoea is assessed does not currently exist. In addition, the number and diversity of dyspnoea measures makes any comprehensive critical synthesis difficult, as has been noted in several systematic reviews [5–7].

In our health-care system, increasing pressure on emergency departments (EDs) to limit costs and waiting times has resulted in the development of many clinical decision aids and admission prediction tools designed to assist physicians in meeting these demands. However, most of these tools are disease specific [8,9] and none are currently available for application to patients presenting to the ED with shortness of breath. Although somewhat limited, current evidence supports the utilization of a simple dyspnoea rating scale, to assist in the evaluation of clinical severity, and to potentially provide useful information to facilitate rapid and accurate site-of-care decisions in this setting [10].

The most widely used scales to evaluate the level of dyspnoea are the visual analogue scale (VAS), the verbal category scale and a

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hybrid of these, the Borg numerical category scale. The VAS has been validated as a measure of dyspnoea but has been used primarily in a research setting [11]. Furthermore, the VAS is cumbersome to administer because it requires adequate levels of visual acuity, motor function, and the cognitive ability to translate a sensation of dyspnoea into a distance measure. With the numerical rating scale (NRS), patients are asked to indicate the intensity of pain by reporting a number that best represents it. The NRS is easy to administer verbally in a clinical setting and is a familiar clinical tool [12]. However, to the best of our knowledge, the use of these instruments in an acute setting has not been validated.

The primary purpose of this study was to compare the NRS and VAS scales in the ED setting.

2. Material and methods

2.1. Study design and selection of patients

The present study analysed a subgroup of patients included in the "Biomarcoeurs" prospective cohort, namely patients admitted to the ED of Lariboisière university hospital in Paris, France. Patients were enrolled in the "Biomarcoeurs" cohort if they were presenting to the ED with shortness of breath as their primary complaint. All patients were 18 years or older. Patients with altered level of consciousness, decreased visual acuity, physical abnormalities that precluded VAS scoring were excluded. Demographic parameters and clinical history were recorded on a standardized case report form. Patients were then asked to grade their dyspnoea with two different scales. The first was a 10 cm visual analogue scale (VAS). *A priori*, this line was divided into 10 equal 1 cm increments providing a range of 0–10 (11-point VAS). If patients marked anywhere within a particular centimetre increment, the recorded result on the 11-point VAS was identical (i.e. 21 mm = 3 cm, 29 mm = 3 cm). Patients were asked: "Show me on the ruler the level of your shortness of breath: here there is no shortness of breath, and there is the worst possible shortness of breath you can possibly imagine" (Fig. 1). The second was a numeric rating scale (NRS) using the following verbatim "Tell me on a scale of 0 to 10, what is the level of your shortness of breath. Zero is no shortness of breath and 10 is the worst possible shortness of breath you can possibly imagine". The order of presentation of the NRS and VAS was random. This study was registered in clinical trials.gov and the identifier is NCT01374880. Informed consent was obtained from all patients. The study was approved by the local institutional review board: CEERB (n° 10-017).

2.2. Data analysis

Values are expressed as medians (with interquartile ranges) or as numbers and percentages as appropriate. Groups were compared with independent sample *t*-tests and Chi^2 tests as appropriate. The agreement between the two dyspnoea scales was assessed using the intraclass correlation coefficient (ICC). The NRS scores were regressed on the VAS scores (in centimetres) in order to assess the equivalence of the two measures. If the measures were equivalent, we would expect a y-intercept of 0 and a slope of 1. In order to assess the agreement and interchangeability between the two measures, the differences between each paired NRS and VAS score, and the interval that included 95% of these differences, were determined with the Bland–Altman method. Agreement between the 2 scales was also studied by age category, aetiology of dyspnoea and level of dyspnoea. A *P*-value of less than 0.05 was considered statistically significant. Statistics were performed using SPSS software, version 17 (SPSS Inc., Chicago, IL).

3. Results

From September 2010 to April 2012, 117 patients were included in this analysis. Patients' characteristics are presented in Table 1. Vital signs and laboratory tests at admission are presented in Table 2. The median age for the whole study population was 67 years and 42% of patients were male. The aetiology of dyspnoea was acute heart failure (AHF) in 35% of patients. The median level of dyspnoea was 7 for both the VAS and the NRS.

Figs. 2 and 3 both show the distribution of NRS scores by VAS scores and the regression line that describes the relationship between the two measures using linear regression in Fig. 2 and the passing-bablock regression method in Fig. 3. There was good agreement between the two scores (ICC = 0.795; 95% CI = 0.717–0.853; $P < 0{,}001$). Using a linear regression model to compare the visual analogue and numerical rating scales, the y-intercept was 1.674 and the slope was 0.752 (95% CI = 0.646–0.859). The interval that included 95% of the differences between the paired NRS and VAS scores extended from –0.28 to +0.26 around the mean difference. Because scores can be correlated but still yield scores that are clinically interpreted as different, we compared the absolute value of the score by using an independent sample *t*-test, as recommended by Bland and Altman [13] (Fig. 4). The scores from the two scales were not significantly different ($t = -0.063$, $P = 0.137$). The correlation between NRS and VAS scores was similar in AHF patients ($r = 0.810$, $P < 0.001$, $n = 41$) and in non-AHF patients ($r = 0.788$, $P < 0.001$, $n = 76$ patients). When compared by age categories, i.e. less than 45 years (yrs), from 46 to 75 yrs and above 76 yrs, the NRS and VAS scores were found to be statistically similar ($P = 0.206$). We then compared VAS and NRS scores according to the patient's VAS dyspnoea score classified into 2 groups: from 0 to 5 and from 6 to 10. Here the mean difference in VAS and NRS scores between the 2 groups was found to be higher if the dyspnoea intensity was lower, i.e. when VAS scores were less than 5, ($P = 0.001$)

The NRS/VAS mean differences and bias 95% limits of agreement for each age, aetiology and dyspnoea intensity groups are presented in Table 3.

4. Discussion

The present study shows that dyspnoea, as measured by a verbally administered NRS, is strongly correlated with VAS scores.

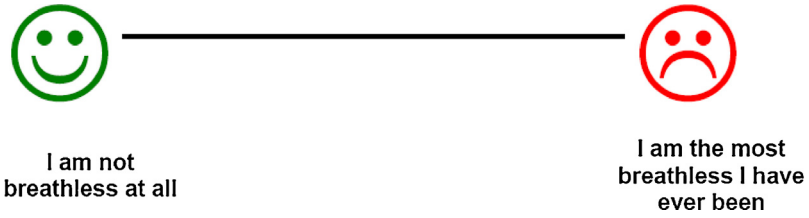

Fig. 1. Visual analogue scale; 10 cm VAS figure used for dyspnoea evaluation.

Table 1
Patients' characteristics.

	Total population	AHF patients	Non-AHF patients	*P*-value
Groups	117 (100)	41 (35)	76 (65)	
Age (years)	67 (54–80)	71 (63–83)	62 (51–80)	0.008
Sex: male	49 (42)	12 (29)	37 (49)	0.042
BMI (kg/m^2)	25.5 (22.9–30.8)	26.2 (21.9–29.3)	25.3 (23.1–31.1)	0.508
Medical history				
Chronic heart failure	27 (23)	20 (49)	7 (9)	<0.001
Coronary artery disease	30 (26)	16 (39)	14 (18)	0.015
Myocardial infarction	18 (15)	15 (37)	3 (4)	<0.001
Myocardial revascularization	14 (12)	9 (22)	5 (7)	0.015
Valvular disease/previous valvular surgery	9 (8)	4 (10)	5 (7)	0.538
Atrial fibrillation/flutter	25 (21)	15 (37)	10 (13)	0.003
Obesity	9 (8)	5 (12)	4 (5)	0.179
Hypertension	62 (53)	25 (61)	37 (49)	0.204
Insulin-dependent diabetes	10 (9)	7 (17)	3 (4)	0.015
Non-insulin-dependent diabetes	19 (16)	7 (17)	12 (16)	0.085
Dyslipidemia	31 (27)	11 (27)	20 (26)	0.952
Stroke	14 (12)	5 (12)	9 (12)	0.955
Peripheral vascular disease	12 (10)	6 (15)	6 (8)	0.252
Pulmonary embolism	5 (4)	1 (2)	4 (5)	0.471
Asthma/COPD	20 (26)	6 (15)	35 (46)	0.001
Renal insufficiency	6 (5)	5 (12)	1 (1)	0.011
Anaemia	2 (3)	0 (0)	2 (3)	0.295
Medication before admission				
Diuretics	49 (42)	25 (61)	24 (32)	0.002
ACE inhibitors/angiotensin II antagonists	47 (40)	26 (63)	21 (28)	<0.001
Dihydropyrindine/calcium channel blocker	29 (25)	11 (27)	18 (24)	0.707
Beta-blockers	34 (29)	21 (51)	13 (17)	<0.001
Aldosterone antagonists	11 (9)	7 (17)	4 (5)	0.037
Cardiac glycosides	3(3)	1 (2)	2 (3)	0.950
Nitrates	8 (7)	2 (5)	6 (8)	0.537
Statins	28 (24)	10 (24)	18 (24)	0.932
Platelet antiaggregants	39 (33)	21 (51)	18 (24)	0.003
Oral anticoagulants	18 (15)	10 (24)	8 (11)	0.047
Inhaled steroids	17 (15)	2 (5)	15 (20)	0.030
Inhaled beta 2-mimetics	29 (25)	3 (7)	26 (34)	0.001

Values are presented as numbers (%) or medians (interquartile range) as appropriate. AHF: acute heart failure; COPD: chronic obstructive pulmonary disease. *P*-values were computed between the AHF and the non-AHF groups.

Table 2
Vital signs and laboratory tests at admission.

	Total population	AHF patients	Non-AHF patients	*P*-value
Groups	117 (100)	41 (35)	76 (65)	
Vital signs at admission				
SBP (mmHg)	132 (122–153)	136 (123–156)	130 (122–149)	0.238
DBP (mmHg)	80 (70–89)	86 (70–95)	78 (70–84)	0.06
Heart rate (b/min)	100 (83–111)	95 (81–110)	100 (85–111)	0.567
Respiratory rate (c/min)	26 (24–32)	29 (25–34)	26 (24–32)	0.223
SpO_2 (%)	95 (93–98)	95 (92–98)	95 (93–98)	0.529
Laboratory parameters at admission				
Hb (g/dL)	12 (11–14)	12 (11–13)	13 (11–14)	0.347
Creatinine (μmol/L)	82 (66–113)	103 (82–138)	74 (60–98)	0.025
Glomerular filtration rate, mL/min/1.73 m^2	72 (49–92)	56 (39–75)	82 (61–96)	<0.001
Urea (mmol/L)	6 (4–9)	8 (6–12)	5 (3–7)	<0.001
Sodium (mmol/L)	137 (135–139)	137 (136–139)	137 (135–140)	0.532
Potassium (mmol/L)	4 (3–4)	4 (3–4)	4 (3–4)	0.144
Troponin (ng/mL)	0 (0–2)	1 (0–1)	0 (0)	0.046
BNP (pg/mL)	430 (136–1581)	1581 (928–2540)	173 (38–332)	<0.001
Blood glucose (mmol/L)		15 (6–54)	23 (9–76)	0.347
CRP (mg/L)	22 (8–64)	15 (6–54)	23 (9–76)	0.085
Dyspnea at admission				
Visual analogue scale (cm)	7 (5–8)	7 (5–9)	7 (5–8)	0.852
Numeric rating scale	7 (5–8)	7 (5–9)	7 (5–8)	0.544

Values are presented as numbers (%) or medians (interquartile range) as appropriate. AHF: acute heart failure; SBP: systolic blood pressure; DBP: diastolic blood pressure; COPD: chronic obstructive pulmonary disease. *P*-values were computed between the AHF and the non-AHF groups.

These results are similar to the findings of Gift and Narsavage [12] that compared NRS and VAS for dyspnoea level assessment in patients with chronic obstructive pulmonary disease followed in an outpatient clinic. However, to the best of our knowledge, it is the first time that NRS and VAS scores are compared specifically when evaluating dyspnoea in the ED setting. Improvement in dyspnoea is seen by the scientific community, industry, and regulatory agencies including the European Medicines Agency (EMA) and the Food and Drug Administration (FDA) as an important measure of improved acute heart failure (AHF) in

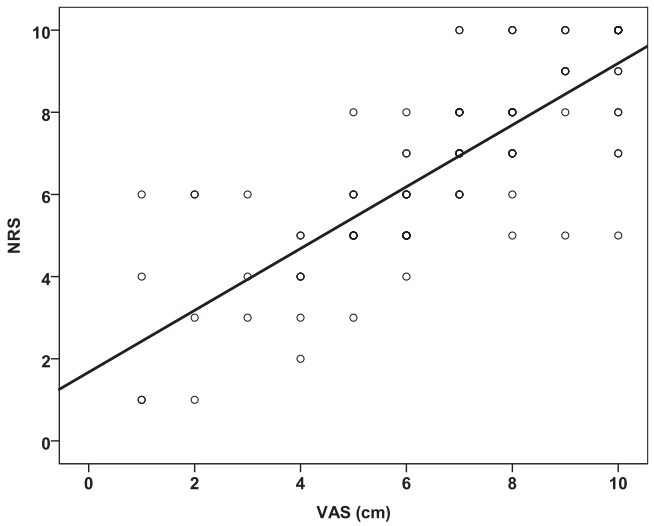

Fig. 2. Relationship between NRS and VAS scores, both scores were well correlated ($n = 117$, $r = 0.794$, $P < 0.001$). NRS for numerical rating scale and VAS for visual analogue scale.

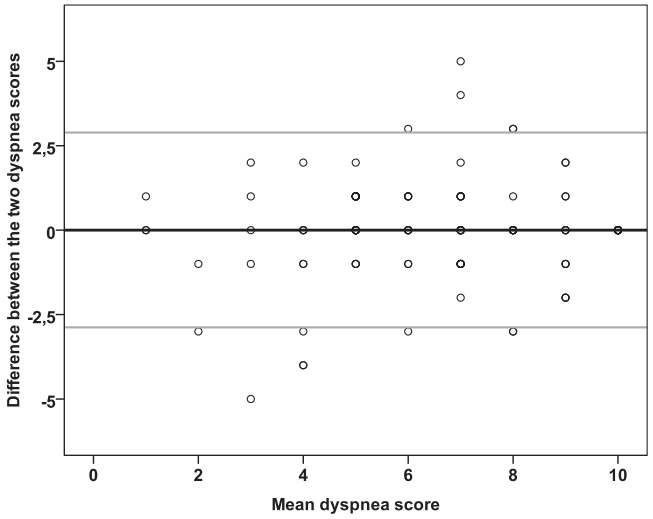

Fig. 4. Bland–Altman. The y axis represents for each patient the difference between the two dyspnoea scores (VAS-NRS). The x axis represents for each patient the mean value of the two dyspnoea scores.

clinical trials [14,15]. Indeed, many AHF trials had dyspnoea measures as primary or secondary objectives [16,17]. A number of studies have compared different instruments for dyspnoea assessment, although a few of them have investigated the use of these instruments on patients with acute dyspnoea [14]. In a study of patients with chronic lung disease, 28 patients underwent dyspnoea evaluation on both a VAS and a 7-point Likert scale before and after rehabilitation. The VAS showed a greater standardized improvement in symptoms of dyspnoea, but it was also accompanied by a greater variation in response [18]. One study in normal subjects compared VAS, Borg scales, and Likert scales during submaximal exercise [19]. The VAS was found to be the most reproducible and sensitive measure of changes in breathlessness, although the Borg scale was more sensitive to changes in fatigue. There is evidence showing that VAS scores have superior metrical characteristics as compared to discrete scales [20]. The two main scales used to assess level of dyspnoea are the VAS and a 5-point Likert scale: (i) not short of breath, (ii) mildly short of breath, (iii) moderately short of breath, (iv) severely short of breath, and (v) very severely short of breath [21]. We recently showed that the VAS is an optimal way to measure dyspnoea at baseline and during follow-up [22]. However, the VAS requires a printed version of the scale and is restricted to use among patients with adequate levels of visual acuity and motor function. In the ED, pain levels were usually evaluated using a 10 cm VAS. NRS scores have been found to be adequately correlated with the VAS for pain evaluation in the ED [23,24].

Our study has several limitations. Firstly, this was not a consecutive series of patients, and the number of patients was rather low. These results should be confirmed in a large, multicentre study. Secondly, dyspnoea ratings by numerical rating and visual analogue scales were performed immediately after each other. Although the order was random, because the patient's response to the second measure is not independent of the response to the first measure administered, the degree of agreement between the measures may be overestimated. Performing VAS before NRS in future studies might improve the independence between the two measures. Simon et al. also demonstrated years ago that shortness of breath "may encompass multiple sensations, and, therefore, may not be explainable by a single physiologic mechanism". Further studies will need to explore agreement between VAS and NRS scores in specific diseases like pneumonia or chronic obstructive pulmonary disease [25].

In summary, we showed that numerical rating and visual analogue scales agree well when assessing the severity of dyspnoea in the ED setting. Further studies with larger cohorts of patients are needed to confirm these preliminary results.

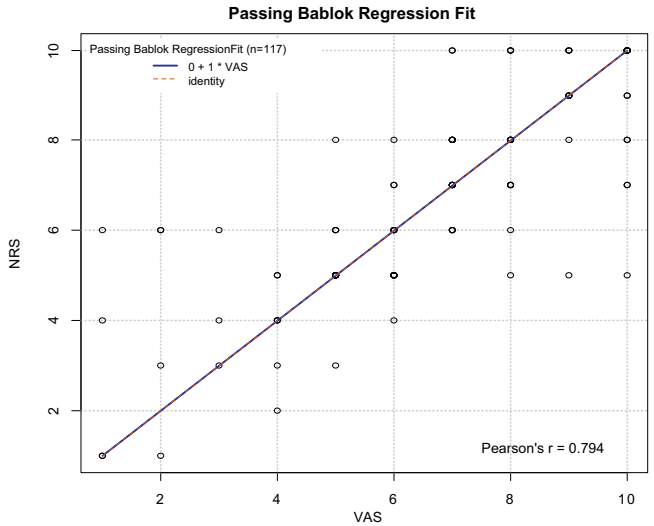

Fig. 3. Passing Bablock Regression Fit.

Table 3
NRS/VAS bias and 95% limits of agreement according to the Bland and Altman method for each group.

	n	Mean difference[a] (95% CI)
Age groups (years)	≤45	−0.25 (−1.1, 0.61)
	46–75	−0.17 (−0.55, 0.22)
	>75	0.33 (−0.09, 0.76)
Dyspnoea categories (VAS)	1–5	−0.72 (−1.31, −0.12)
	6–10	0.26 (−0.03, 0.54)
Aetiology groups	AHF	−0.24 (−0.74, 0.25)
	Non-AHF	0.12 (−0.21, 0.44)

Bias: ANOVA, $P = 0.206$ for age groups; ANOVA, $P = 0.001$ for dyspnoea categories; ANOVA, $P = 0.217$ for etiological groups.
[a] Between NRS and VAS.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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