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SUPPLEMENTARY MATERIAL

Ultrasound-guided diaphragm evaluation and outcomes in severe acute exacerbation of chronic obstructive pulmonary disease (uDISCO Study): an observational study

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Key words: excursion, diaphragmatic thickening fraction index, diaphragm dysfunction, transdiaphragmatic pressure, sonography, NIV failure.

Supplementary Table 1. Clinical and demographic details of study participants (n=60).

Parameter	Study population			
Mean age (±SD), years	64.68 (±8.63)			
Males:females	58:2			
Mean BMI (±SD), kg/m^2	19.94 (± 3.84)			
Mean duration of smoking (±SD), years	32.75 (±12.57)			
Mean pack years of smoking (±SD), pack-years	34.58 (±15.38)			
Infectious exacerbations as the cause of AECOPD, N (%)	28 (46.67%)			
Previously needed IMV, N (%)	4 (6.67%)			
Previously needed NIV, N (%)	14 (23.33%)			
Previously needed Supplemental oxygen, N (%)	21 (35%)			
Respiratory acidosis, N (%)	35 (58.33%)			
Died:survived	5:55			
	Survivors (n=55)	**Died (n=5)**	**Difference relative to survivors**	**p-value**
Mean age (±SD), years	65.16 (±8.68)	59.4 (±6.73)	-8.84%	0.16 (95% CI: -13.76 to +2.24)
Mean BMI (±SD), kg/m^2	20.04 (±3.95)	18.91 (±2.45)	-5.64%	0.53 (95%CI: -4.74 to +2.48)
Mean duration of smoking (±SD), years	33.09 (±12.15)	29 (±17.82)	-12.36%	0.49 (95%CI: -15.8926 to 7.7126)
Mean pack years of smoking (±SD), pack-years	35.09 (±15.22)	29 (±17.82)	-11.66%	0.40 (95%CI: -20.5015 to 8.3215)
Infectious exacerbation as the cause of AECOPD, N (%)	25 (45.45%)	3 (60%)	32.01%	0.53 (Chi square: 0.39)
Previously needed IMV, N (%)	4 (7.27%)	0 (0%)	100%	0.53 (Chi square: 0.39)
Previously needed NIV, N (%)	12 (21.82%)	2 (40%)	83.32%	0.36 (Chi square: 0.85)
Previously needed Supplemental oxygen, N (%)	19 (34.54%)	2 (40%)	15.81%	0.81 (Chi square: 0.06)
Respiratory acidosis, N (%)	32 (58.18%)	3 (60%)	3.13%	0.94 (Chi square: 0.006)
Mean diaphragmatic excursion (±SD), cm	1.59 (±0.53)	0.62 (±0.5)	-61%	0.003 (95%CI: -1.6612 to -0.3688)
Mean diaphragmatic inspiratory thickness (±SD), cm	0.49 (±0.24)	0.20 (±0.10)	-59.18%	0.011 (95%CI: -0.5168 to -0.0702)
Mean diaphragmatic expiratory thickness (±SD), cm	0.26 (±0.12)	0.16 (±0.09)	-38.46%	0.06 (95%CI: -0.2129 to +0.0047)
Mean diaphragmatic thickening index (±SD), %	90.57 (±49.1)%	29.51 (±8.87)%	-67.42%	0.008 (95%CI: -105.4119 to -16.7149)
Mean length of hospital stay (±SD), days	11.04 (± 5.78)	-	-	-
Median length of hospital stay (Q1:Q3), days	10 (7:14)	-	-	-

AECOPD, acute exacerbation of chronic obstructive pulmonary disease; IMV, invasive mechanical ventilation; NIV, noninvasive ventilation; Q1, first quartile; Q3, third quartile; SD, standard deviation.

Supplementary Table 2. Correlation analysis for diaphragm function and individual parameters

	Diaphragmatic thickening fraction				Diaphragmatic excursion			
	R^2	R	p-value	Covariance	R^2	R	p-value	Covariance
Age	0.005	-0.07	0.59	21.76	<0.001	-0.01	0.92	-0.08
Height	0.044	-0.21	0.13	-47.75	0.058	-2.4	0.08	-0.88
BMI	0.033	0.18	0.16	55.8	**0.07**	**0.26**	**0.04**	**0.75**
Pack years	-0.027	<0.001	0.84	-7.78	<0.001	-0.001	0.99	-0.4
Duration of illness	0.006	-0.08	0.55	-23.63	0.019	-0.14	0.29	-42.14
Duration of exacerbation	0.014	-0.12	0.36	-36.34	0.031	-0.18	0.18	-0.55
Number of exacerbations	**0.1**	**-0.325**	**0.01**	**-94.95**	**0.127**	**-0.36**	**0.005**	**-104.1**
Tdi	-	-	-	-	**0.923**	**0.96**	**<0.001**	**293**
Excursion	**0.923**	**0.96**	**<0.001**	**293**	-	-	-	-
LoS	**0.922**	**-0.96**	**<0.001**	**-245.64**	**0.605**	**-0.78**	**<0.001**	**-3.16**
RR	**0.073**	**-0.27**	**0.04**	**-81.33**	0.055	-0.24	0.07	-0.999
pH	0.037	0.19	0.15	56.45	0.03	0.17	0.19	0.01
$PaCO_2$	0.029	-0.17	0.2	-50.2	0.014	-0.12	0.37	-2.46
PaO_2	0.016	-0.12	0.35	-36.8	0.04	-0.2	0.13	-58.95
HCO_3^-	0.001	0.04	0.78	11.1	0.004	0.06	0.62	0.54
SaO_2	0.006	-0.07	0.57	-22.09	0.047	-0.22	0.1	-2.73

BMI, body mass index; HCO_3, bicarbonate; SaO2, oxygen-saturated hemoglobin

Supplementary Table 3. Correlation analysis of length of hospital stay and individual parameters

	Length of stay in hospital			
	R^2	R	p-value	Covariance
Tdi	**0.922**	**-0.96**	**<0.001**	**-245.64**
Excursion	**0.605**	**-0.78**	**<0.001**	**-3.16**
Age	0.053	0.23	0.09	11.51
BMI	0.25	-0.16	0.25	-3.57
Pack years	0.006	0.08	0.56	19.37
Duration of illness	0.006	0.08	0.59	19.01
Duration of exacerbation	<0.001	0.01	0.92	0.35
Number of exacerbations	0.07	0.27	0.05	63.62
Respiratory Rate	0.001	0.03	0.8	0.98
pH	0.025	-0.16	0.25	-0.09
$PaCO_2$	0.448	0.1	0.45	17.17
PaO_2	0.011	0.11	0.44	26.51
HCO_3^-	0.004	-0.07	0.62	-4.5
SaO_2	0.014	0.12	0.38	11.64

BMI, body mass index; HCO^3, bicarbonate; SaO_2, oxygen-saturated hemoglobin; Tdi, thickening index of diaphragm.

Supplementary Table 4. Receiver-operating analysis and performance of thickening index and excursion for outcomes: length of stay and NIV failure.

	Cut-off	AUROC	Sensitivity (95%CI)	Specificity (95%CI)	PPV (95%CI)	NPV (95%CI)	Accuracy (95%CI)
LoS 8 days	Tdi 92%	0.974	89.47 (75.2 to 97.06)	100 (80.49 to 100)	100 (89.72 to 100)	80.95 (62.71 to 91.48)	92.73 (82.41 to 97.98)
	Excu 1.96 cm	0.958	97.37 (86.19 to 99.93)	82.35 (56.57 to 96.2)	92.5 (81.52 to 97.18)	93.33 (66.65 to 98.99)	92.73 (82.41 to 97.98)
Death	Tdi<40%	0.905	100 (39.76 to 100)	89.29 (78.12 to 95.97)	40 (23.84 to 58.68)	100 (92.89 to 100)	90 (79.49 to 96.24)
	Excu 0.7 cm	0.947	80 (28.36 to 99.49)	90.91 (80.05 to 96.98)	44.44 (23.74 to 67.27)	98.04 (89.63 to 99.66)	90 (79.49 to 96.24)
NIV failure	Tdi 51.2%	0.8	80 (28.36 to 99.49)	75 (57.8 to 87.88)	30.77 (17.85 to 47.62)	96.43 (82.24 to 99.37)	75.61 (59.7 to 87.64)
	Excu 1.48 cm	0.75	100 (47.82 to 100)	58.33 (40.76 to 74.49)	25 (18.47 to 32.91)	100 (83.89 to 100)	63.41 (46.94 to 77.88)

AUROC, area under receiver-operating characteristic curve; Excu, excursion; LoS, length of stay; NIV, noninvasive ventilation; NPV, negative predictive value; PPV, positive predictive value; Tdi, diaphragmatic thickening index.

Supplementary Table 5. Correlation analysis for days to death in nonsurvivors.

	Days to death			
	R^2	R	p-value	Covariance
Diaphragmatic excursion	0.01	-0.1	0.75	-0.25
Diaphragmatic inspiratory thickness	0.25	-0.5	0.5	-1.25
Diaphragmatic expiratory thickness	0.64	-0.8	0.2	-2
Diaphragmatic thickening index	0.49	0.7	0.28	1.75

Supplementary Table 6. Comparison of diaphragm parameters in individuals in whom NIV succeeded *vs.* failed.

Parameter	NIV success, n=36. Mean (SD)	NIV failure, n=5. Mean (SD)	Difference in NIV failure relative to NIV success	p-value (95% Confidence Interval)
Diaphragmatic excursion (cm)	1.56 (0.55)	1.1 (0.44)	-29.49%	0.08 (-0.9810 to +0.0610)
Diaphragmatic inspiratory thickness (cm)	0.45 (0.22)	0.57 (0.28)	26.67%	0.27 (-0.0990 to +0.3390)
Diaphragmatic expiratory thickness (cm)	0.24 (0.11)	0.39 (0.18)	62.5%	0.02 (0.0350 to 0.2650)
Diaphragmatic thickening index (%)	88.81 (46.6)	44.21 (18.75)	-50.22%	0.04 (-87.6085 to -1.5915)

IMV, invasive mechanical ventilation; NIV, noninvasive ventilation; SD, standard deviation; USG, ultrasonogram.

Supplementary Table 7. Comparison for individuals with Tdi <40% and 40%.

	Tdi <40%	Tdi 40%	p-value	Risk (95% CI)
N	9/60 (15%)	51/60 (85%)	-	
Died	4/9 (44.44%)	1/51 (2%)	0.003 (Altman relative risk)	22.7 (2.85 to 180.28) (Altman relative risk)
Age (years), mean (Std deviation)	63.56 (7.21)	64.87 (8.9)	0.64 (effect size, d =0.15, small) (Welch's unpaired t test)	
Mean Tdi, Std deviation	26.33 (8.69)	95.93 (46.88)	<0.001	
Median Tdi (Q1-Q3)	26.06 (25-29.63)	73.94 (61.32-130.42)	-	
Received NIV	5/9 (55.56%)	35/51 (68.63%)	0.44 (chi-square = 0.59)	0.81 (0.44 to 1.49)
Incidence of NIV failure	40% (n=2)	8.67% (n=3)	0.048 (Altman relative risk)	4.67 (1.02 to 21.43) (Altman relative risk)
Diaphragm excursion	0.66 (0.37)	1.7 (0.68)	<0.001 (d=1.63, large)	
Median diaphragmatic excursion (Q1-Q3)	0.64 (0.4 to 0.67)	1.68 (1.32 to 2.01)	-	

Tdi, diaphragmatic thickening index; NIV, noninvasive ventilation; SD, standard deviation; Q1, first quartile; Q3, third quartile.