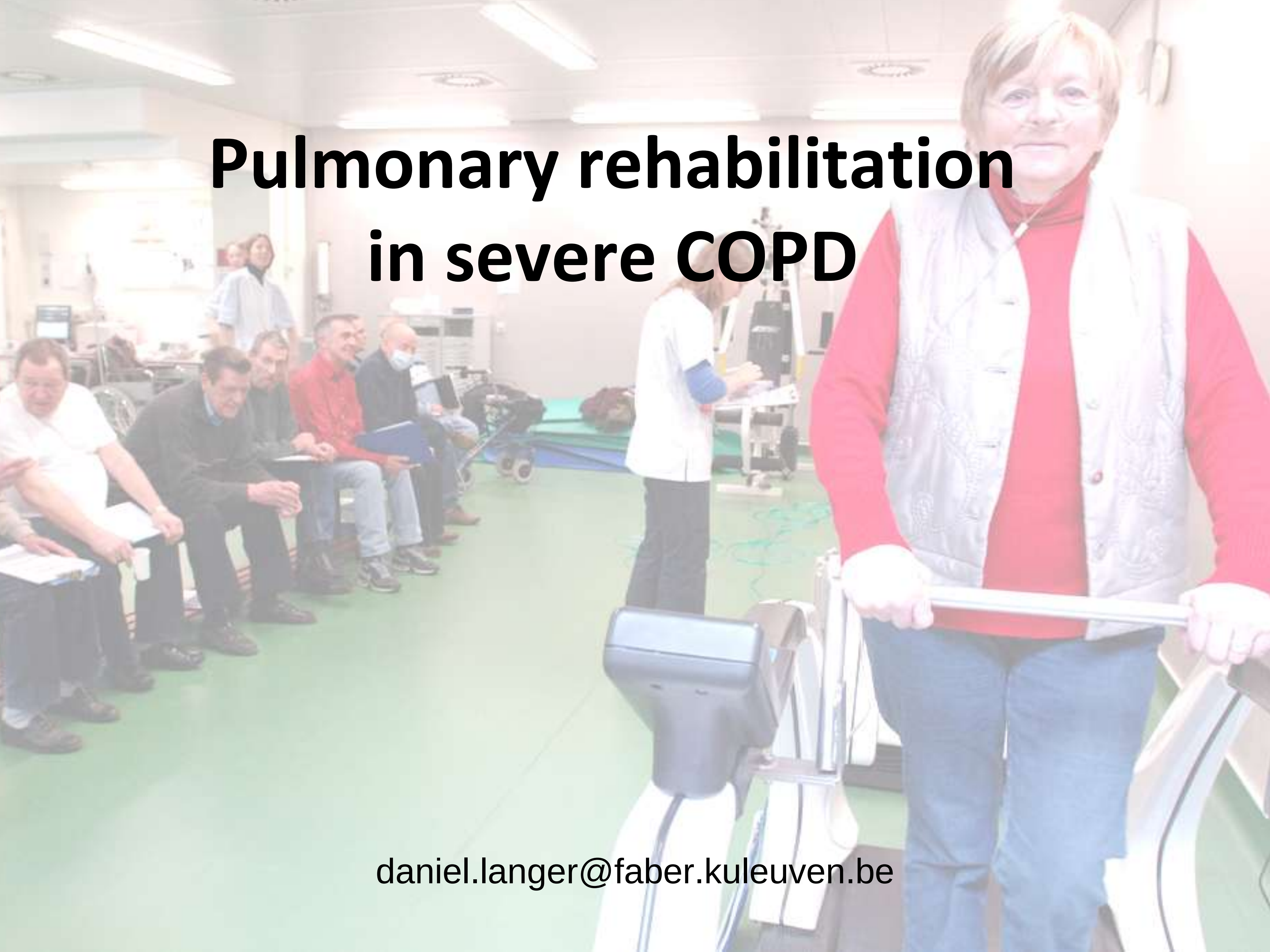


Pulmonary rehabilitation in severe COPD

daniel.langer@faber.kuleuven.be

Content

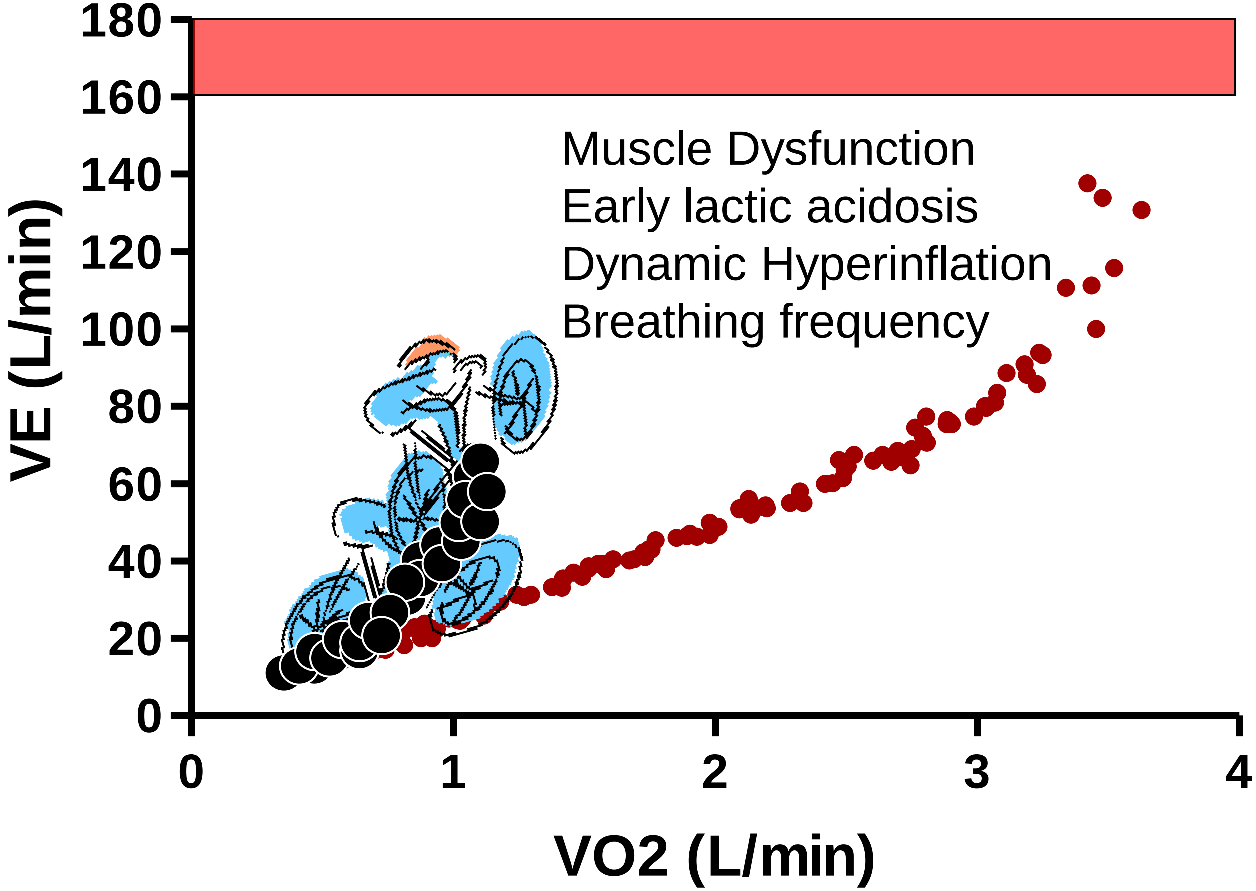
- Rehabilitation (how) does it work ?
- How to train the ventilatory limited patient ?

Chronic Obstructive Pulmonary Disease

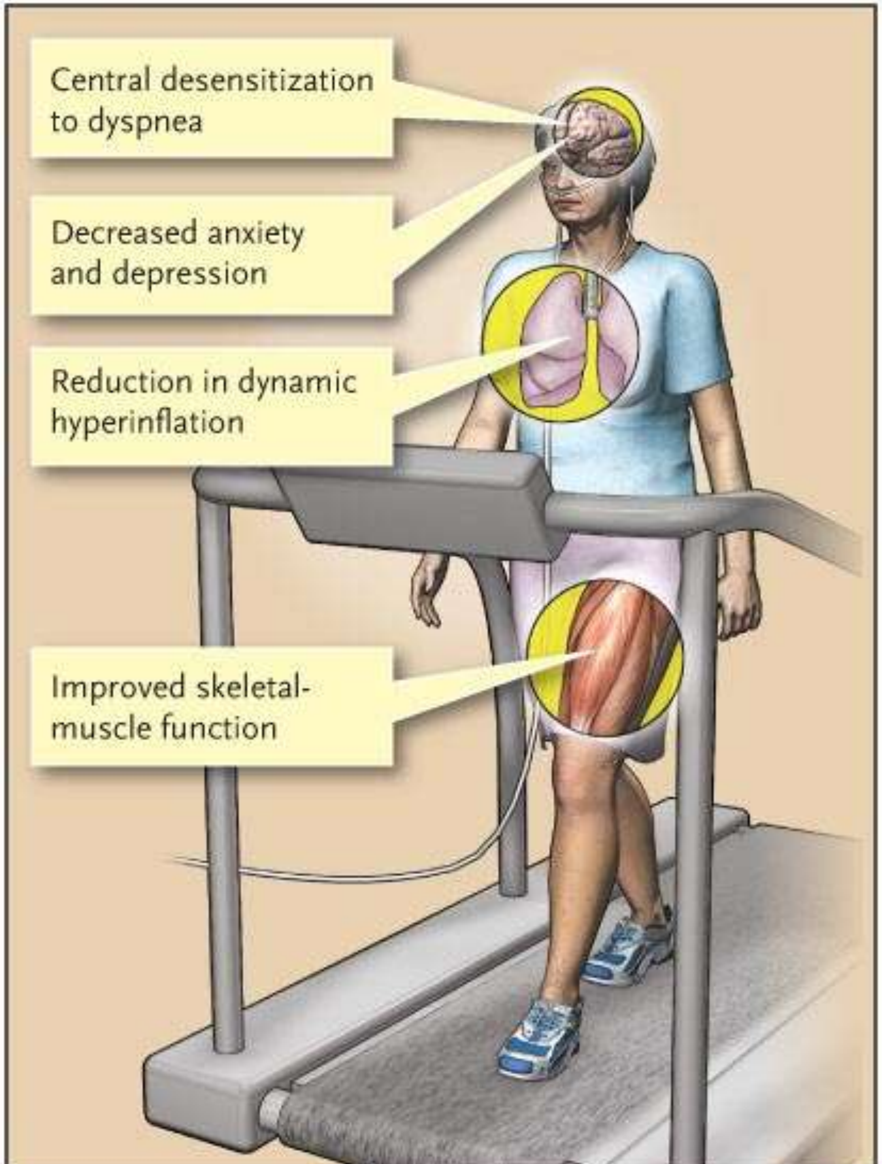
NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Definition:

- Chronic obstructive pulmonary disease is characterized by airflow limitation that is not fully reversible.
- It is a preventable and treatable disease with some significant extrapulmonary manifestations.
    - Skeletal muscle dysfunction
    - Weight loss
    - Cardiovascular disease
    - Depression and Fatigue
    - Osteoporosis

Interaction between pulmonary and extrapulmonary factors



Targets of Exercise Training



- **Improving aerobic function of ambulation muscles**
- **Reducing ventilatory requirement and respiratory rate during exercise**
- **Prolonging expiration time**
- **Reducing dynamic hyperinflation and dyspnea**

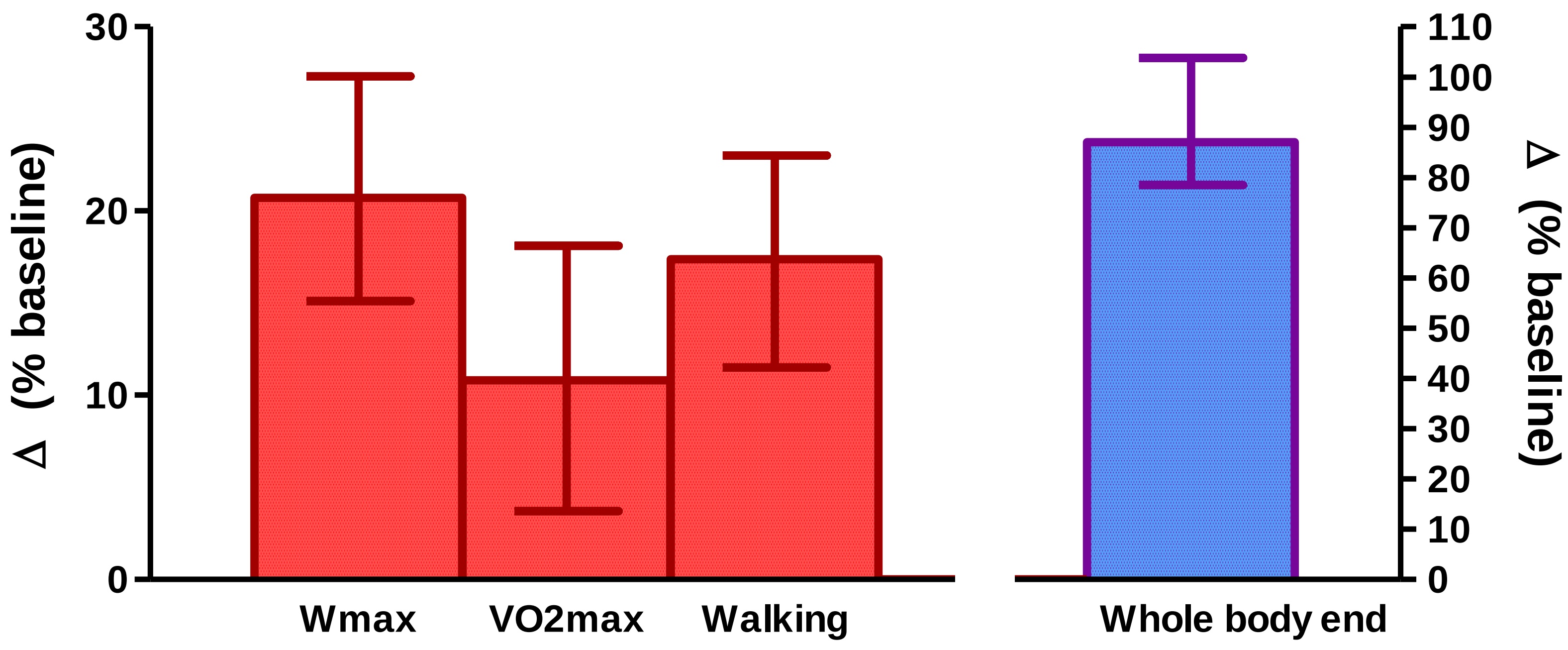
Casaburi et al. N Engl J Med 2009

Content Rehabilitation Program

- **Exercise Training**
  - **Endurance exercise to improve cardiorespiratory fitness**
  - **Resistance training to improve muscular strength and endurance (peripheral and respiratory muscles)**
- **Supplemental interventions during exercise training**
  - **Oxygen**
  - **Heliox**
- **Breathing exercises**
- **Occupational therapy**
- **Nutritional advise**
- **Psychological support**
- **Patient-education / self-management (inactivity)**

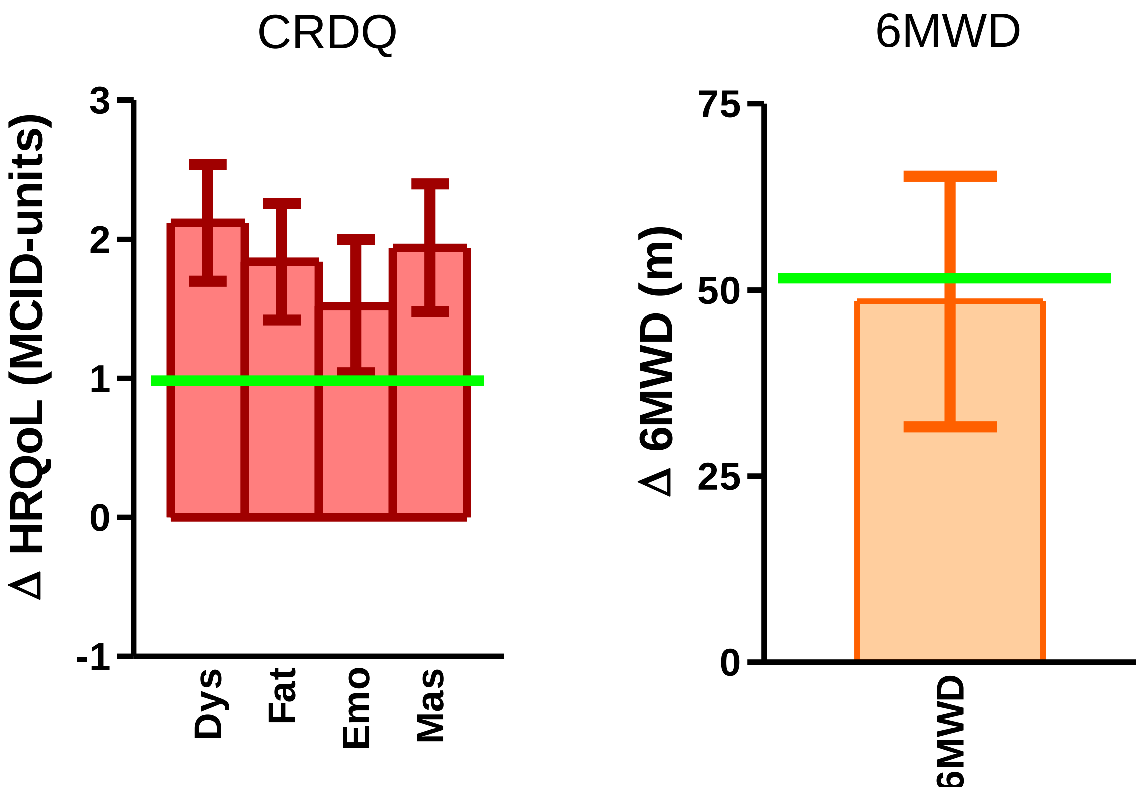
Rehabilitation, the evidence: Exercise tolerance

Exercise tolerance: Weighted mean difference and IQR



Adapted fromTroosters AJRCCM 2005

Rehabilitation, the evidence



Lacasse Eura Medicophys 2007 (Cochrane)

Rehabilitation, the evidence: Health care resources

	Controls		Rehabilitation		
Patients admitted n	41		40		NS
Hospital admissions					
Resp	1.9	1.4	1.4	1.3	*
All	2.2	1.5	1.7	1.1	*
Days spent in hosp					
Resp	18.1	19.3	9.4	10.2	*
All	21.0	20.7	10.4	9.7	*
Days per admission	9 ± 7.6		6 ± 3.4		0.1

Griffiths Lancet 2000

Rehabilitation: the evidence

Evidence from systematic review of meta-analysis of randomised controlled trials (level Ia)

- Improvements in exercise tolerance
- Clinically relevant improvement in health related quality of life (HRQoL).

Evidence from at least one RCT(level Ib)

- Reductions in number of days spent in hospital
- Pulmonary rehabilitation is cost effective

Exercise training, the core of rehabilitation

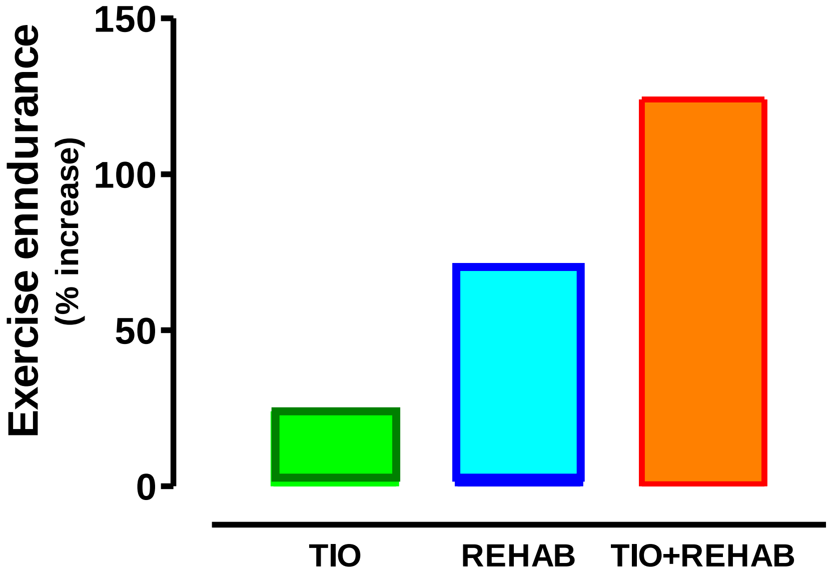
How do we train patients with severe airflow obstruction, dynamic hyperinflation and complaints of dyspnea on exertion?

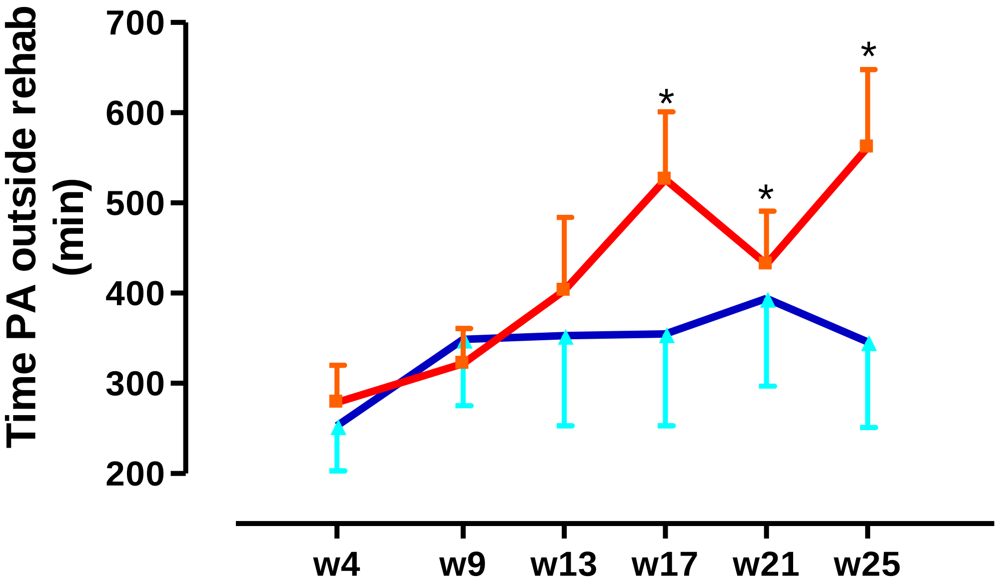
Knowing exercise limitations to guide training

How to train the ventilatory limited patient ?

- Improve the lung function / maximum ventilatory capacity
- Reduce the ventilatory needs
  - Increase the delivery
  - Reduce the demand

Improve lung function





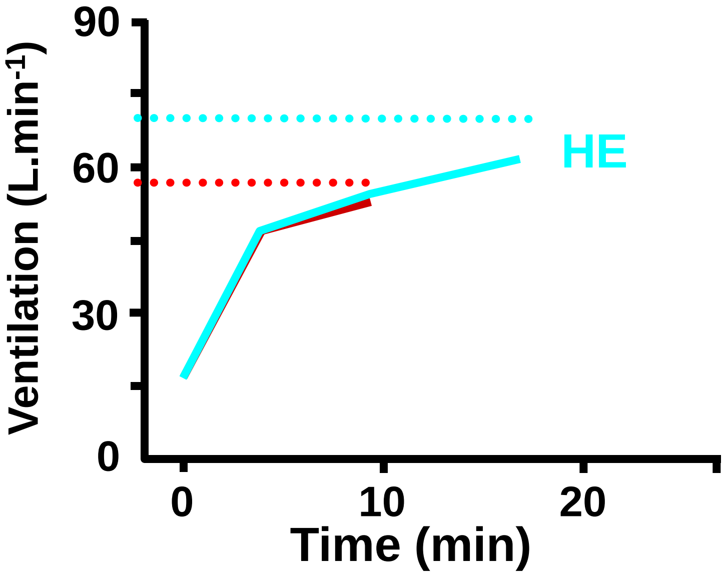
Casaburi et al Chest 2005

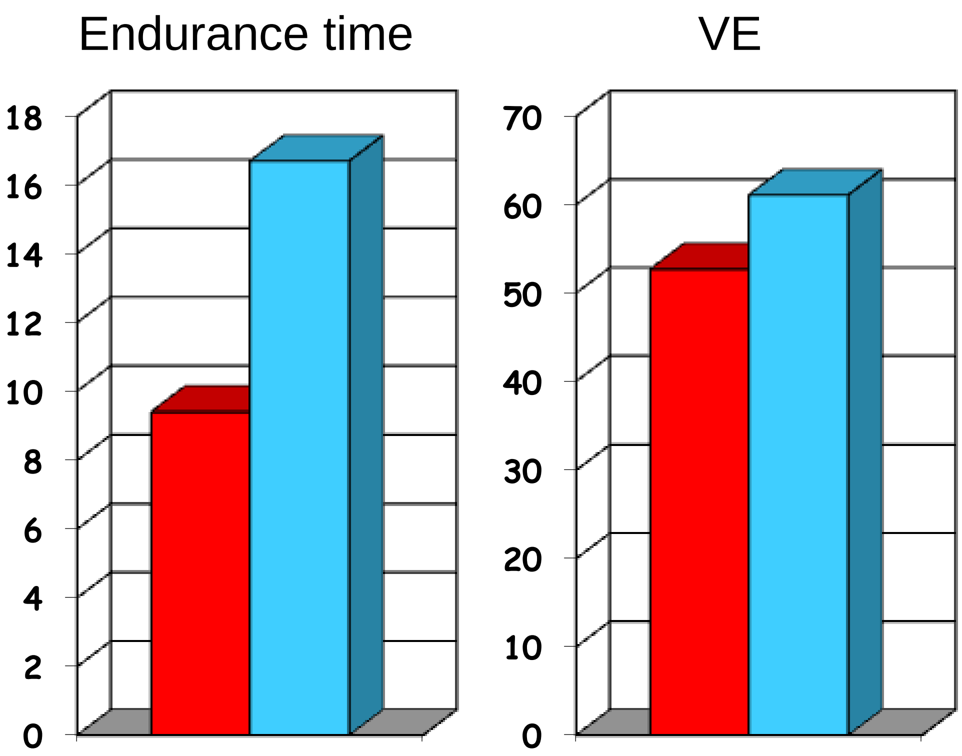
Kesten J COPD 2008

Improve maximal voluntary ventilation

HeliOx

	Air	HeliOx
FEV1	**1.54±0.73**	**1.89±0.73**
FVC	**3.76±1.13**	**3.86±1.18**

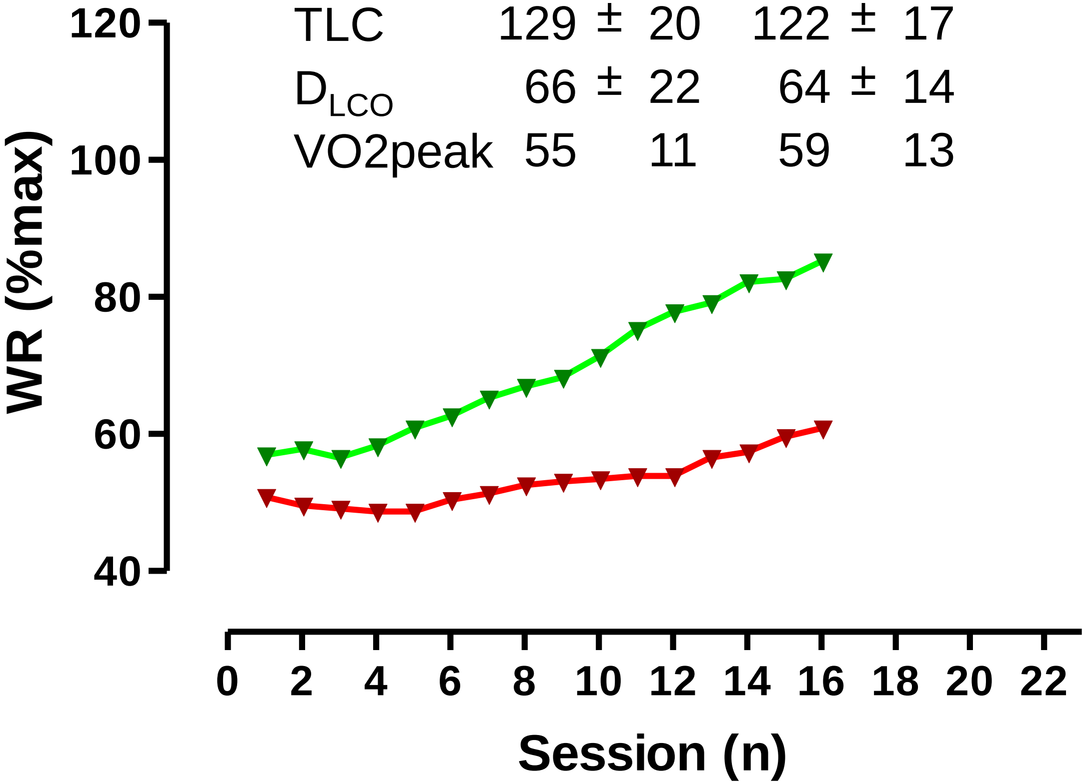


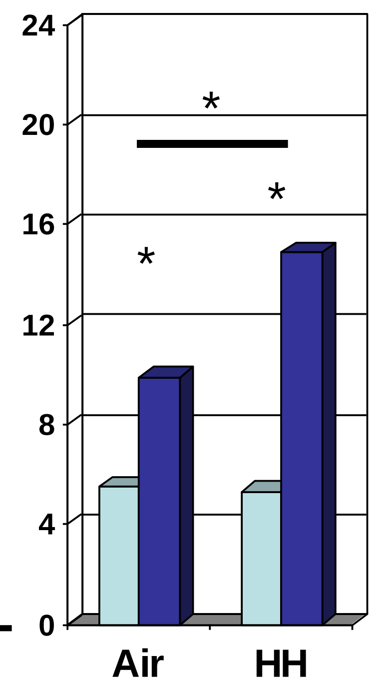


Eves AJRCCM 2006

Training at higher intensity

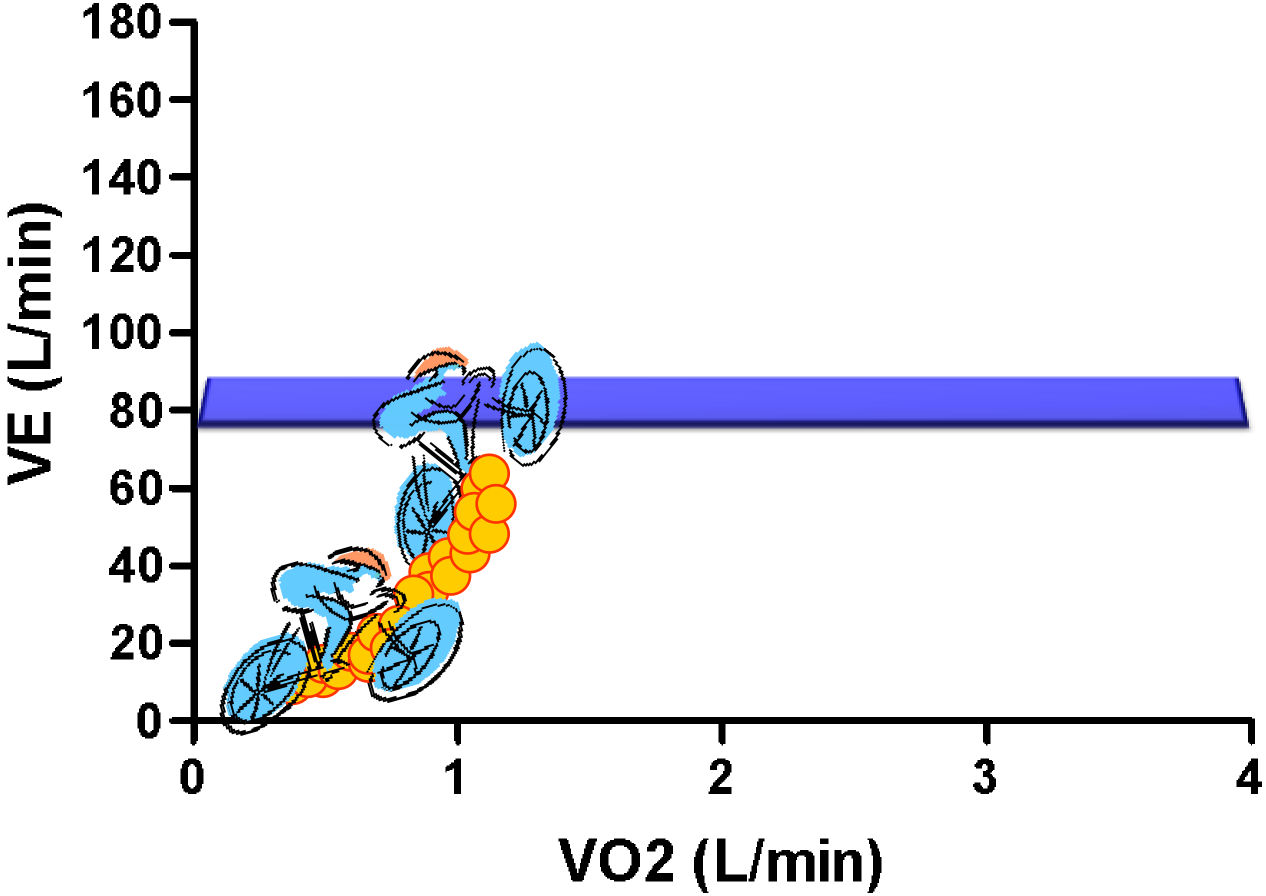
	Air (n=19)			He/O_2(n=19)		
FEV_1	47	±	19	46	±	14
TLC	129	±	20	122	±	17
D_{LCO}	66	±	22	64	±	14
VO2peak	55		11	59		13





Eves Chest 2009

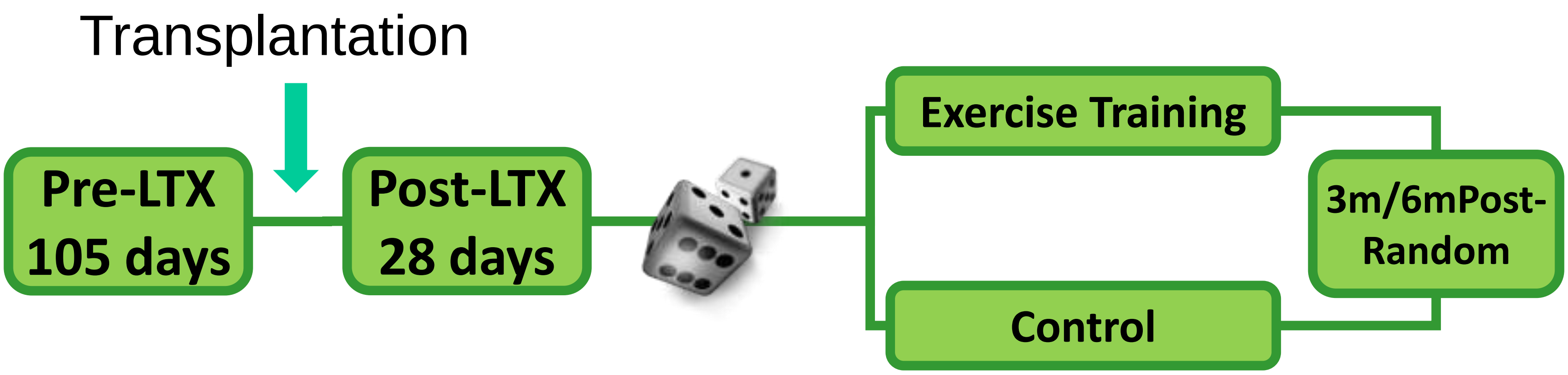
Lung Transplantation



		1yPost-LTX n=22		Healthy n=30
Gender	♂ / ♀	12 / 10		18 / 12
Age	yrs	59 5		58 6
BMI	kg/m^2	23 ± 4		25 ± 4
FEV_1	%pred	79 ± 18*		116 ± 18
Q-Force	Nm	100 ± 36*	-40%	164 ± 41
MEP	cm H_2O	159 ± 44*	-20%	193 ± 47
MIP	cm H_2O	-76 ± 48	-20%	-97 ± 53
Handgrip	kgF	36 ± 16	-15%	42 ± 10
6MWD	m	483 ± 66*	-30%	690 ± 83
Wmax	%pred	74 ± 22*	-60%	182 ± 57

Langer et al. Journal of Heart and Lung Transplantation 2009

Study Design RCT
Exercise Training after LTX



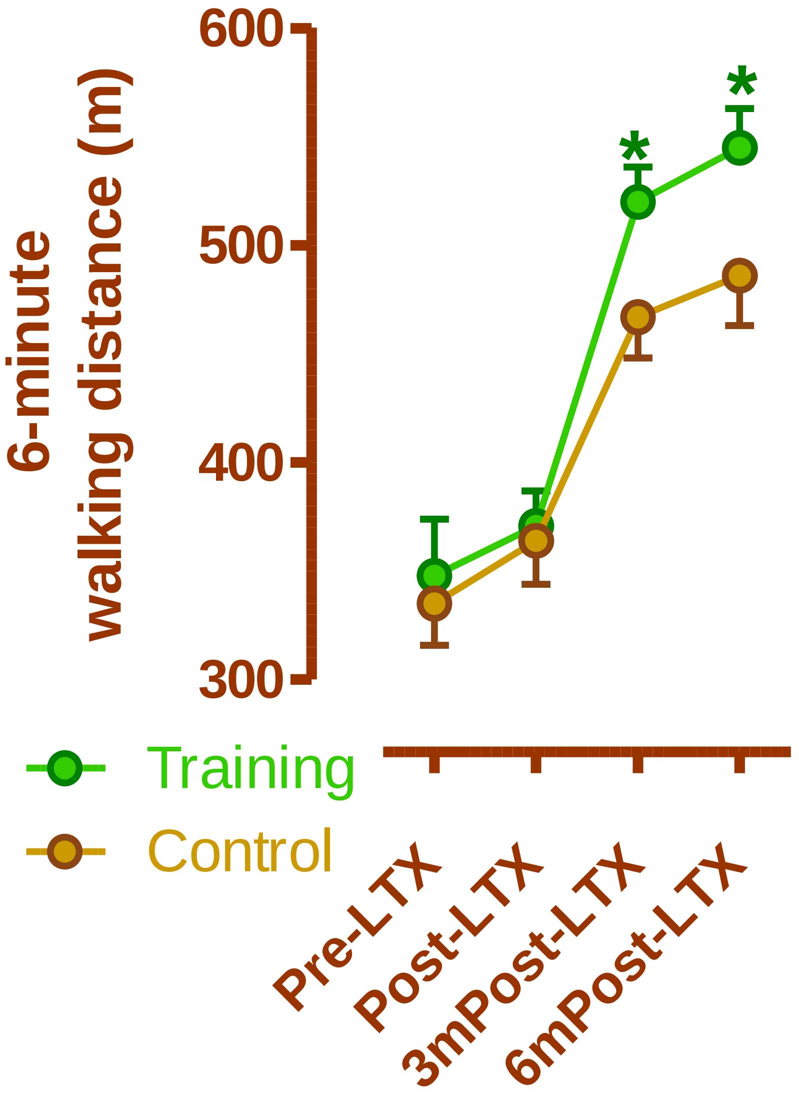
Baseline Characteristics

	Post-LTX	
	Training (n=15)	Control (n=13)
Male / Female	8 / 7	7 / 6
Early acute rejection (yes / no)	6 / 7	3 / 9
SLTX / SSLTX	1 / 14	3 / 10
Diagnosis COPD / ILD	12 / 3	11 / 2
Age	56 ± 4	56 ± 7
BMI (kg/m^2)	20,7 ± 4,6	21,6 ± 4,2
$FEV_{1,}$ (% pred)	72 ± 18	74 ± 16

Exercise Training

- **3 sessions per week**

Results



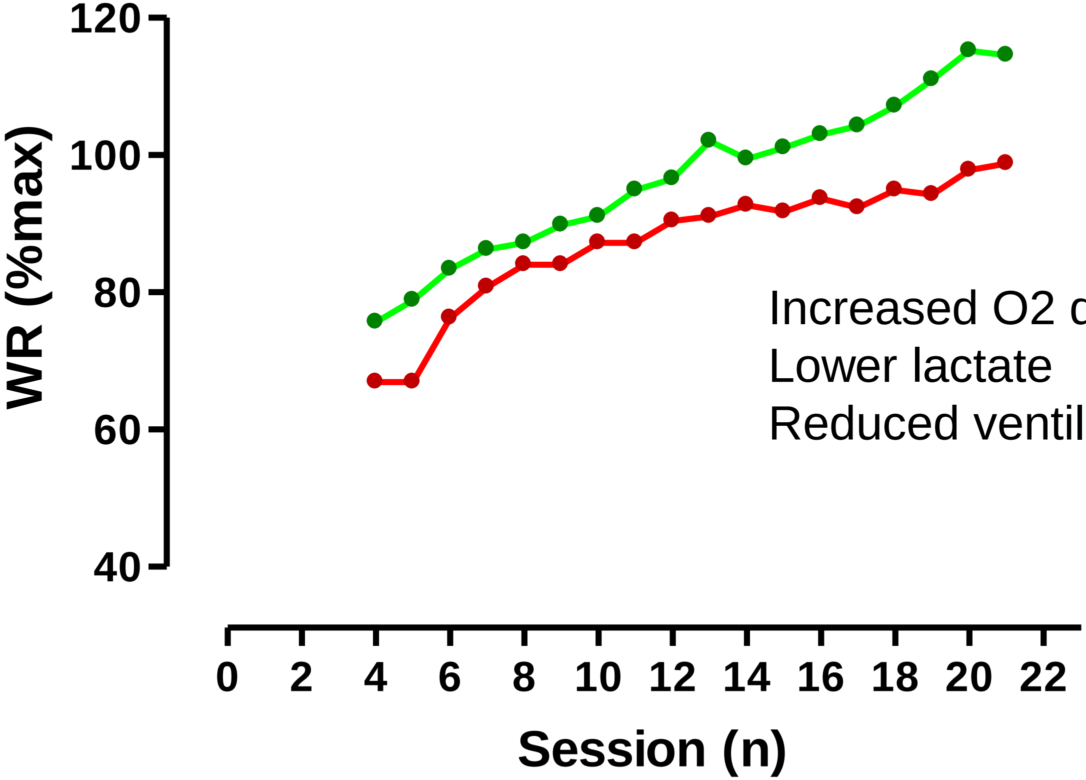
6-minute
walking distance (m)
600
500
400
300
*
*
Training
Control
Pre-LTX
Post-LTX
3mPost-LTX
6mPost-LTX

Knowing exercise limitations to guide training

How to train the ventilatory limited patient ?

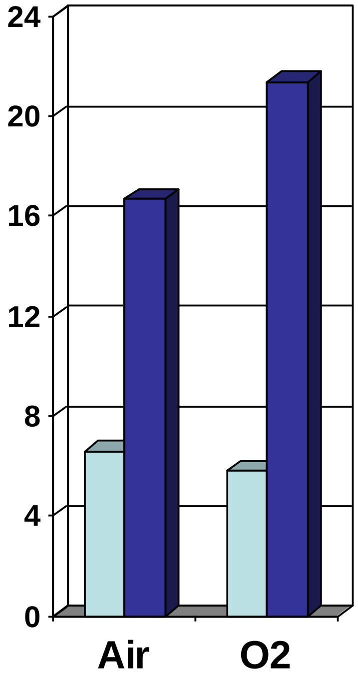
- Improve the lung function / maximum ventilatory capacity
- Reduce the ventilatory needs
  - Increase the delivery
  - Reduce the demand

Training at higher intensity



Increased O2 delivery
Lower lactate
Reduced ventilatory drive

Endurance time



Emtner AJRCCM 2003

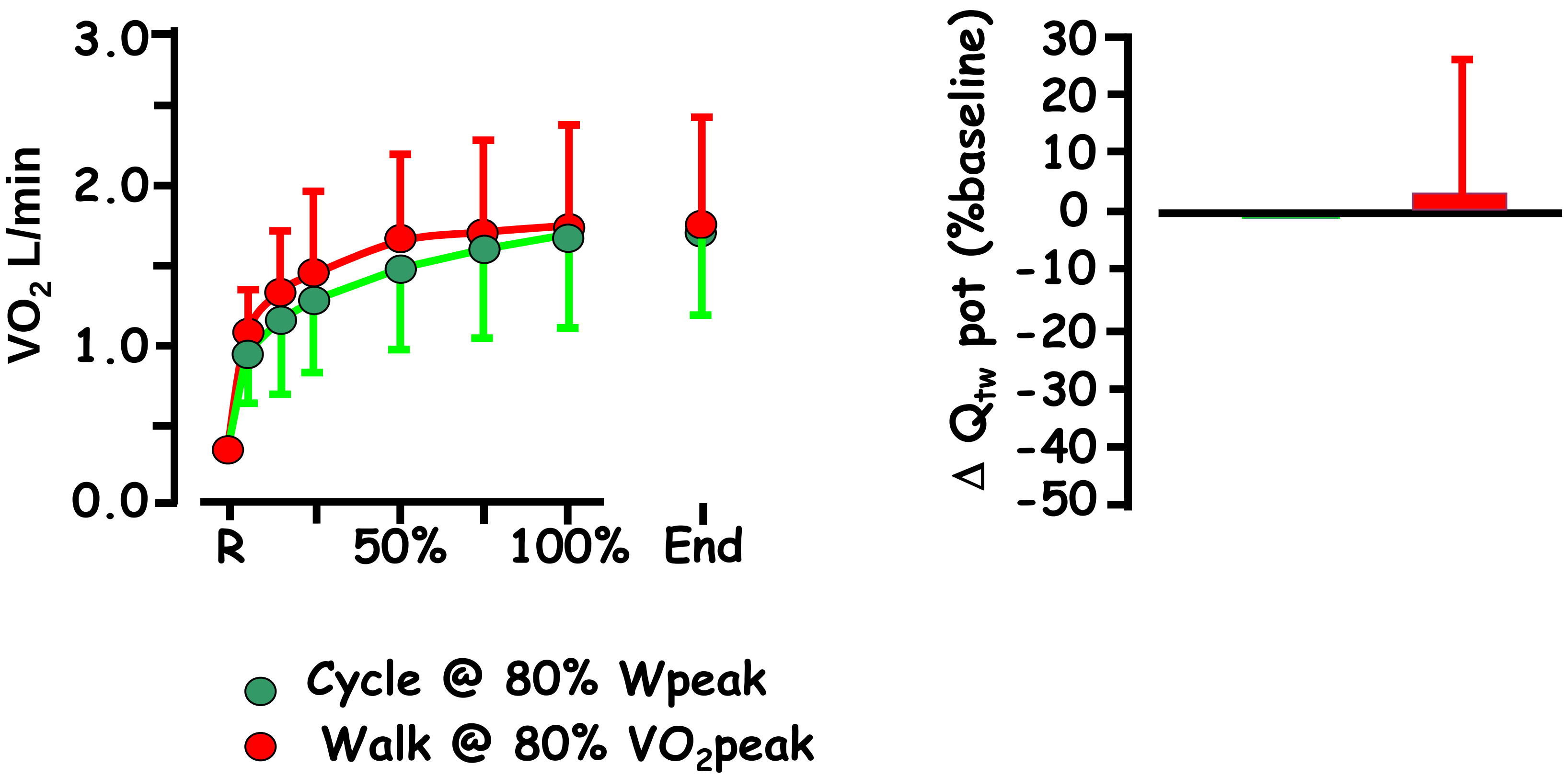
Knowing exercise limitations to guide training

How to train the ventilatory limited patient ?

- Improve the lung function / maximum ventilatory capacity
- Reduce the ventilatory needs
  - Increase the delivery
  - Reduce the demand

Reduce the demand

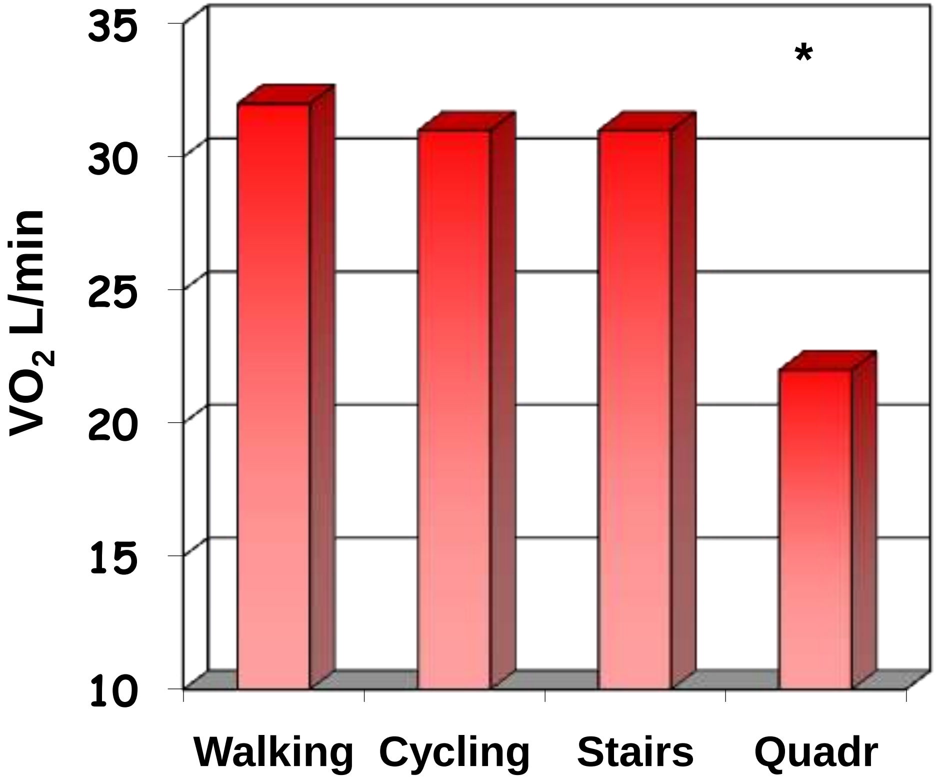
- Enhance the stress to the muscle for a given VO2 (walking vs cycling)



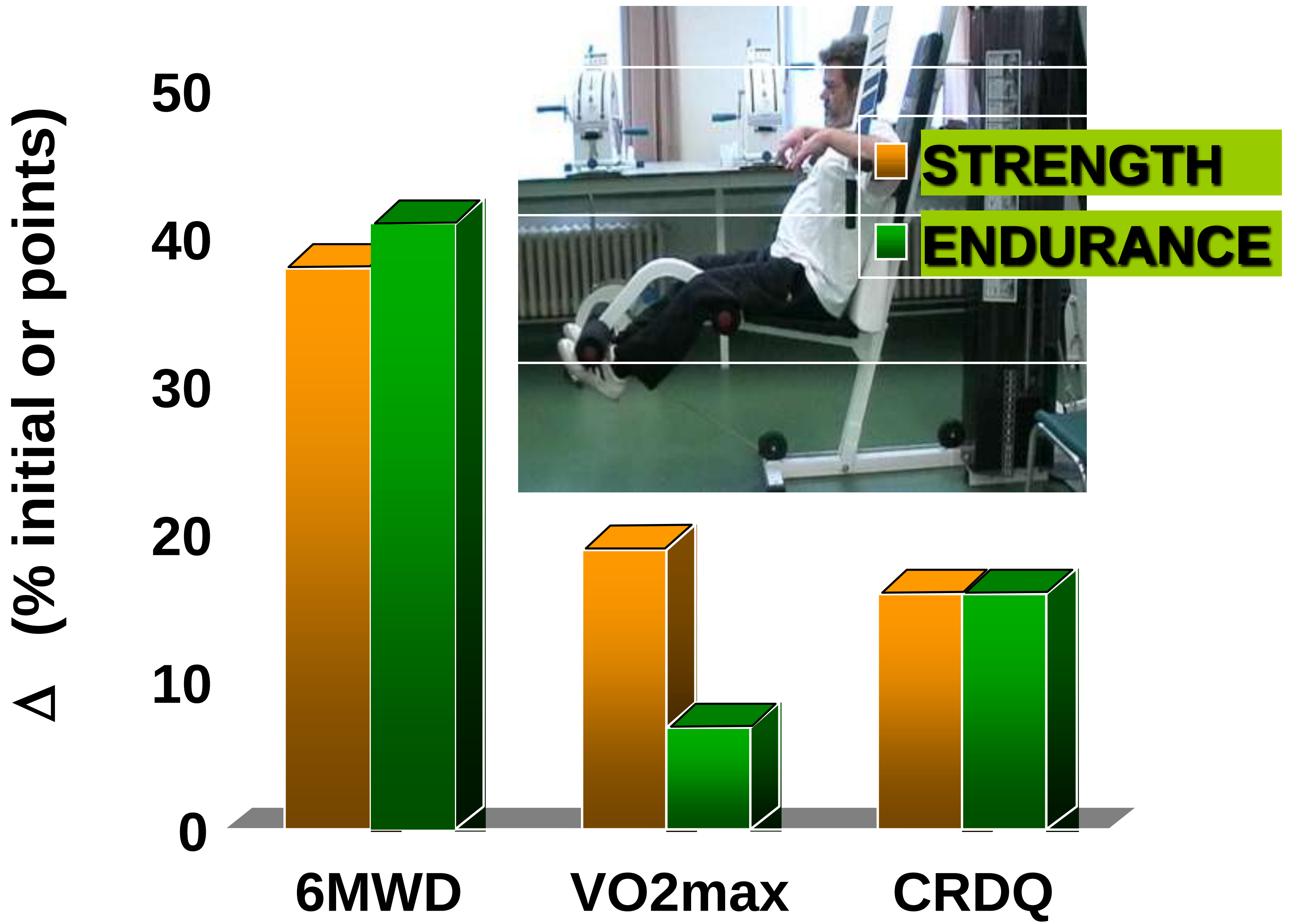
Pepin AJRCCM 2005

Reduce the demand

- **Enhance the stress to the muscle for a given VO2 (walking vs cycling)**
- **Reduce the amount of muscle mass at work (resistance training, NMES).**



Probst ERJ 2006



Spruit et al. Eur.Respir.J. 2002; 19:1072-1078

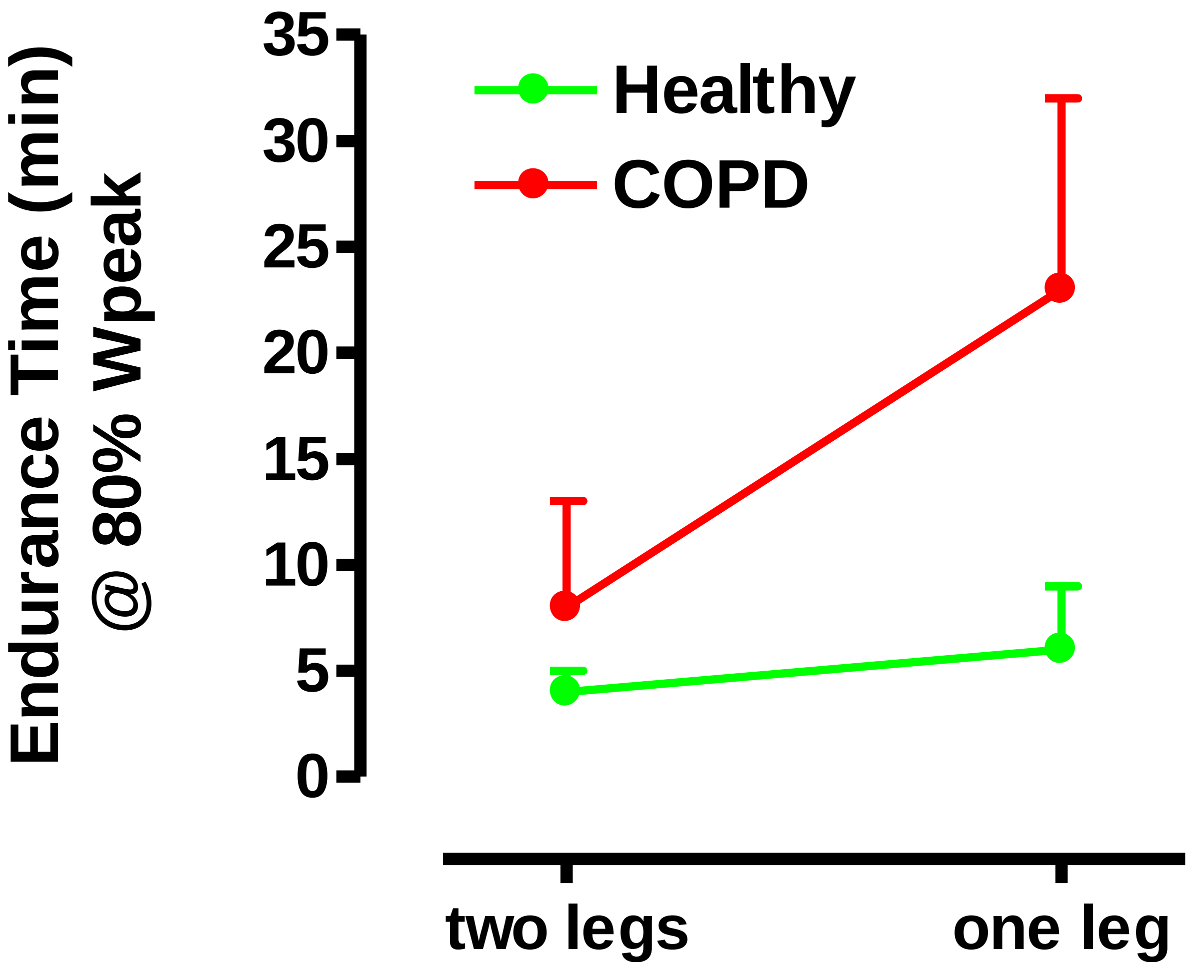
Reduce the the demand

- Enhance the stress to the muscle for a given VO2 (walking vs cycling)
- Reduce the amount of muscle mass at work (resistance training, NMES, single leg)

Single Leg Exercise

Dolmage Chest 2008

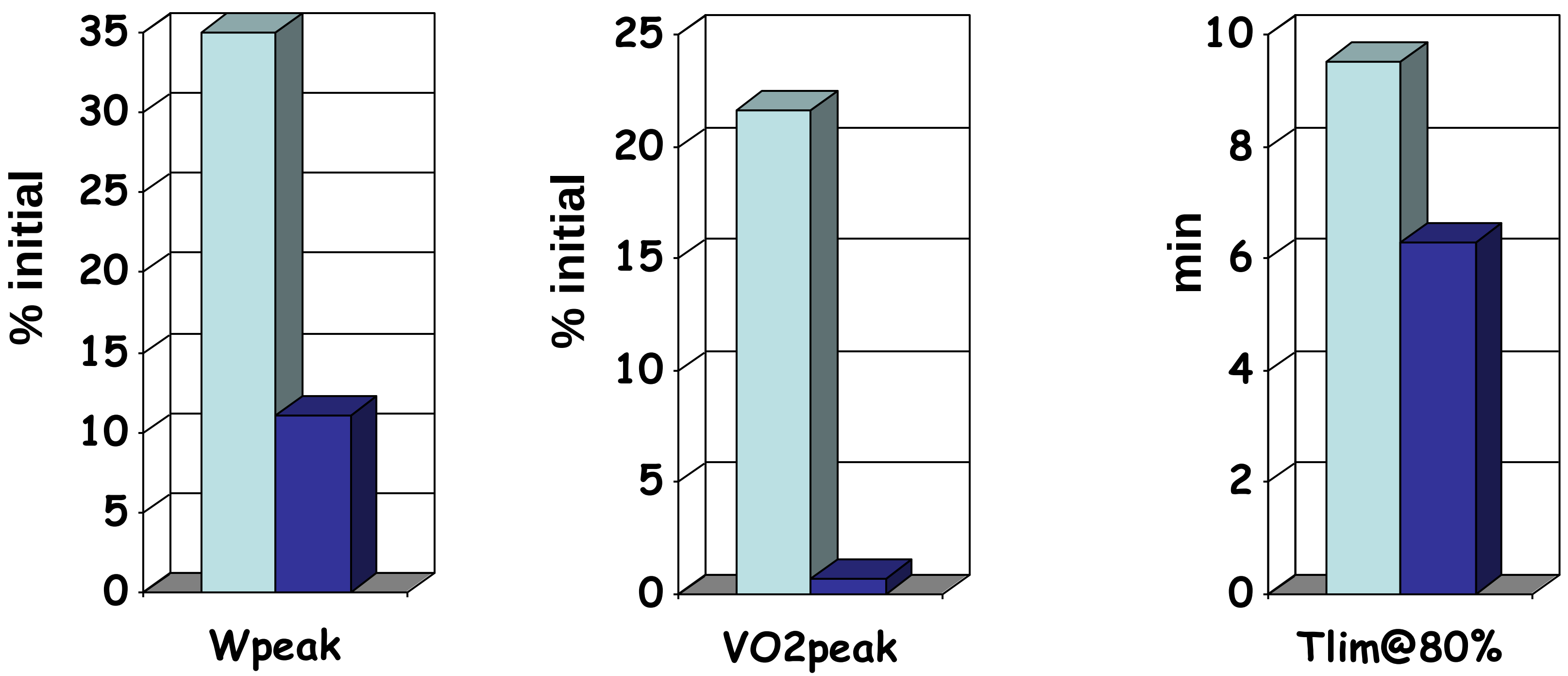
Single leg exercise



Dolmage et al Chest 2006

Single leg training

30 min of conventional cycling training versus single leg cycling (15 min each leg)
3 times per week
7 weeks
FEV1 37 and 40%pred



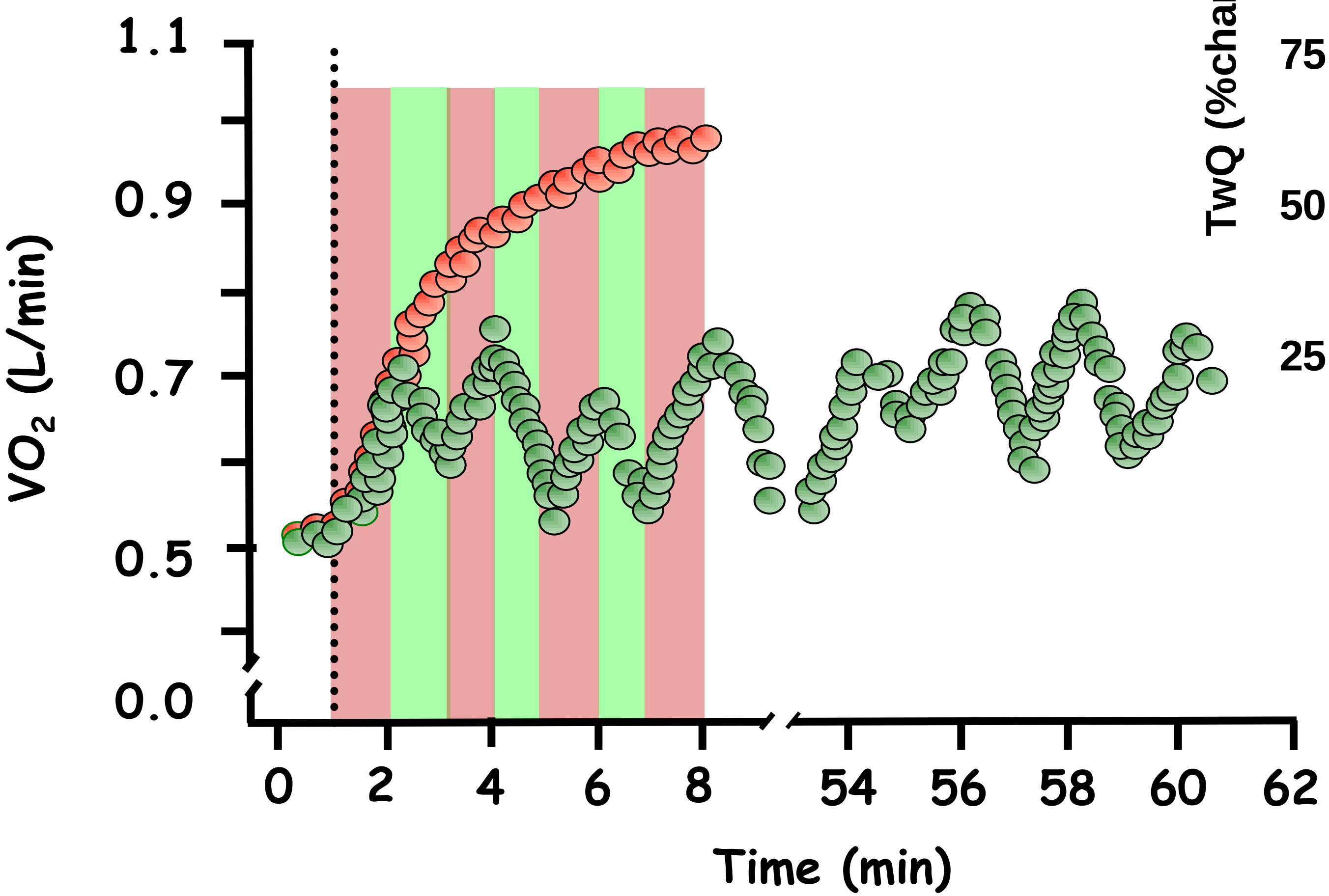
Dolmage Chest 2008

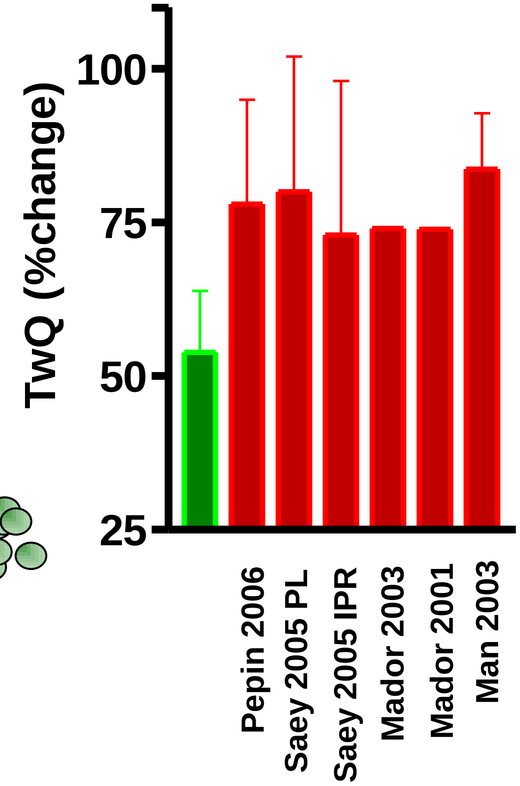
Reduce the demand

- Enhance the stress to the muscle for a given VO2
- Reduce the amount of muscle mass at work
- Shorten the bouts of exercise to keep ventilation lower than needed in steady state (interval training)

☞ Slow oxygen uptake (ventilatory) kinetics : your friend in pulmonary rehab…

Interval exercise, often more realistic





Sabapathy Thorax 2004

Conclusions

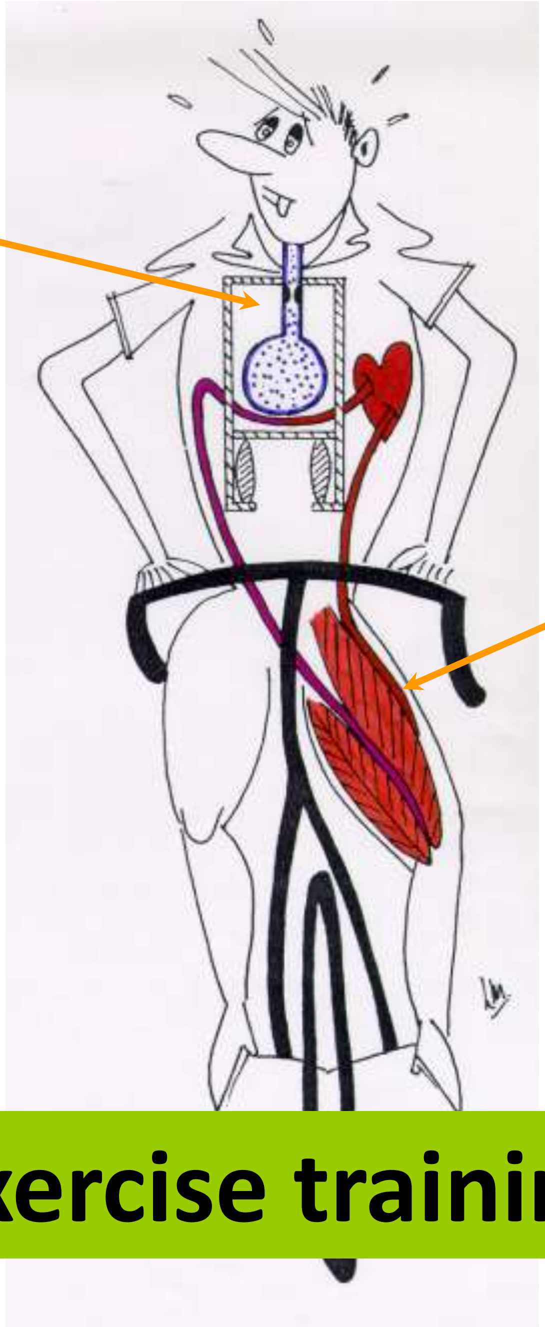
- **Pulmonary rehabilitation works: 'GRADE A'-level of evidence**
- **Exercise training can be fine-tuned to the exercise limitations of patients**
- **Several options available for ventilatory limited patients**

Increase

Ventilatory Capacity:

Bronchodilators

Heliox



High intensity

Peripheral

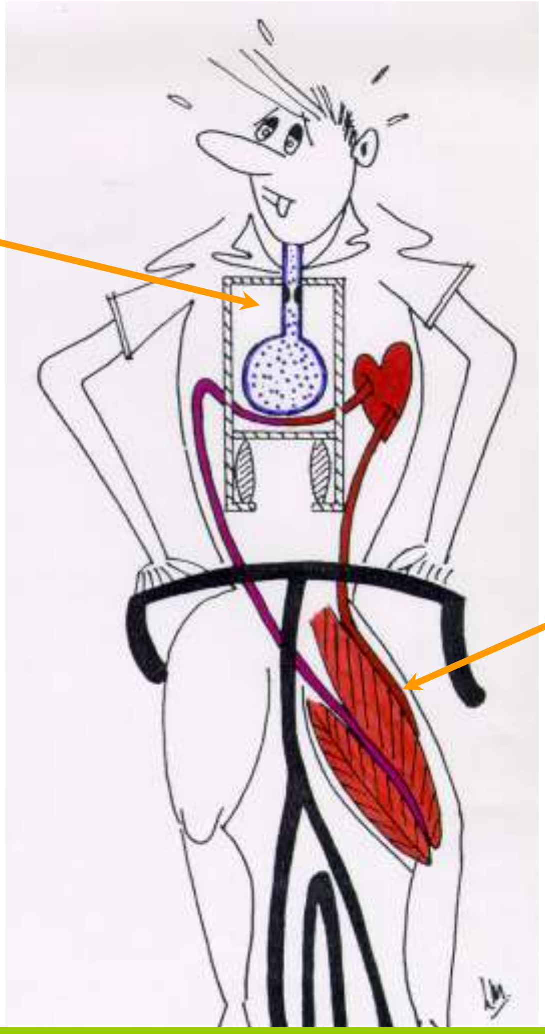
Muscle

Training

Exercise training

Reduce Ventilatory Requirements:

O_2 supplementation
Small muscle mass
Short intervals



High intensity Peripheral Muscle Training

One-leg exercise
Interval training
Resistance training

Thank you for your attention

Greetings from the Leuven Pulmonary Rehabilitation team