호흡재활 치료: Targeted Approach

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Contents

1. Targeted approach : Comorbidities in COPD
   - Cardiovascular
   - Musculoskeletal : Limb and Respiratory muscle dysfunction
   - Metabolic : Osteosarcopenia and nutrition

2. Severe dyspnea with Exercise-Induced Desaturation :

   Effect of Oxygen supplementation?

Comorbidities in COPD

TABLE 1 Comorbidities commonly associated with chronic obstructive pulmonary disease

- **Cardiovascular disease**
  - Hypertension
  - Coronary artery disease
  - Systolic and/or diastolic left ventricular dysfunction
  - Pulmonary hypertension
  - Peripheral vascular disease
  - Cerebrovascular disease
  - Stroke
- **Skeletal muscle dysfunction and loss of muscle mass**
- **Osteoporosis, osteopenia or osteoarthritis**
- **Psychological disturbances**
  - Depression
  - Anxiety
- **Cognitive impairment**
- **Anaemia**
- **Obstructive sleep apnoea**
- **Diabetes/metabolic syndrome**
- **Renal insufficiency**
- **Gastro-oesophageal reflux disease**
- **Lung cancer**
- **Infections**

Franssen, Frits ME, and Carolyn L. Rochester. "Comorbidities in patients with COPD and pulmonary rehabilitation: do they matter?." (2014): 131-141

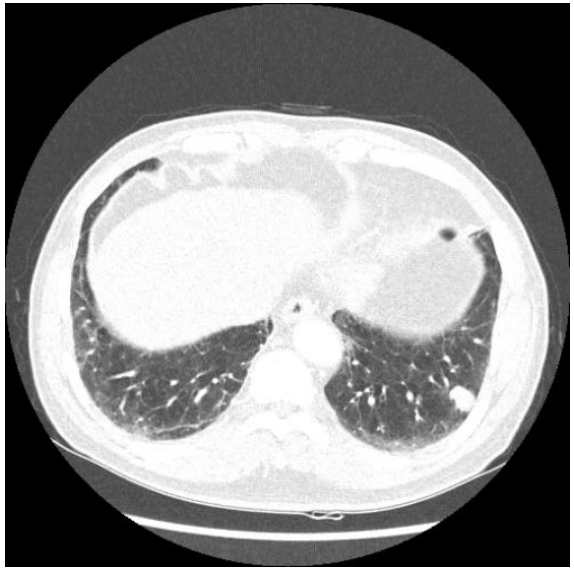
Comorbidities in COPD : Cardiovascular disease

- **Hypertension**
- **CAOD**
- **Heart Failure**
- **Pulmonary hypertension**
- Peripheral vascular disease
- Cerebrovascular disease

Cardio-Pulmonary Exercise Test

CPET Case 1: M/68 ,

- CC: Exertional dyspnea
- CT chest:
  - Lobulated nodule(1.4cm) at left lower lobe posterior basal segment.
    -- with persistent enhancement
    --> DDx.)
    1) early lung cancer
    2) organizing pneumonia



- PFT : normal
- Cardiac echo : Normal LV systolic function
- ECG : NSR
- Refer for the Preoperative CPET

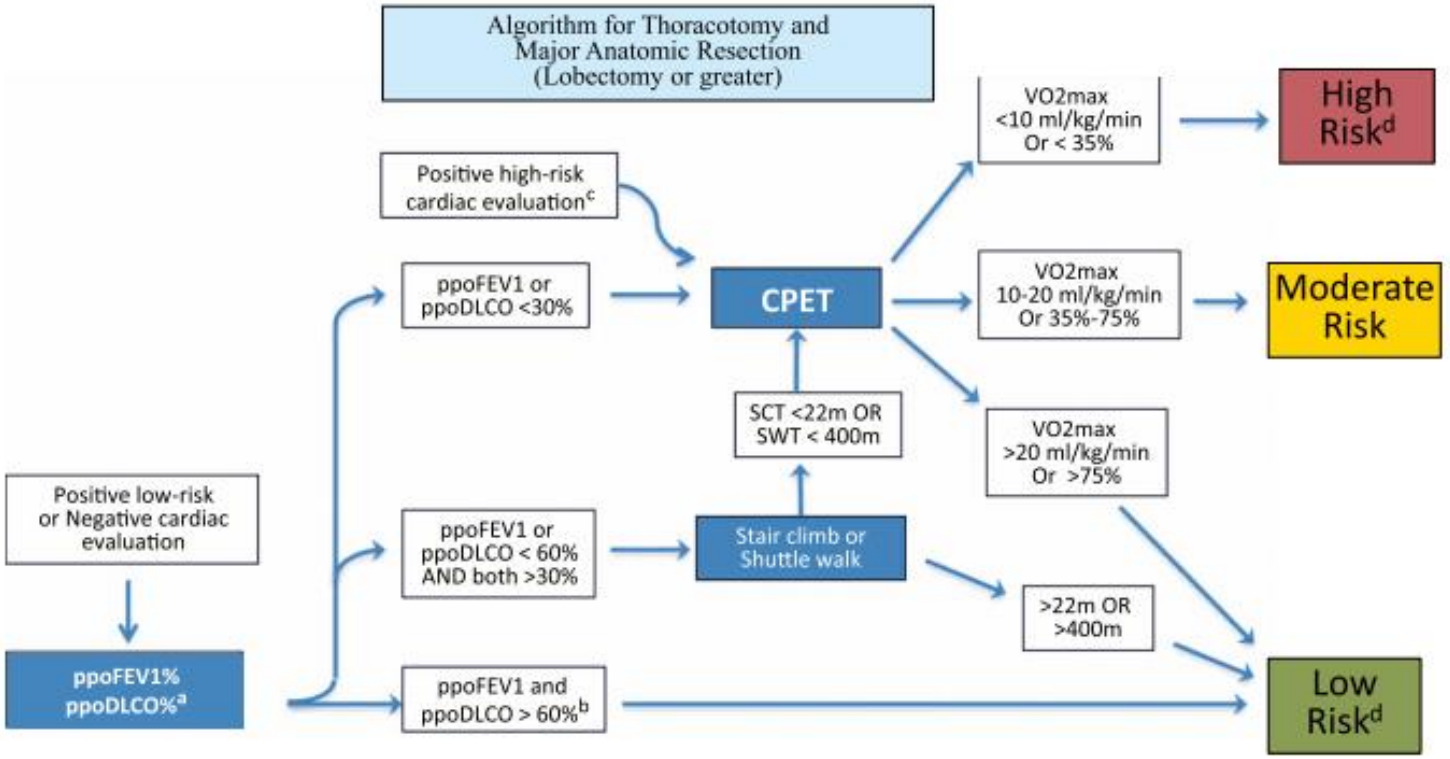
CHEST Supplement

DIAGNOSIS AND MANAGEMENT OF LUNG CANCER, 3RD ED: ACCP GUIDELINES

Physiologic Evaluation of the Patient With Lung Cancer Being Considered for Resectional Surgery

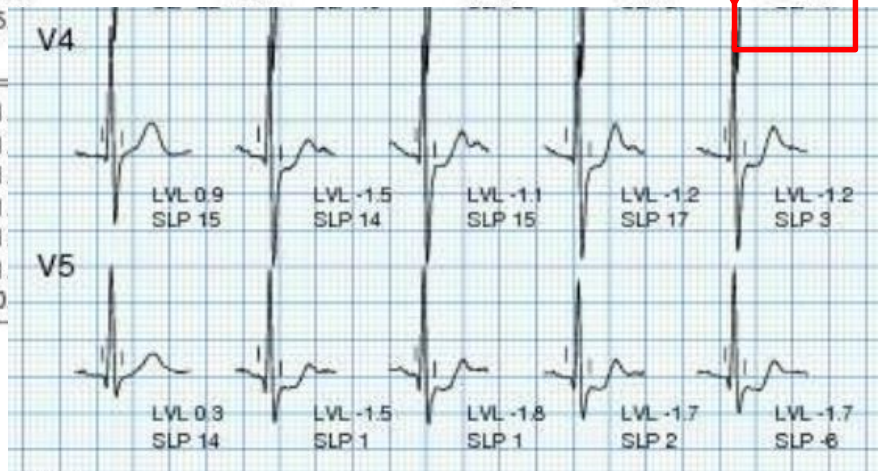
Diagnosis and Management of Lung Cancer, 3rd ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines

Alessandro Brunelli, MD, FCCP; Anthony W. Kim, MD, FCCP; Kenneth I. Berger, MD, FCCP; and Doreen J. Addrizzo-Harris, MD, FCCP



Exercise Testing	Rest	Warm-up	LT	RC	Peak	Pred	%Pred	Recov+2min
t (hh:mm:ss)	---	---	00:10:00	00:11:45	00:13:30	---	---	00:02:00
Power (Watt)	---	---	40	40	55	137	40	27
RPM (1/min)	---	---	12	12	14	---	---	---
Metabolic Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	**[Hansen]**
VO2 (ml/min)	---	---	1188	1432	1633	1721	95	
VO2/Kg (ml/min/Kg)	---	---	17.87	21.54	24.56	25.88	95	
METS (---)	---	---	5.1	6.2	7.0	7.4	95	
R (---)	---	---	0.91	1.00	1.19	---	---	
Ventilatory Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
VE (l/min)	---	---	40.9	53.9	78.0	103.6	75	
BR (%)	---	---	60	47	24	30.00	80	
VT (l)	---	---	1.583	1.745	1.999	---	---	
Rf (b/min)	---	---	25.8	30.9	39.0	50.0	78	
Cardiovascular Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
HR (bpm)	---	---	116	119	129	152	85	115
HRres (%)	---	---	23	21	15	15	100	---
VO2/HR (ml/bpm)	---	---	10.2	12.0	12.7	11.3	112	9.8
Qt (l/min)	---	---	8.9	9.6	10.1	---	---	8.7
SV (ml/beat)	---	---	77	81	78	---	---	76
P Syst (mmHg)	---	---	---	---	---	---	---	---
P Diast (mmHg)	---	---	---	---	---	---	---	---
DP (mmHg/min)	---	---	---	---	---	---	---	---
ST V5 (mm)	---	---	---	---	---	---	---	---
S V5 (mV/sec)	---	---	---	---	---	---	---	---
Gas Exchange	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
PetCO2 (mmHg)	---	---	35	35	32	---	---	
PetO2 (mmHg)	---	---	110	113	120	---	---	
VE/VO2 (---)	---	---	34.4	37.6	47.7	---	---	
VE/VCO2 (---)	---	---	37.7	37.5	40.0	---	---	
SpO2 (%)	---	---	---	---	---	---	---	
Other Indexes	**Meas.**	**Pred**						
VE/VCO2 slope	34.0	---						

Stage	Total Stage Time	HR	ER	SpO2	BP	HRxBP	TM Speed km/h	TM Grade %	LVL II	LVL V2	LVL V5
REST	08:25	95	0	---	122/ 92	11590	1.9	0.0	0.0	0.8	0.3
Stage 1	01:00	98	0	---	---/---	---	2.7	0.0	- 0.2	0.6	0.6
	RPE 7										
	02:00	102	5	---	---/---	---	2.7	0.0	0.1	0.4	0.2
	03:00	96	2	---	143/ 85	13728	2.7	0.0	0.0	0.5	0.0
Stage 2	01:00	105	0	---	---/---	---	2.7	5.0	0.2	0.3	0.2
	RPE 11										
	02:00	108	4	---	---/---	---	2.7	5.0	0.0	0.3	- 0.2
	03:00	106	1	---	155/ 83	16430	2.7	5.0	0.0	0.3	- 0.1
Stage 3	01:00	110	6	---	---/---	---	2.7	10.0	0.0	0.1	- 0.5
	02:00	113	6	---	---/---	---	2.7	10.0	- 0.3	0.1	- 0.9
	RPE 15										
	03:00	112	0	---	151/ 84	16912	2.7	10.0	- 0.4	0.2	- 0.4
Stage 4	01:00	120	0	---	---/---	---	4.0	12.0	- 0.4	0.0	- 1.0
	RPE 16										
	02:00	122	0	---	---/---	---	4.0	12.0	- 0.4	- 0.1	- 1.3
	03:00	123	0	---	141/ 80	17343	4.0	12.0	- 0.4	0.0	- 1.2
Stage 5	RPE 18										
	01:00	129	0	---	---/---	---	5.4	14.0	- 0.9	- 0.8	- 1.5
	01:20	131	0	---	---/---	---	5				
Stop exercise at 13:20											
RECOVERY	01:00	119	0	---	126/ 73	14994	1				
	02:00	108	0	---	126/ 73	13608	1				
	03:00	104	0	---	119/ 85	12376	1				
	04:00	98	0	---	119/ 85	11662	1				
	05:00	97	0	---	119/ 85	11543	1				
	06:00	100	0	---	143/ 85	14300	1				
	06:09	101	0	---	143/ 85	14443	0				



OPEN ACCESS Freely available online

PLOS ONE

Pulmonary Hypertension in Patients with Idiopathic Pulmonary Fibrosis – The Predictive Value of Exercise Capacity and Gas Exchange Efficiency

Sven Gläser[1]*, Anne Obst[1], Beate Koch[1], Beate Henkel[1], Anita Grieger[1], Stephan B. Felix[1], Michael Halank[2], Leonhard Bruch[3], Tom Bollmann[1], Christian Warnke[1], Christoph Schäper[1], Ralf Ewert[1]

1 Department of Internal Medicine B - Cardiology, Intensive Care, Pulmonary Medicine and Infectious Diseases, University of Greifswald, Greifswald, Germany, **2** Department of Internal Medicine I, University Hospital Carl Gustav Carus of TU Dresden, Dresden, Germany, **3** Clinic for Internal Medicine, Trauma Hospital Berlin - Association of BG Hospitals, Berlin, Germany

- In IPF, coexisting PH further impairs diffusing capacity, exercise capacity and ventilatory efficiency.

- The statistically most powerful prognosticator was the presence of PH assessed by right heart catheterization. -> ***Invasive!!***

- The clinical and prognostic consequences of PH might not adequately be assessed by resting PFT only.

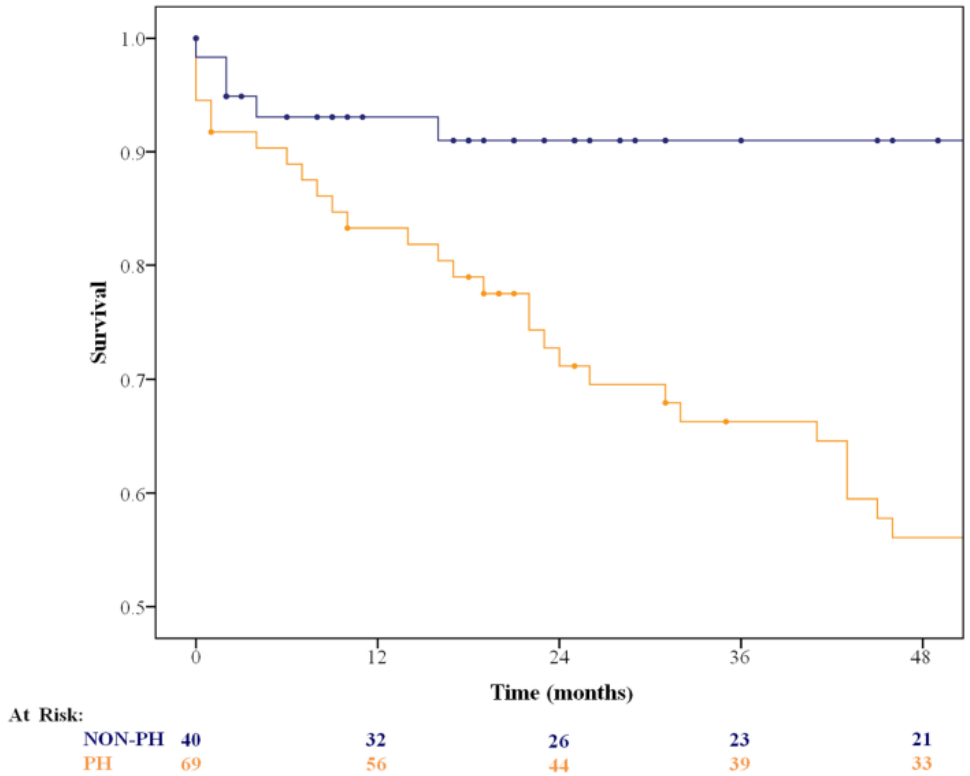


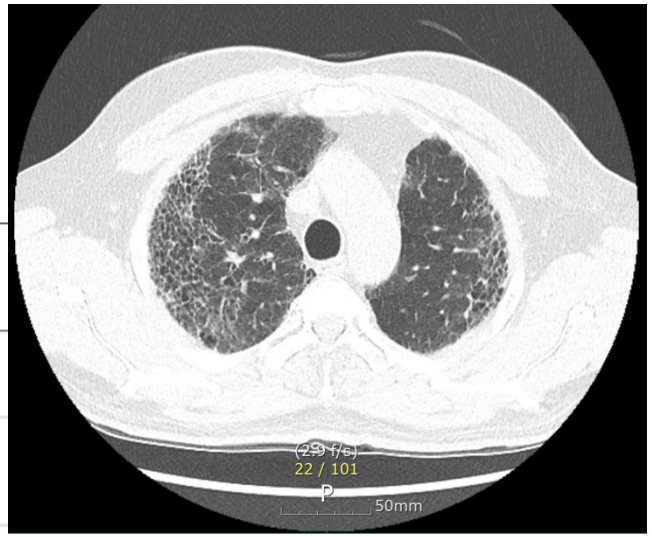
Figure 1. Survival of 133 patients with IPF with and without interceding pulmonary hypertension. Non-PH (blue line), PH (orange line).

Ventilatory efficiency quantified by **VE vs. VCO2 slope** is the most reliable predictor of pulmonary hypertension.

Cardiopulmonary Exercise Testing				
peakVO_2	mL/min	810.4	1161.3	<0.001
		[579.6; 1012.0]	[870.1; 1493.1]	
VO_2@AT	mL/min	631.5	866.78	0.005
		[482.7; 765.4]	[598.41; 989.00]	
VE vs. VCO_2 slope	ratio	48	32	<0.001
		[40; 64]	[30; 37]	

CPET Case 2 : M/72 , Idiopathic pulmonary fibrosis

Spirometry	Pre Ex	Pred	%Pred	Post Ex	%Pre Ex			
FVC (l)	---	3.58	---	---	---			
FEV1 (l)	---	2.73	---	---	---			
MVV (l/min)	---	106	---	---	---			
IC (l)	---	---	---	---	---			
Exercise Testing	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	**Recov+2min**
t (hh:mm:ss)	---	---	00:06:30	---	00:13:00	---	---	00:02:00
Speed (Kmh*10)	---	---	27	---	55	151	36	27
Elevation (%)	---	---	10	---	14	---	---	---
Metabolic Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	**[Hansen]**
VO2 (ml/min)	---	---	1238	---	1765	2011	88	
VO2/Kg (ml/min/Kg)	---	---	15.10	---	21.52	24.53	88	
METS (---)	---	---	4.3	---	6.3	7.0	90	
R (---)	---	---	0.80	---	0.90	---	---	
Ventilatory Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
VE (l/min)	---	---	45.1	---	83.3	109.3	76	
BR (%)	---	---	58	---	23	30.00	77	
VT (l)	---	---	1.583	---	1.848	---	---	
Rf (b/min)	---	---	28.5	---	45.0	50.0	90	
Cardiovascular Response	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
HR (bpm)	---	---	114	---	151	148	102	134
HRres (%)	---	---	22	100	-2	15	-13	---
VO2/HR (ml/bpm)	---	---	10.9	---	12.0	13.6	89	10.1
Qt (l/min)	---	---	9.5	---	11.0	---	---	9.8
SV (ml/beat)	---	---	83	---	73	---	---	73
P Syst (mmHg)	---	---	---	---	---	---	---	---
P Diast (mmHg)	---	---	---	---	---	---	---	---
DP (mmHg/min)	---	---	---	---	---	---	---	---
ST V5 (mm)	---	---	---	---	---	---	---	---
S V5 (mV/sec)	---	---	---	---	---	---	---	---
Gas Exchange	**Rest**	**Warm-up**	**LT**	**RC**	**Peak**	**Pred**	**%Pred**	
PetCO2 (mmHg)	---	---	30	---	26	---	---	
PetO2 (mmHg)	---	---	111	---	119	---	---	
VE/VO2 (---)	---	---	36.4	---	45.8	---	---	
VE/VCO2 (---)	---	---	45.3	---	50.8	---	---	
SpO2 (%)	---	---	---	---	---	---	---	
Other Indexes	**Meas.**	**Pred**						
VE/VCO2 slope	56.6	---						



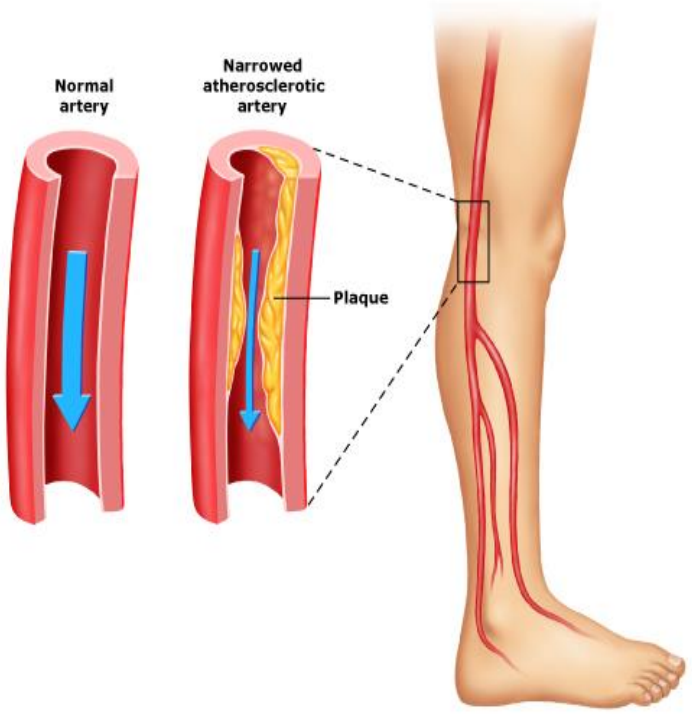
- MIP : 117 cmH2O
- MEP : 86 cmH2O
- PCF : 370 L/min

Comorbidities in COPD : Cardiovascular disease

- Hypertension
- CAOD
- Heart Failure
- Pulmonary hypertension
- **Peripheral vascular disease**
- Cerebrovascular disease

Vascular claudication !

Discomfort, numbness, or tiredness in the legs that occurs during walking or standing and is relieved by rest.



Comorbidities in COPD : Cardiovascular disease

- Hypertension
- CAOD
- Heart Failure
- Pulmonary hypertension
- Peripheral vascular disease
- **Cerebrovascular disease : stroke, TIA**

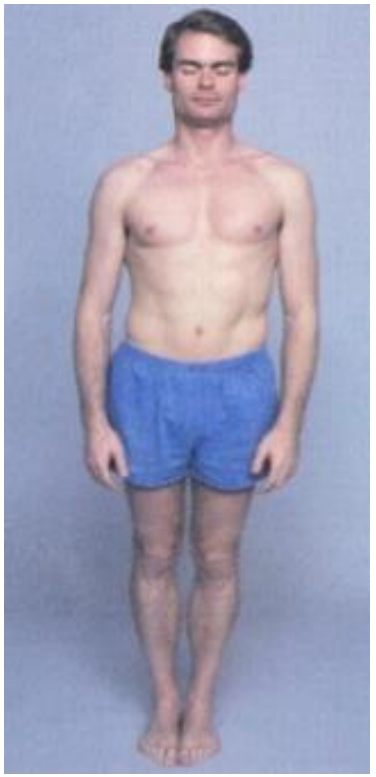
Balance problems !!

Check **Romberg** or **TUG test** at the OPD

Romberg's Test

- Stand feet together
- Eye open -> close for 20-30 sec without support

- + with eye open : cerebellar ataxia
- + with eye close : Impaired proprioception



Who have balance problems or extremely deconditioned ?
Timed up and Go test (TUG) : **14 seconds !!!**

Normative Reference Values by Age

Age Group	Time in Seconds (95% Confidence Interval)	
60 – 69 years	8.1	(7.1 – 9.0)
70 – 79 years	9.2	(8.2 – 10.2)
80 – 99 years	11.3	(10.0 – 12.7)

Cut-off Values Predictive of Falls by

Group	Time in Seconds
Community Dwelling Frail Older Adults	> 14 associated with high fall risk
Post-op hip fracture patients at time of discharge[3]	> 24 predictive of falls within 6 months after hip fracture
Frail older adults	≥ 30 predictive of requiring assistive device for ambulation and being dependent in ADLs

3 meters, regular pace

Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the timed up & go test. Phys Ther. 2000;80:896-903

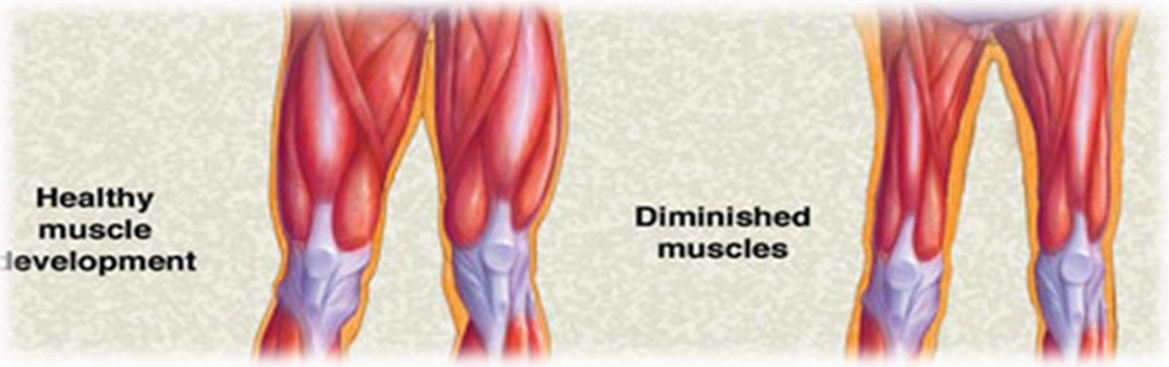
Contents

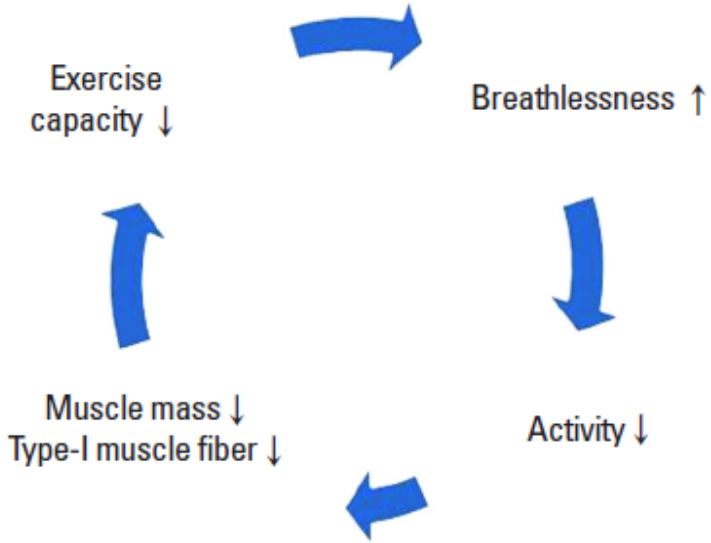
1. Targeted approach : Comorbidities in COPD
   - Cardiovascular
   - **Musculoskeletal : Limb and Respiratory muscle dysfunction**
   - Metabolic : Osteosarcopenia and nutrition

2. Severe dyspnea with Exercise-Induced Desaturation :

   Effect of Oxygen supplementation?

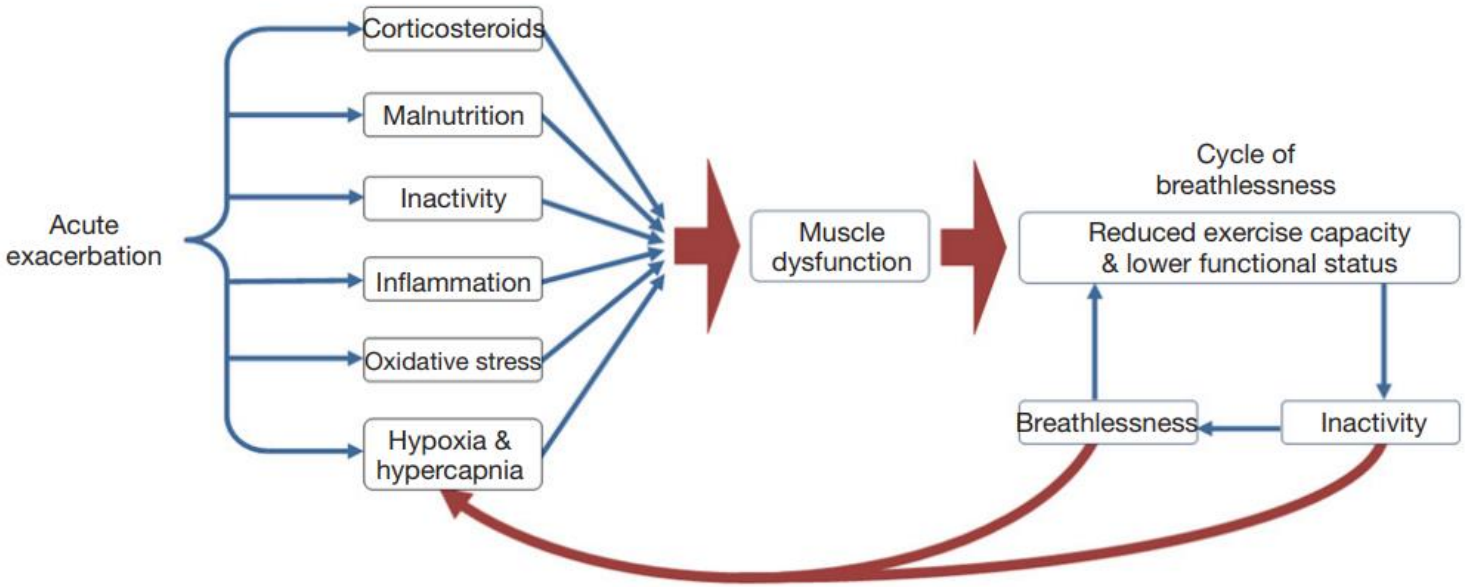
Comorbidities in COPD : Limb muscle dysfunction





Vicious cycle of inactivity in COPD

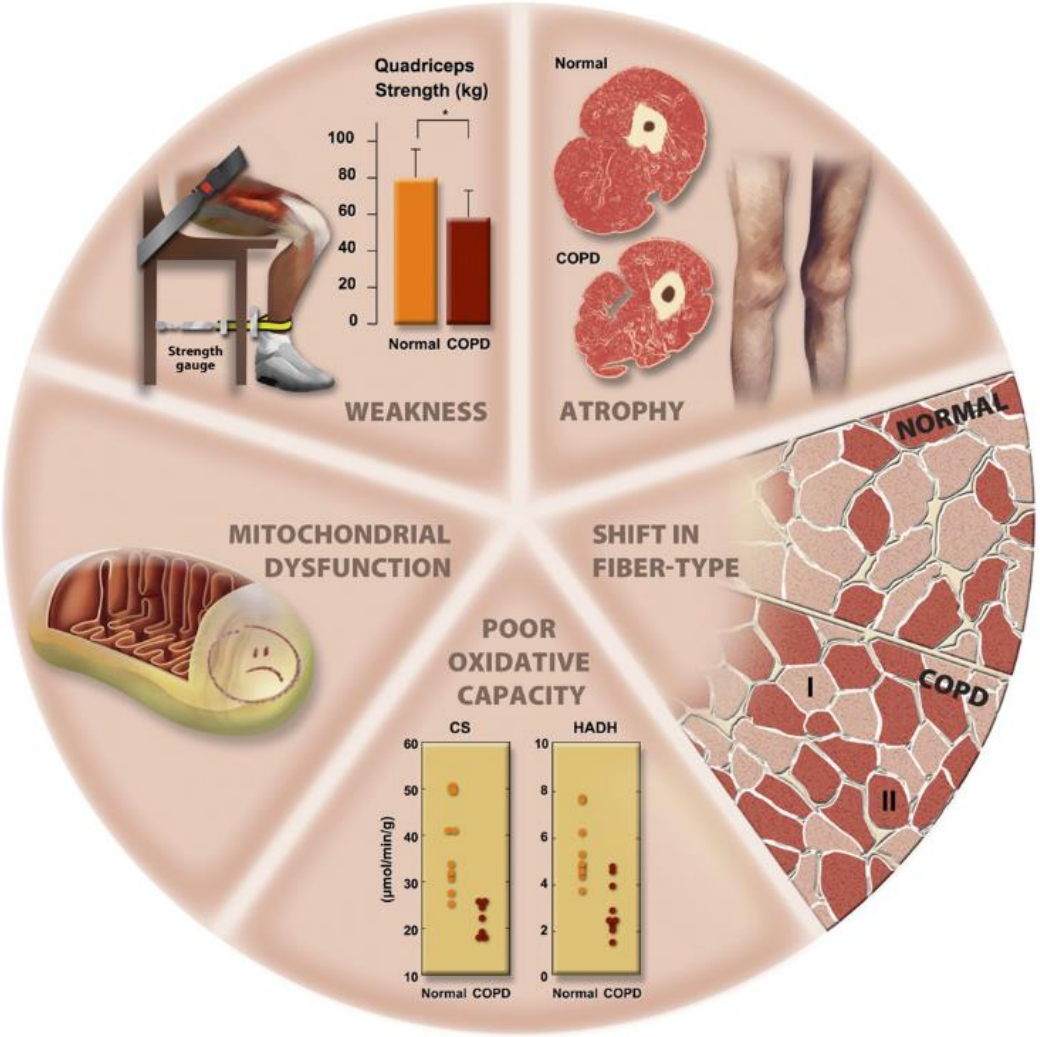
Comorbidities in COPD : Limb muscle dysfunction



Schematic of the impact of acute exacerbations of COPD upon the cycle of breathlessness (adapted from Burtin *et al.*, 2011).

"Pulmonary Rehabilitation in Patients with an Acute Exacerbation of Chronic Obstructive Pulmonary Disease." *Journal of Thoracic Disease* (2018): S1390-S99.

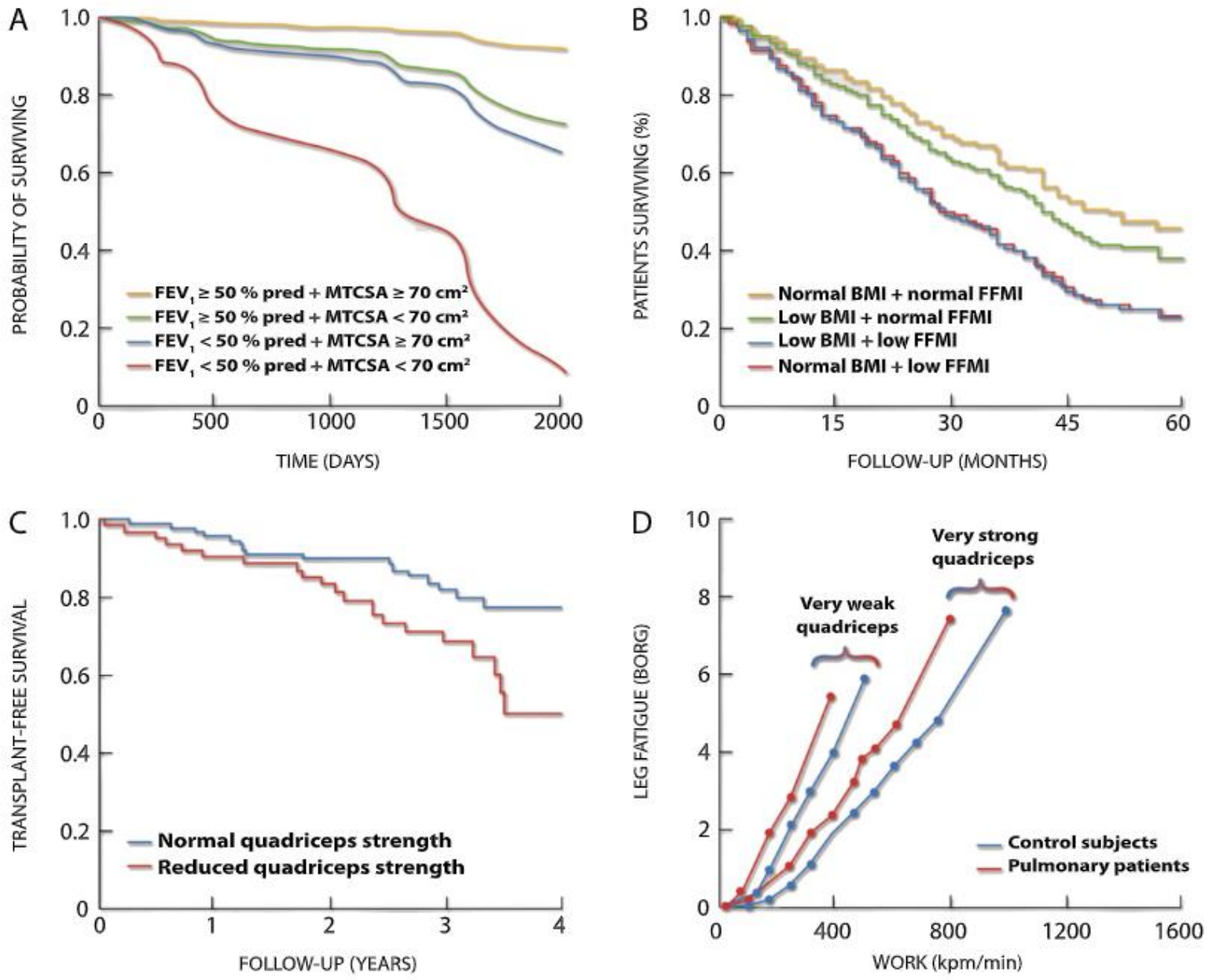
Comorbidities in COPD : Limb muscle dysfunction



Morphological and structural alterations reported in limb muscles in patients with COPD

Characteristics	Type I	Type IIA	Type IIX
Contraction Time	Slow	Fast	Very Fast
Oxidative Capacity	High	High	Low
Diameter	Small	Medium	Large
Resistance to Fatigue	High	Moderate	Small
Generating Force	Small	Moderate	Very High

Maltais, François, et al. "An official American Thoracic Society/European Respiratory Society statement: update on limb muscle dysfunction in chronic obstructive pulmonary disease."



Relationships between muscle mass and strength and clinical outcomes in patients with COPD

Comorbidities in COPD : Limb muscle dysfunction

Treatment	Mass	Strength	Exercise Tolerance	Survival
Exercise	√ (497)	√ (496, 497)	√ (662)	?
Oxygen	?	?	√ (539–541)	√
Nutrition alone	No (663)	No (663)	No (663)	?
Nutrition with exercise training	√ (552, 554, 567)	√ (554, 567)	√ (552, 554, 567)	?
Nutrition with exercise training and anabolic hormone supplementation	√ (558)	√ (558)	√ (558)	?
Testosterone	√ (466)	√ (466)	No (466, 575)	?
Growth hormones	√ (596)	No (596)	No (596)	?
Ghrelin	?	?	?	?
Megestrol	No (630)	?	No (630)	?
Creatine	?	?	No (633–635)	?
Antioxidants	?	?	?	?
Vitamin D alone	?	?	?	?
Vitamin D with exercise training	?	?	?	?

√: Studies support that the treatment has a favorable effect on the outcome; No: studies support that the treatment has no favorable effect on the outcome; ?: there are no supporting data for a treatment effect on the outcome.

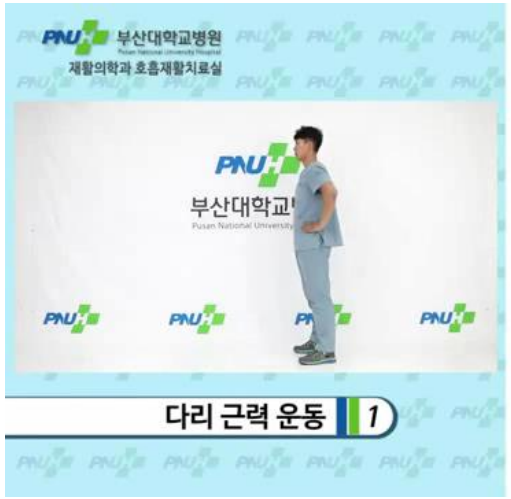
Conclusion

- ✓ Limb muscle dysfunction is a clinically relevant systemic manifestation of COPD.
- ✓ Limb muscle dysfunction influences important clinical outcomes in COPD.
- ✓ Limb muscle dysfunction **can be treated with exercise training**.

Exercise prescription for limb muscle training

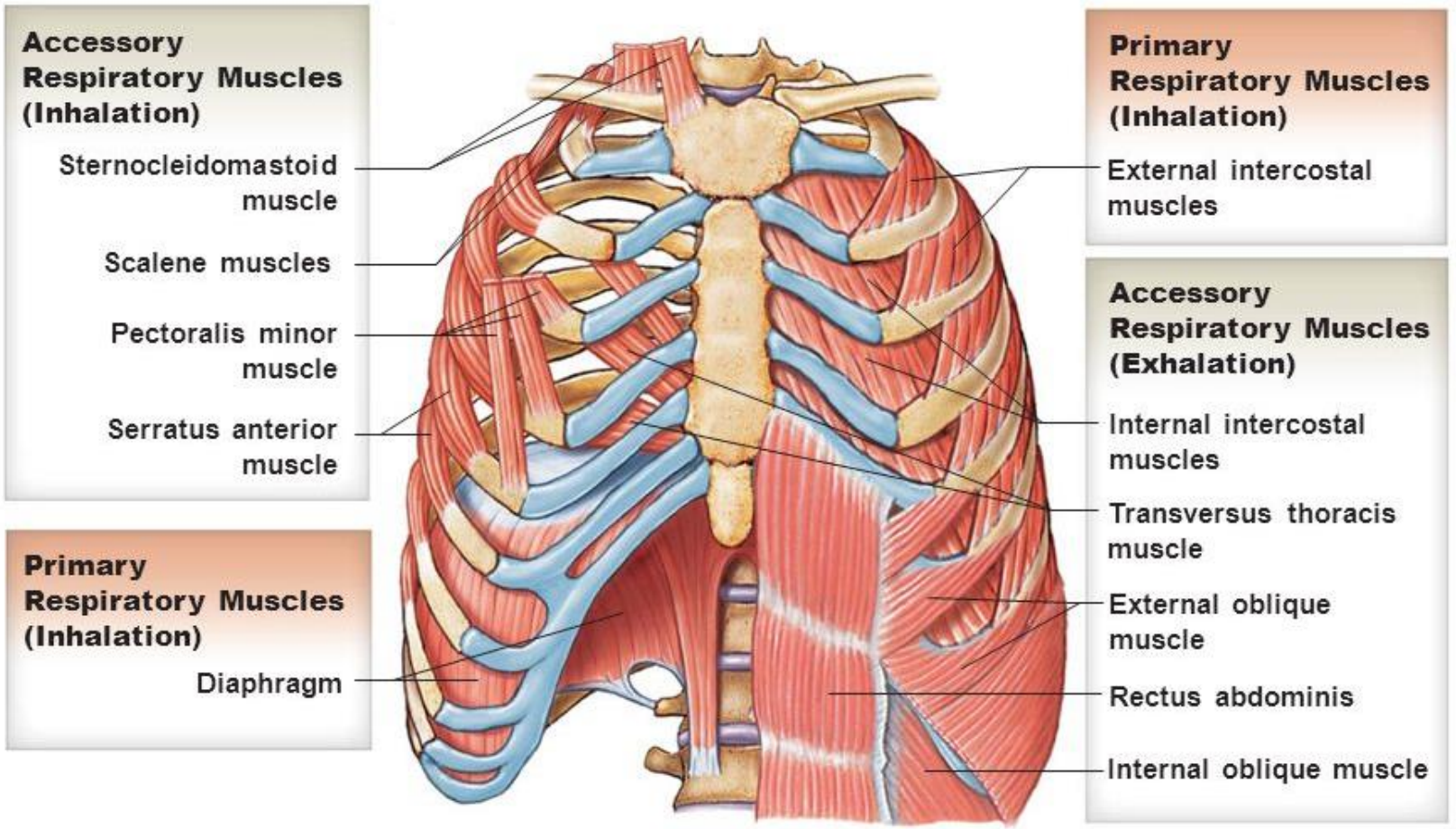
FITT recommendations for patients with COPD

- Frequency : 2-3 day/week
- Intensity : 60-70% of 1 RM(repetition maximum) for beginners,
  Increase the weight if 3 sets can be performed easily
- Time : 2-4 Sets , 8-12 repetitions
- Type : weight machines, dumbbell, Elastic band



American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. Lippincott Williams & Wilkins, 2013.

Comorbidities in COPD : respiratory muscle dysfunction



Comorbidities in COPD : respiratory muscle dysfunction

Table 2

Right Diaphragmatic Excursions and Limit Values in Men and Women*

Variables	Men, cm	Women, cm	p Value
Quiet breathing	1.8 ± 0.3 (1.1–2.5)	1.6 ± 0.3 (1–2.2)	< 0.001
Voluntary sniffing	2.9 ± 0.6 (1.8–4.4)	2.6 ± 0.5 (1.6–3.6)	< 0.001
Deep breathing	7 ± 1.1 (4.7–9.2)	5.7 ± 1 (3.6–7.7)	< 0.001

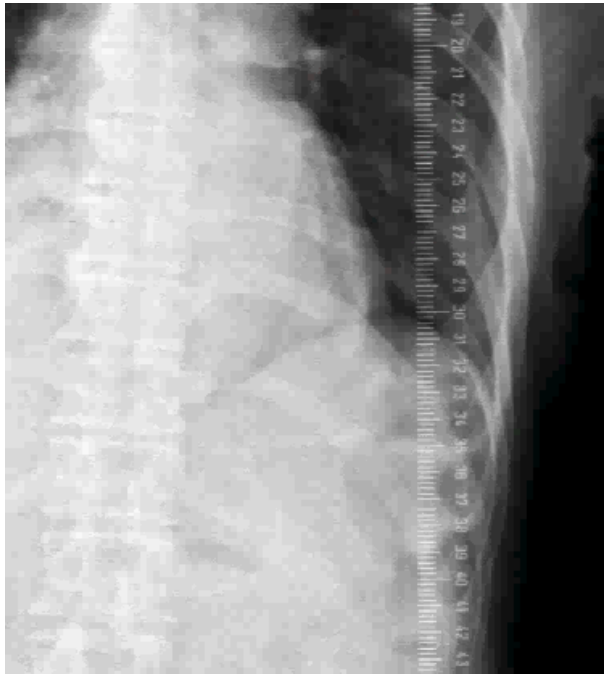
Table 3

Left Diaphragmatic Excursions and Limit Values in Men and Women*

Variables	Men, cm	Women, cm	p Value
Quiet breathing	1.8 ± 0.4 (1–2.6)	1.6 ± 0.4 (0.9–2.4)	0.002
Voluntary sniffing	3.1 ± 0.6 (1.9–4.3)	2.7 ± 0.5 (1.7–3.7)	< 0.001
Deep breathing	7.5 ± 0.9 (5.6–9.3)	6.4 ± 1 (4.3–8.4)	< 0.01

View Table in HTML

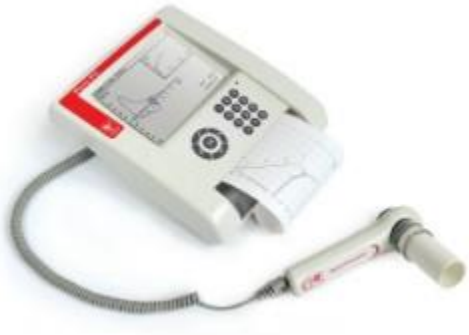
* Data are presented as mean ± SD (5th to 95th percentile).

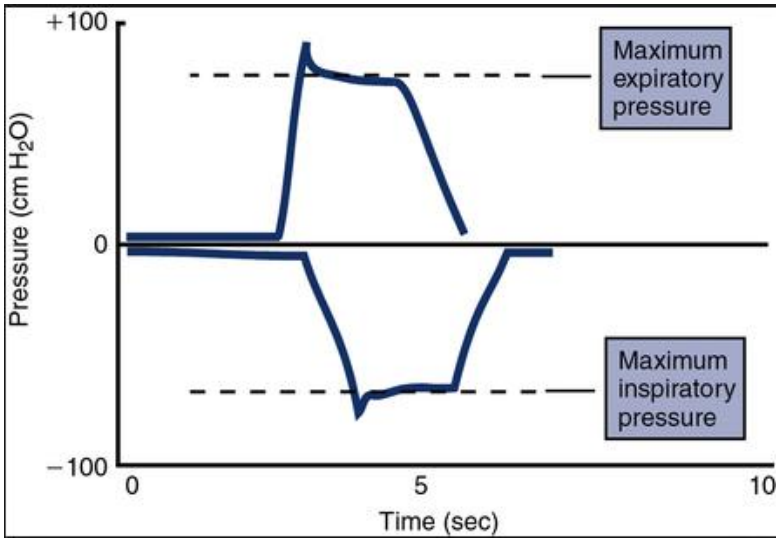


Comorbidities in COPD : respiratory muscle dysfunction

Maximal Inspiratory Pressure and Maximal Expiratory Pressure

- A measure of the strength of respiratory muscles





Comorbidities in COPD : respiratory muscle dysfunction

Maximal inspiratory pressure (MIP) for men and women in different age groups derived from the random-effects model used in the meta-analysis

	Men		Women	
Age group, years	Studies, n/sample size, n	MIP, cmH_2O, mean (95% CI)	Studies, n/sample size, n	MIP, cmH_2O, mean (95% CI)
18–29	6/96	128.0 (116.3–139.5)	6/92	97.0 (88.6–105.4)
30–39	6/69	128.5 (118.3–138.7)	6/66	89.0 (84.5–93.5)
40–49	6/72	117.1 (104.9–129.2)	6/71	92.9 (78.4–107.4)
50–59	5/61	108.1 (98.7–117.6)	5/60	79.7 (74.9–84.9)
60–69	5/65	92.7 (84.6–100.8)	5/66	75.1 (67.3–82.9)
70–83	5/63	76.2 (66.1–86.4)	5/59	65.3 (57.8–72.7)

In the patient with COPD,

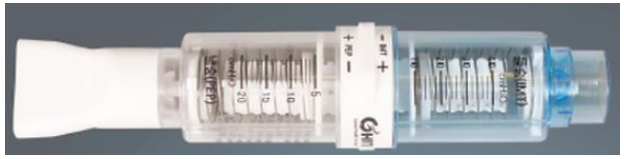
- Lower MIP than healthy person (25.5% lower in male, 29.6% lower in female)

Pessoa, Isabela, et al. "Reference values for maximal inspiratory pressure: a systematic review." Canadian respiratory journal 21.1 (2014): 43-50.
Wijkstra, Peter J., et al. "Peak inspiratory mouth pressure in healthy subjects and in patients with COPD." Chest 107.3 (1995): 652-656.

Comorbidities in COPD : respiratory muscle dysfunction

Threshold PEP

Power Breathe



IMT-PEP

Threshold IMT

Power Breathe

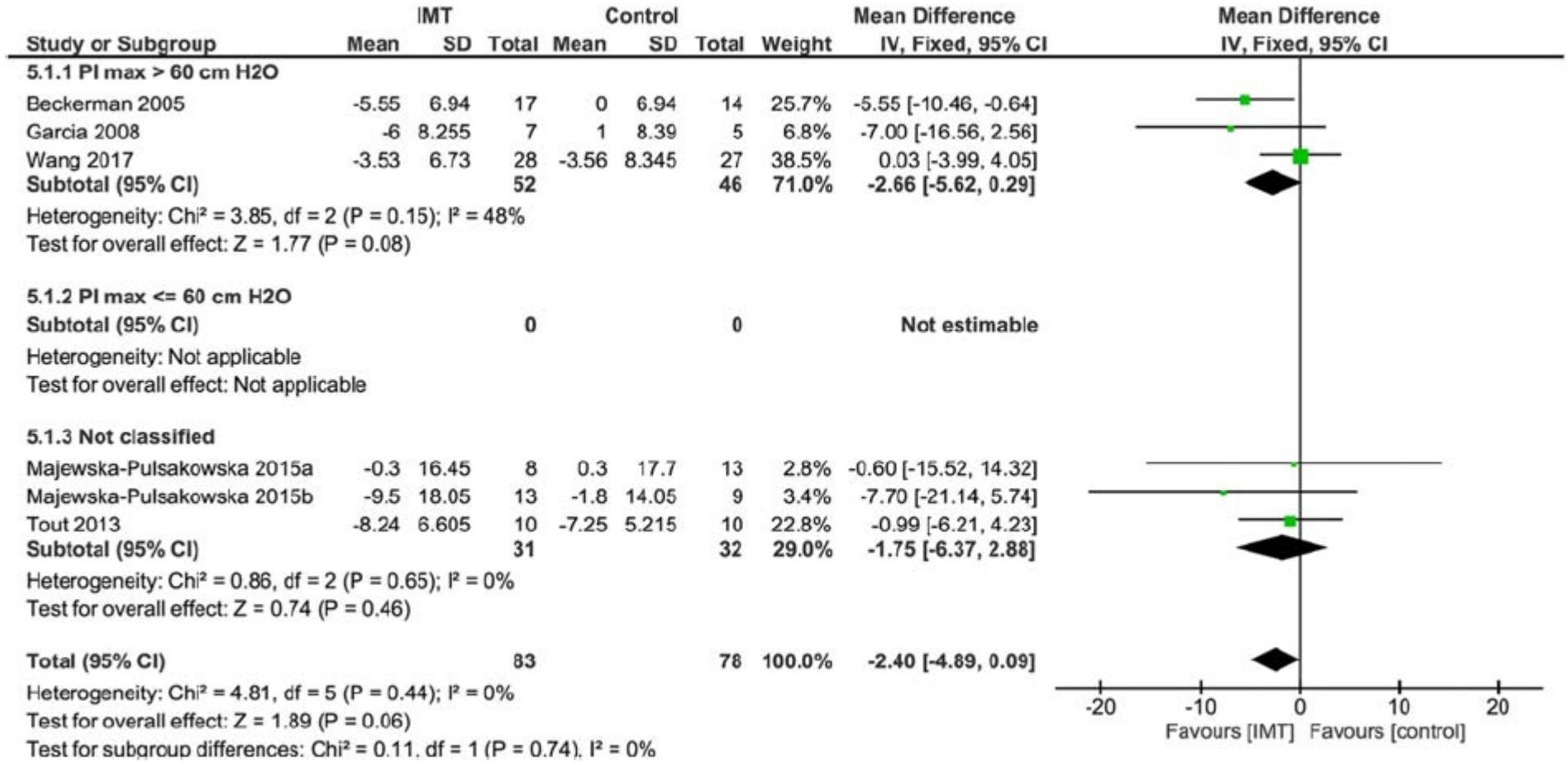
Breather

Respiratory muscle exercise devices
: Threshold IMT(Inspiratory Muscle Trainer)

흡기근 훈련기 실제 적용

1. 처음은 환자가 도구에 적응하기 쉽게 마우스피스만 먼저 불어봅니다.
2. 적응이 되면 본체와 마우스피스 연결 후 저항값을 설정합니다.
3. 목적에 따라 운동을 실시합니다.
4. 1회 호흡 시간은 환자의 상태에 따라 조정합니다.

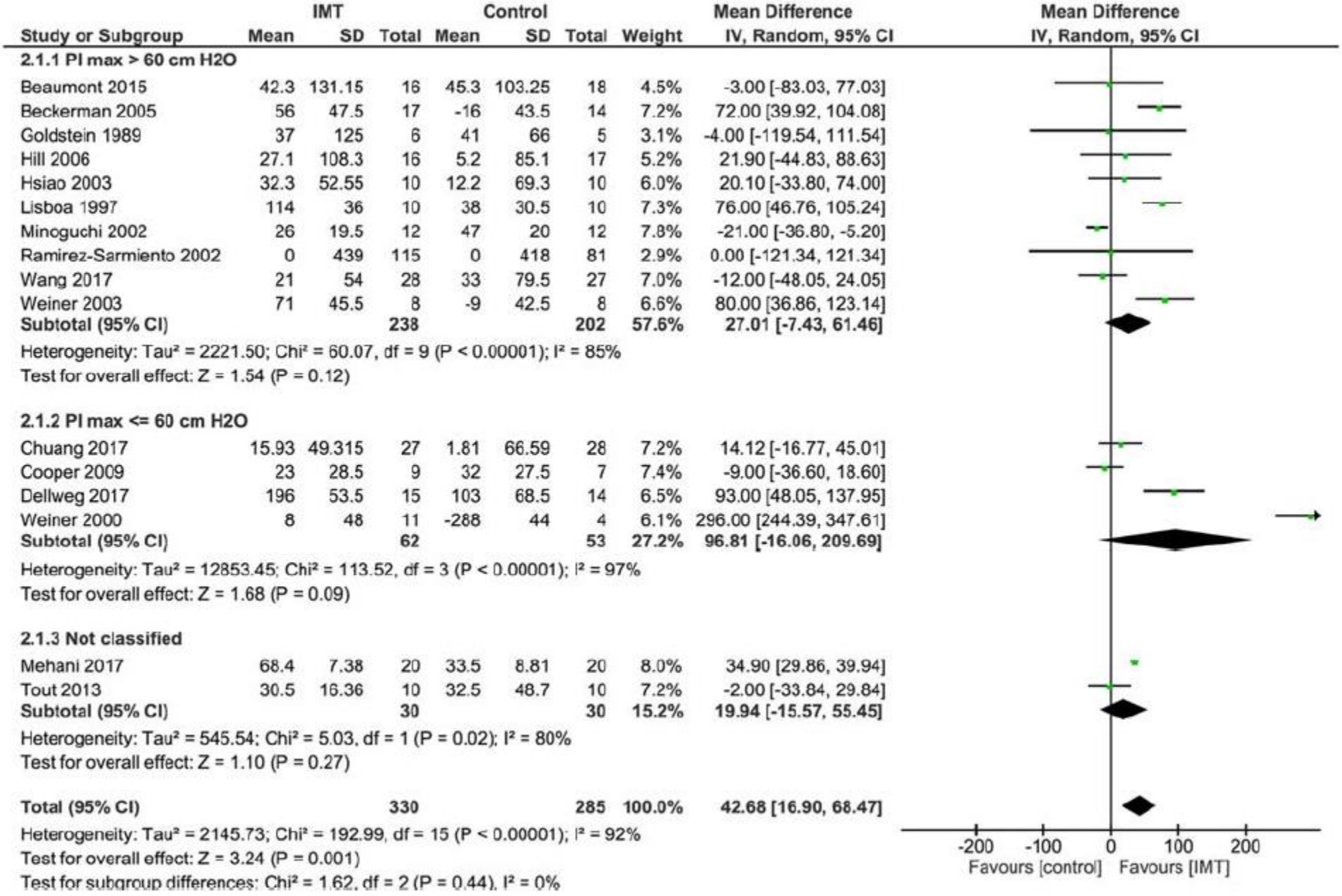
※ 강도 설정은 최대흡기압력(MIP)의 30~40% 강도를 추천합니다.



Study or Subgroup	IMT Mean	IMT SD	IMT Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
5.1.1 PI max > 60 cm H2O								
Beckerman 2005	-5.55	6.94	17	0	6.94	14	25.7%	-5.55 [-10.46, -0.64]
Garcia 2008	-6	8.255	7	1	8.39	5	6.8%	-7.00 [-16.56, 2.56]
Wang 2017	-3.53	6.73	28	-3.56	8.345	27	38.5%	0.03 [-3.99, 4.05]
Subtotal (95% CI)			**52**			**46**	**71.0%**	**-2.66 [-5.62, 0.29]**
Heterogeneity: Chi² = 3.85, df = 2 (P = 0.15); I² = 48%								
Test for overall effect: Z = 1.77 (P = 0.08)								
5.1.2 PI max <= 60 cm H2O								
Subtotal (95% CI)			**0**			**0**		**Not estimable**
Heterogeneity: Not applicable								
Test for overall effect: Not applicable								
5.1.3 Not classified								
Majewska-Pulsakowska 2015a	-0.3	16.45	8	0.3	17.7	13	2.8%	-0.60 [-15.52, 14.32]
Majewska-Pulsakowska 2015b	-9.5	18.05	13	-1.8	14.05	9	3.4%	-7.70 [-21.14, 5.74]
Tout 2013	-8.24	6.605	10	-7.25	5.215	10	22.8%	-0.99 [-6.21, 4.23]
Subtotal (95% CI)			**31**			**32**	**29.0%**	**-1.75 [-6.37, 2.88]**
Heterogeneity: Chi² = 0.86, df = 2 (P = 0.65); I² = 0%								
Test for overall effect: Z = 0.74 (P = 0.46)								
Total (95% CI)			**83**			**78**	**100.0%**	**-2.40 [-4.89, 0.09]**
Heterogeneity: Chi² = 4.81, df = 5 (P = 0.44); I² = 0%								
Test for overall effect: Z = 1.89 (P = 0.06)								
Test for subgroup differences: Chi² = 0.11, df = 1 (P = 0.74), I² = 0%								

Effects of inspiratory muscle training on quality of life (SGRQ)

Beaumont, Marc, et al. "Effects of inspiratory muscle training in COPD patients: A systematic review and meta-analysis." The clinical respiratory journal 12.7 (2018): 2178-2188.



Effects of inspiratory muscle training on exercise capacity (6MWD)

Exercise prescription for respiratory muscle training

- **Conclusions and clinical implications**
  - ✓ Respiratory muscles also undergo adaptation in response to stimuli overload during exercise.
  - ✓ a training frequency of **1–2 times per day** for a total amount of **30 minutes**, with a frequency of **3–5 days per week** for a duration of **6 weeks** has been suggested
  - ✓ training loads that **exceed 30% of MIP** with a repetition duration dependent upon the load (**2-minutes** of breathing followed by **1 minute** of rest)
  - ✓ **IMT is slightly superior** to EMT (reduction in dyspnea)

Crisafulli, Ernesto, et al. "Respiratory muscles training in COPD patients." *International Journal of Chronic Obstructive Pulmonary Disease* 2.1 (2007): 19.

Contents

1. Targeted approach : Comorbidities in COPD
   - Cardiovascular
   - Musculoskeletal : Limb and Respiratory muscle dysfunction
   - **Metabolic : Osteosarcopenia and nutrition**

2. Severe dyspnea with Exercise-Induced Desaturation :

   Effect of Oxygen supplementation?

ICD-10-CM Code (M62.84) for Sarcopenia Announced

Effective October 01, 2016, the code M62.84 will be used by the healthcare community for sarcopenia, thus recognizing it as a distinctly reportable condition. The AIM (Aging in Motion Coalition) announced this ICD-10-C code, as established by the CDC (Centers for Disease Control and Prevention.

Comorbidities in COPD : Metabolic

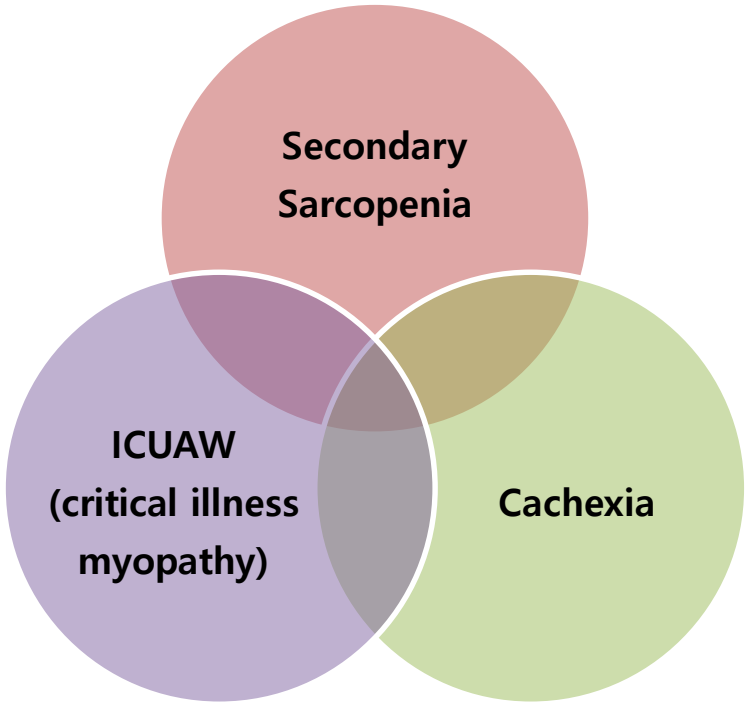
- Sarcopenia : progressive loss of muscle mass and strength with a risk of adverse outcomes such as disability, poor quality of life and death.
- Cachexia : a multifactorial syndrome characterized by severe body weight, fat and muscle loss due to an underlying illness.

	Sarcopenia	Cachexia
Definition	Muscle mass <2SD of young healthy population, decreased muscle function	Weight loss >5% in 6 months
Mechanism	Aging	Pathologic
Comorbid condition	+/−	+++
Functional limitation	++	+++
Inflammation	−	++
Fat mass	Increased	Decreased
Protein degradation	−/+	+++
Resting Energy Expenditure	Decreased	Increased
Anorexia	+	++

Ali, Sumbul, and Jose M. Garcia. "Sarcopenia, cachexia and aging: diagnosis, mechanisms and therapeutic options-a mini-review." Gerontology 60.4 (2014): 294-305.

Comorbidities in COPD : Metabolic

- **ICU-Acquired Weakness after AECOPD**
  - **Critical illness myopathy and/or polyneuropathy**
- Primary sarcopenia due to aging process
- **Secondary sarcopenia due to one or more other cause (COPD)**
- **Cachexia** due to chronic illness



Muscle dysfunction in COPD

Comorbidities in COPD : Metabolic

- **Osteosarcopenia : Osteopenia + Sarcopenia**

- Prevalance of osteosarcopenia in community dwelling older people : 10~15%
- Prevalence of sarcopenia in stable COPD : 15 to 25%

	Muscle strength	Muscle quan-tity/quality	Physical per-formance
Probable sarcopenia	↓		
Sarcopenia	↓	↓	
Severe sarcopenia	↓	↓	↓

	Muscle mass	Muscle strength	Physical performance
EWGSOP2	ASM/ht$^{2a)}$ <7.0 kg/m^2 in men <6.0 kg/m^2 in women	Grip strength <27 kg in men <16 kg in women	SPPB ≤8 Gait speed ≤0.8 m/sec TUG ≥20 sec 400 m walk test ≥6 min for completion or non-completion

- **Grip Strength**
- Inbody or DEXA
- **6MWT or TUG**

ORIGINAL ARTICLE

Vitamin D to prevent exacerbations of COPD: systematic review and meta-analysis of individual participant data from randomised controlled trials

David A Jolliffe,[1] Lauren Greenberg,[1] Richard L Hooper,[1] Carolien Mathyssen,[2] Rachida Rafiq,[3] Renate T de Jongh,[3] Carlos A Camargo,[4] Christopher J Griffiths,[1,5] Wim Janssens,[2] Adrian R Martineau[1,5]

Conclusions

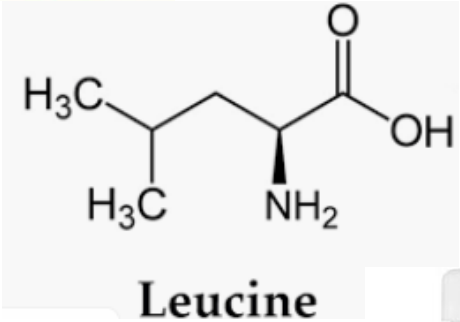
- **no overall effect of vitamin D** supplementation on the rate of moderate or severe COPD exacerbations.
- However, subgroup analysis revealed **clinically and statistically significant protective effects of vitamin D** supplementation among patients with baseline circulating 25(OH)D concentrations of less than 25nmol/L.
- Check vit D level routinely and offering supplementation who needs!

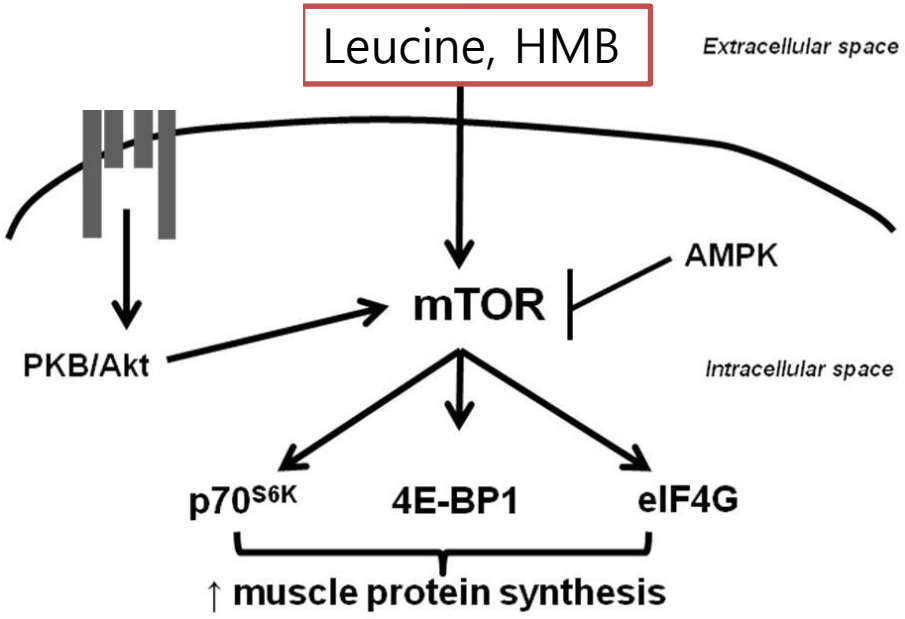
*Jolliffe, David A., et al. "Vitamin D to prevent exacerbations of COPD: systematic review and meta-analysis of individual participant data from randomised controlled trials." **Thorax 74.4 (2019):** 337-345.*

Comorbidities in COPD : Nutrition

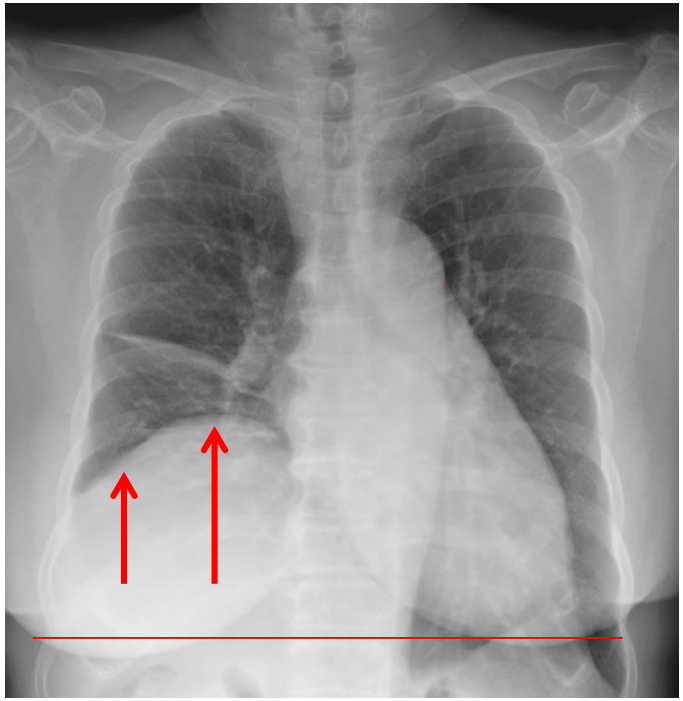
Q. 뭘 먹으면 좋나요?

A. 단백질이 중요합니다. 한 끼에 적어도 30g의 단백질을 섭취해야 하고 두부 반모, 삼겹살 0.9인분 오징어 반마리, 달걀 5개에 해당합니다. 영양보조제로는 류신이 많이 함유된 제품을 드시면 근육 강화에 도움이 됩니다.





Case Review : F/74



- Diagnosis

r/o COPD (FEV1 57%), Diaphragmatic eventration, right

- 6MWT : 378meters (76%) with exercise induced desaturation (O2 nadir 88%)
- Peak Cough Flow : 225 L/min
- **MIP : 36 cmH2O (68%)**
- MEP : 70 cmH2O
- Grip test (Rt./Lt.) : 29 /23kg (>18)
- Muscle mass : 7.58 (> 5.14 appendicular skeletal muscle mass/Ht^2)

Fluoroscopic diaphragm movement test	**Right (cm)**	**Left (cm)**
supine (rest/forced)	<0.5/<0.5	4.0/5.0

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2. **Severe dyspnea with Exercise-Induced Desaturation :**

   Effect of Oxygen supplementation?

Effect of Oxygen supplementation

Prescription of long term O2 for stable COPD patients

PaO2 < 55mmHg or SaO2 < 88%

Or

60 > PaO2 >55mmHg with pul. HTN or CHF, polycythemia (Hct >55%)

Prescribe supplemental oxygen and titrate to keep **SaO2 ≥ 90%**

Recheck in 60 to 90 days to assess :

If oxygen is still indicated

If prescribed supplemental oxygen is effective

2019 GOLD COPD guideline

Effect of Oxygen supplementation

Treatment of hypoxemia

- In patients with severe resting hypoxemia long-term oxygen therapy is indicated **(Evidence A)**.
- In patients with stable COPD and resting or exercise-induced moderate desaturation, long term oxygen treatment should not be routinely prescribed. However, individual patient factors may be considered when evaluating the patient's needs for supplemental oxygen **(Evidence A)**.

2017 GOLD COPD guideline

OXYGEN THERAPY

- The long-term administration of oxygen increases survival in patients with severe chronic resting arterial hypoxemia **(Evidence A)**.
- In patients with stable COPD and moderate resting or exercise-induced arterial desaturation, prescription of long-term oxygen does not lengthen time to death or first hospitalization or provide sustained benefit in health status, lung function and 6-minute walk distance **(Evidence A)**. ??
- Resting oxygenation at sea level does not exclude the development of severe hypoxemia when traveling by air **(Evidence C)**.

2019 GOLD COPD guideline

Effect of Oxygen supplementation

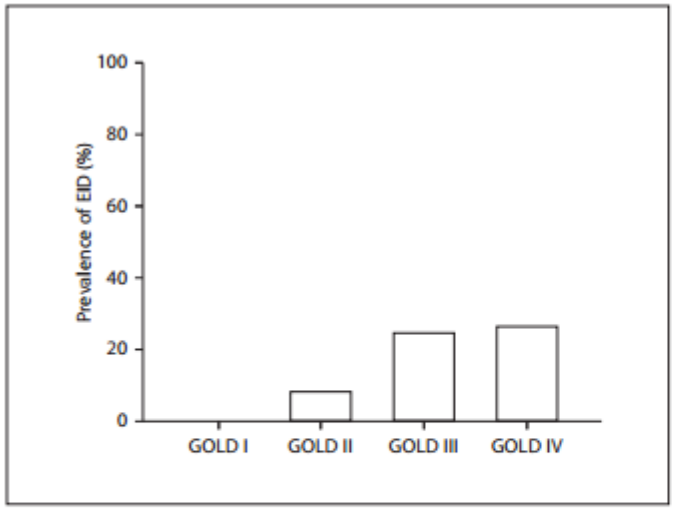
Prevalence and Prediction of Exercise-Induced Oxygen Desaturation in Patients with Chronic Obstructive Pulmonary Disease

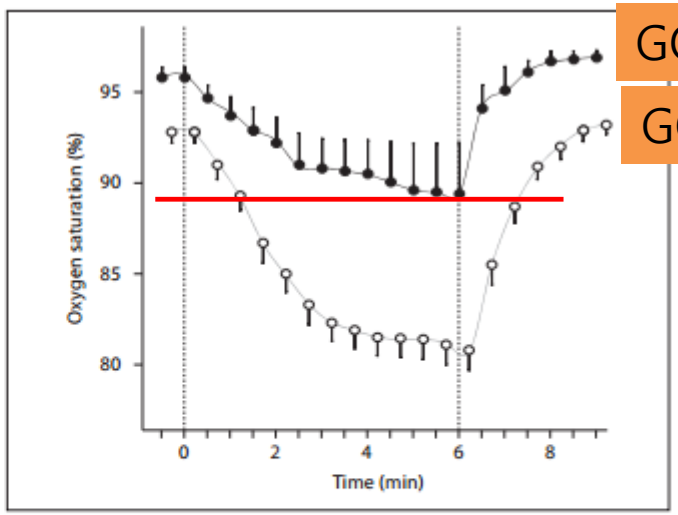
A.J.R. van Gestel[a–c] C.F. Clarenbach[a] A.C. Stöwhas[a] S. Teschler[c] E.W. Russi[a]
H. Teschler[c] M. Kohler[a]

- Stable COPD의 경우 보통 휴식 시 Normoxemia
- Exercise-induced desaturation (EID) :
  - drop in SpO2 <90% or 88%
- **FEV1, DLCO, resting SpO2** 중 예측인자는??

Respiration 2012;84:353–359

Effect of Oxygen supplementation





GOLD I,II

GOLD III,IV

Fig. 1. Prevalence of EID during the 6MWT in patients with COPD grouped according to GOLD stages: GOLD IV 27.9%, GOLD III 26.6%, GOLD II 7.1% and GOLD I 0%.

- **FEV1 이 EID의 유일한 예측인자!**
- **FEV1 이 50%미만일 경우 운동 중 저산소증의 발생가능성은 50%**

Respiration 2012;84:353–359

ELSEVIER

Chest

Volume 151, Issue 4, April 2017, Pages 795-803

Original Research: COPD

Short-term Effects of Supplemental Oxygen on 6-Min Walk Test Outcomes in Patients With COPD: A Randomized, Placebo-Controlled, Single-blind, Crossover Trial

- 124 patients with COPD
  - 34 patients with resting hypoxemia (HYX)
  - 43 patients with exercise-induced hypoxemia (EIH)
  - 31 patients with normoxemia (NOX).
- via standard nasal prongs (2 L/min)
- patients with HYX and EIH generally benefit from supplemental oxygen by **increasing exercise capacity**. However, less than one-half of patients reached the threshold of clinically relevant improvements(≥ 30 meters)

EUROPEAN RESPIRATORY *journal*

FLAGSHIP SCIENTIFIC JOURNAL OF ERS

Oxygen compared to air during exercise training in COPD with exercise-induced desaturation

Jennifer A. Alison, Zoe J. McKeough, Regina W.M. Leung, Anne E. Holland, Kylie Hill, Norman R. Morris, Sue Jenkins, Lissa M. Spencer, Catherine J. Hill, Annemarie L. Lee, Helen Seale, Nola Cecins, Christine F. McDonald

European Respiratory Journal 2019; **DOI:** 10.1183/13993003.02429-2018

- People with COPD who demonstrated oxygen desaturation <90% : 111 participants
- Multi center randomization
- Oxygen group vs. room air group (5L/min)
- Exercise for 8 weeks
- Endurance shuttle walk test, CRQ-total score

- **Exercise capacity and health-related quality of life improved in both groups, with no greater benefit from training with supplemental oxygen than medical air**

Alison, Jennifer A., et al. "Oxygen compared to air during exercise training in COPD with exercise-induced desaturation." European Respiratory Journal (2019): 1802429.

Figure 7.5 Pulmonary rehabilitation program modifications for patients with interstitial lung disease

Exercise Assessment

- CPET when possible
- 6-minute walk or shuttle walk test

Assessment of Oxygen Requirements

- Resting arterial blood gas
- Exercise oximetry: test at highest intensity level to be performed using the patient's own portable system

Exercise Training

- Strength and endurance training of the upper and lower extremities
- Strong focus on pacing and energy conservation techniques
  - High F_IO_2 may be required during exercise training

Age-appropriate Patient and Family Education Topics

- Nature and expected course of disease
- Physiological basis of symptoms and exercise limitation (emphasize that cough is not a contagious condition)
- Expected benefits versus potential adverse effects of medical therapy
- Rationale for and proper use of supplemental oxygen
- Pulmonary drainage techniques (especially for persons with bronchiectasis)
- Recognition of symptoms and signs of secondary infection
- Prevention strategies: influenza and pneumococcal vaccines
- Community resources
- Advance directives
- Coping techniques for assistance in managing anxiety and depression
- Training in options for and outcomes of mechanical ventilation

Nutrition Evaluation and Counseling

- Prevention of muscle or weight loss
- Use of disease-appropriate health-status outcomes measurement tools

Ries, Andrew L., et al. "Pulmonary rehabilitation: joint ACCP/AACVPR evidence-based clinical practice guidelines." Chest 131.5 (2007): 4S-42S.

Effect of Oxygen supplementation

- **치료실에서의 산소공급 방법**

	O2 tank	가정용 산소발생기	휴대용 산소발생기
장점	✓강하고 정확한 유량	✓중간 정도 강한 유량 ✓충전이 필요 없음	✓휴대 쉬움
단점	✓이동 시 불편함 ✓산소충전필요	✓이동 시 불편 ✓전원 공급 필요 ✓실제유량보다 약함 (1-5L/min)	✓비연속형 저유량 공급 ✓배터리 충전 필요 ✓실제유량보다 약함 (1-3L/min)
적응증	✓강한 산소공급 필요한 중증환자 ✓Reserve bag mask 사용시 (5L/min이상)	✓Home Ex. program	✓Home Ex. program ✓활동적인 운동 시 ✓중증 환자 외출 시
			

Original Paper

Chronic Respiratory Disease

What prevents people with chronic obstructive pulmonary disease from attending pulmonary rehabilitation? A systematic review

Chronic Respiratory Disease
8(2) 89–99

DOI: 10.1177/1479972310393756
crd.sagepub.com
SAGE

Barriers to uptake

- **Travel and transport**
- **Lack of perceived benefit of PR**

Barriers to completion

- **A current smoker**
- **Depression**

A positive approach by doctors and social support could increase the level of adherence to PR !

Clinical tips

- **Low Adherence**
  1. Perceived benefit of PR (**Check MIP and MEP and grip strength**)
  2. Set a specific training time of the day (while watching TV)
  3. Use a variety of educational materials (**Leaflet, video clip**, exercise diary)
  4. Use fitness video game device

kel5504@gmail.com