

Hypercapnia and lung function parameters in chronic obstructive pulmonary disease

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Table S1: Area under the ROC curve of pulmonary function parameters regarding the prediction of chronic hypercapnia

Spirometry	AUROC (95%CI)	P value
FVC	0.74 (0.70 – 0.78)	< 0.01
FVC%	0.77 (0.72 – 0.81)	< 0.01
FEV1 (L)	0.74 (0.70 – 0.79)	< 0.01
FEV1%	0.75 (0.70 – 0.79)	< 0.01
Body plethysmography		
RV (L)	0.58 (0.53 – 0.62)	< 0.01
RV%	0.58 (0.53 – 0.63)	< 0.01
TLC (L)	0.53 (0.48 – 0.58)	0.334
TLC%	0.51 (0.46 – 0.56)	0.695
Lung diffusion capacity		
DCO-SB (mmol*min ⁻¹ *kPa ⁻¹)	0.61 (0.55 – 0.68)	0.011
DCO-SB%	0.64 (0.58 – 0.71)	< 0.01
DCO-VA (mmol*min ⁻¹ *kPa ⁻¹ *L ⁻¹)	0.58 (0.51 – 0.64)	0.100
DCO-VA%	0.63 (0.57 – 0.69)	< 0.01

Legend

The accuracy of each index in predicting chronic hypercapnic respiratory failure presented as the area under the ROC curve with 95% confidence intervals. The parameters of lung diffusion capacity were available in 234 patients (55%), 58 (36%) of whom had hypercapnia.

Abbreviations: AUROC, area under the receiver operating characteristic curve; 95%CI, 95% confidence interval; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; RV, residual volume; TLC, total lung capacity; DCO-SB, single-breath lung diffusion capacity for carbon monoxide; DCO-VA, transfer coefficient for carbon monoxide (Krogh index).

Table S2: Sensitivity analysis: Area under the ROC curve of pulmonary function parameters regarding the prediction of chronic hypercapnia with a $\text{PCO}_2 > 52$ mmHg

Spirometry	AUROC (95%CI)	P value
FVC (L)	0.74 (0.69 – 0.78)	< 0.01
FVC%	0.77 (0.73 – 0.81)	< 0.01
FEV1 (L)	0.73 (0.68 – 0.77)	< 0.01
FEV1%	0.74 (0.70 – 0.78)	< 0.01
Body plethysmography		
RV (L)	0.56 (0.52 – 0.61)	0.062
RV%	0.57 (0.52 – 0.63)	0.047
TLC (L)	0.52 (0.47 – 0.57)	0.530
TLC%	0.51 (0.46 – 0.57)	0.844
Lung diffusion capacity		
DCO-SB ($\text{mmol} \cdot \text{min}^{-1} \cdot \text{kPa}^{-1}$)	0.63 (0.57 – 0.69)	0.014
DCO-SB%	0.65 (0.58 – 0.71)	< 0.01
DCO-VA ($\text{mmol} \cdot \text{min}^{-1} \cdot \text{kPa}^{-1} \cdot \text{L}^{-1}$)	0.56 (0.49 – 0.62)	0.306
DCO-VA%	0.61 (0.55 – 0.68)	0.033

Legend

The accuracy of each index in predicting chronic hypercapnia with a $\text{PCO}_2 > 52$ mmHg presented as the area under the ROC curve with 95% confidence intervals. The parameters of lung diffusion capacity were available in 234 patients (55%), 58 (36%) of whom had hypercapnia.

Abbreviations: AUROC, area under the receiver operating characteristic curve; 95%CI, 95% confidence interval; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; RV, residual volume; TLC, total lung capacity; DCO-SB, single-breath lung diffusion capacity for carbon monoxide; DCO-VA, transfer coefficient for carbon monoxide (Krogh index).

Table S3: Rank correlations of pulmonary function parameters with spontaneous breathing PCO₂

Spirometry	Spearman`s correlation coefficient (ρ)	P value
FVC	- 0.454 (- 0.527 – - 0.375)	< 0.01
FVC%	- 0.510 (- 0.578 – - 0.436)	< 0.01
FEV1 (L)	- 0.473 (- 0.544 – - 0.396)	< 0.01
FEV1%	- 0.493 (- 0.562 – - 0.417)	< 0.01
Body plethysmography		
RV (L)	0.203 (0.110 – 0.292)	< 0.01
RV%	0.228 (0.136 – 0.317)	< 0.01
TLC (L)	- 0.002 (- 0.097 – 0.093)	0.968
TLC%	0.069 (- 0.027 – 0.163)	0.160
Lung diffusion capacity		
DCO-SB (mmol*min ⁻¹ *kPa ⁻¹)	- 0.170 (- 0.293 – - 0.041)	0.010
DCO-SB%	- 0.209 (- 0.330 – - 0.081)	< 0.01
DCO-VA (mmol*min ⁻¹ *kPa ⁻¹ *L ⁻¹)	- 0.126 (- 0.250 – 0.003)	0.055
DCO-VA%	- 0.185 (- 0.305 – - 0.059)	< 0.01

Legend

Spearman`s correlation coefficient (ρ) of rank correlation (with 95% confidence intervals). The parameters of lung diffusion capacity were available in 234 patients (55%), 58 (36%) of whom had hypercapnia.

Abbreviations: ρ , Spearman`s rank correlation coefficient; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; RV, residual volume; TLC, total lung capacity; DCO-SB, single-breath lung diffusion capacity for carbon monoxide; DCO-VA, transfer coefficient for carbon monoxide (Krogh index).

Table S4: Variables associated with chronic hypercapnia – Results of univariable and multivariable binary logistic regression analysis (all patients; N = 423)

Variables	Univariable analysis		Multivariable analysis	
	OR (95%CI)	<i>P</i> value	OR (95%CI)	<i>P</i> value
Clinical characteristics				
Age (years)	1.01 (0.98–1.03)	0.610	–	n.s.
Female gender	1.13 (0.75–1.68)	0.565	–	n.s.
Obesity (BMI $\geq$ 30 kg/m ²)	1.05 (0.57–1.90)	0.886	–	n.s.
Pulmonary function parameters				
FVC%	0.94 (0.92–0.95)	< 0.01	0.95 (0.93–0.97)	< 0.01
FEV1%	0.92 (0.90–0.94)	< 0.01	0.97 (0.94–0.99)	0.029
RV%	1.00 (1.00–1.01)	0.010	–	n.s.
TLC%	1.00 (0.99–1.01)	0.816	–	n.s.

Legend

The multivariable model used forward selection and included variables deemed clinically significant a priori (age, gender, and obesity) and those lung function parameters with a *P* value of less than 0.2 in bivariate analysis.

Abbreviations: n.s., not significant; BMI, body mass index; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; RV, residual volume; TLC, total lung capacity.

Table S5: Variables associated with chronic hypercapnia – Multivariable binary logistic regression model (all patients; N = 423)

Logit(p)	L = 3.537 - 0.052 * FVC% - 0.031 * FEV1%			
OR (95%CI); P value	FVC%	0.95 (0.93–0.97)	< 0.01	
	FEV1%	0.97 (0.94–0.99)	0.029	
Hosmer & Lemeshow	0.239			
Nagelkerke R²	0.287			
AUROC (95%CI)	0.77 (0.73 – 0.81)			
2 x 2 table	TP 92	FP 46		
	FN 70	TN 215		
Metrics from 2 x 2 table (95%CI)	Sensitivity	57% (48–65)	PLR	3.2
	Specificity	82% (77–87)	NLR	0.52
	PPV	67% (60–73)	DOR	6
	NPV	75% (72–79)	F₁ score	0.62
	Accuracy	73% (68–77)	MCC	0.40

Legend

Abbreviations: L, log-odds/Logit(p); OR, odds ratio; 95%CI, 95% confidence interval; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; AUROC, area under the receiver operating characteristic curve; TP, true positive; FP, false positive; FN, false negative; TN, true positive; PPV, positive predictive value; NPV, negative predictive value; PLR, positive likelihood ratio; NLR, negative likelihood ratio; DOR, diagnostic odds ratio; MCC, Matthews correlations coefficient

Table S6: Linear and multiple regression models (all patients; N = 423)

Linear regression model for FVC%		
Regression equation	PCO ₂ = 63.08 - 0.285 * FVC%	
Coefficient of determination R ²	0.219	
F-ratio	118.2	P < 0.01
Shapiro-Wilk test	W = 0.937	
Linear regression model for FEV1%		
Regression equation	PCO ₂ = 58.06 - 0.345 * FEV1%	
Coefficient of determination R ²	0.172	
F-ratio	87.2	P < 0.01
Shapiro-Wilk test	0.917	
Multiple regression model for FVC% and FEV1%		
Regression equation	PCO ₂ = 63.34 - 0.219 * FVC% - 0.120 * FEV1%	
R ² adjusted	0.225	
Variation Inflation Factor	FVC%	2.29
	FEV1%	2.29
F-ratio	62.1	P < 0.01
Shapiro-Wilk test	W = 0.934	

Legend

Abbreviations: FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second.