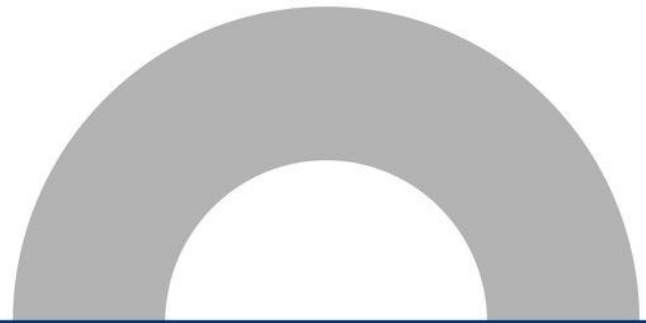




YONSEI  
UNIVERSITY



# 운동 치료의 실제

Ji Soo Choi

Clinical assistant professor, Division of Pulmonology,  
Department of Internal Medicine, Severance Hospital,  
Yonsei University College of Medicine

*Severance*



- > **Pulmonary Rehabilitation**
- > **Exercise training based on guideline**
- > **Exercise training in practice**
- > **Exercise training in ICU patients**

# Pulmonary Rehabilitation

# Pulmonary Rehabilitation

- *“Pulmonary rehabilitation”* is a **comprehensive intervention** based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to **improve the physical and psychological condition** of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviors.
- **The goals of pulmonary rehabilitation** include,
  - minimizing symptom burden, maximizing exercise performance, promoting autonomy, increasing participation in everyday activities, enhancing (health-related) quality of life, and effecting long-term health-enhancing behavior change.

# Pulmonary rehabilitation in COPD

## Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: a randomised controlled trial

*T L Griffiths, M L Burr, I A Campbell, V Lewis-Jenkins, J Mullins, K Shiels, P J Turner-Lawlor, N Payne, R G Newcombe, A A Lonescu, J Thomas, J Tunbridge*

- RCT, 200 patients with disabling chronic lung disease  
(the majority with **COPD**, FEV1 less than 60%, BD response less than 20%)
- multidisciplinary rehabilitation program (n = 99) vs standard medical management (n = 101)
- Intervention: 3 days per week for 6 weeks, each session 2hr long
- **Shorter days spent in hospital, fewer primary-care home visits, greater improvements in walking ability**
- No difference in the number of patients admitted to hospital

# Pulmonary rehabilitation in ILD

## Effects of pulmonary rehabilitation in patients with idiopathic pulmonary fibrosis

OSAMU NISHIYAMA,<sup>1</sup> YASUHIRO KONDOH,<sup>1</sup> TOMOKI KIMURA,<sup>1</sup> KEISUKE KATO,<sup>1</sup> KENSUKE KATAOKA,<sup>1</sup>  
TOMOYA OGAWA,<sup>2</sup> FUMIKO WATANABE,<sup>2</sup> SHINICHI ARIZONO,<sup>2</sup> KOICHI NISHIMURA<sup>3</sup> AND  
HIROYUKI TANIGUCHI<sup>1</sup>

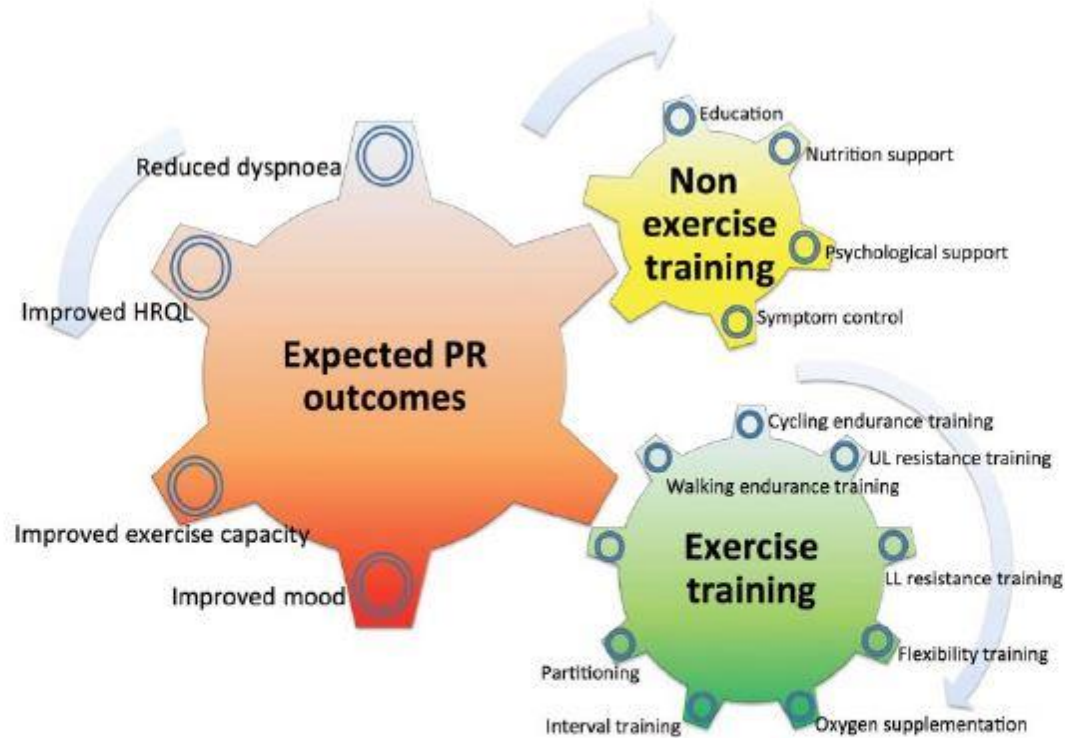
*Departments of<sup>1</sup>Respiratory Medicine and Allergy and <sup>2</sup>Rehabilitation, Tosei General Hospital, Seto, Aichi,  
and <sup>3</sup>Respiratory Division, Kyoto-Katsura Hospital, Kyoto, Japan*

- RCT, **IPF** with less than 75 years and no infection or exacerbation in previous 3 months
- multidisciplinary rehabilitation group (n = 13) vs control group (n = 15)
- Intervention: 2 times per week for 10 weeks
- **Marked improvements were observed in the 6MWD, total SGRQ score**
- No significant effects on measures of pulmonary function, values of arterial blood gas analysis or dyspnea rating

# Pulmonary Rehabilitation

- Exercise training
- Education: use of medications, bronchial hygiene, maintain physical activities
- Psychological support: anxiety and depression
- Nutritional support
- Symptom control
- Management of comorbidity

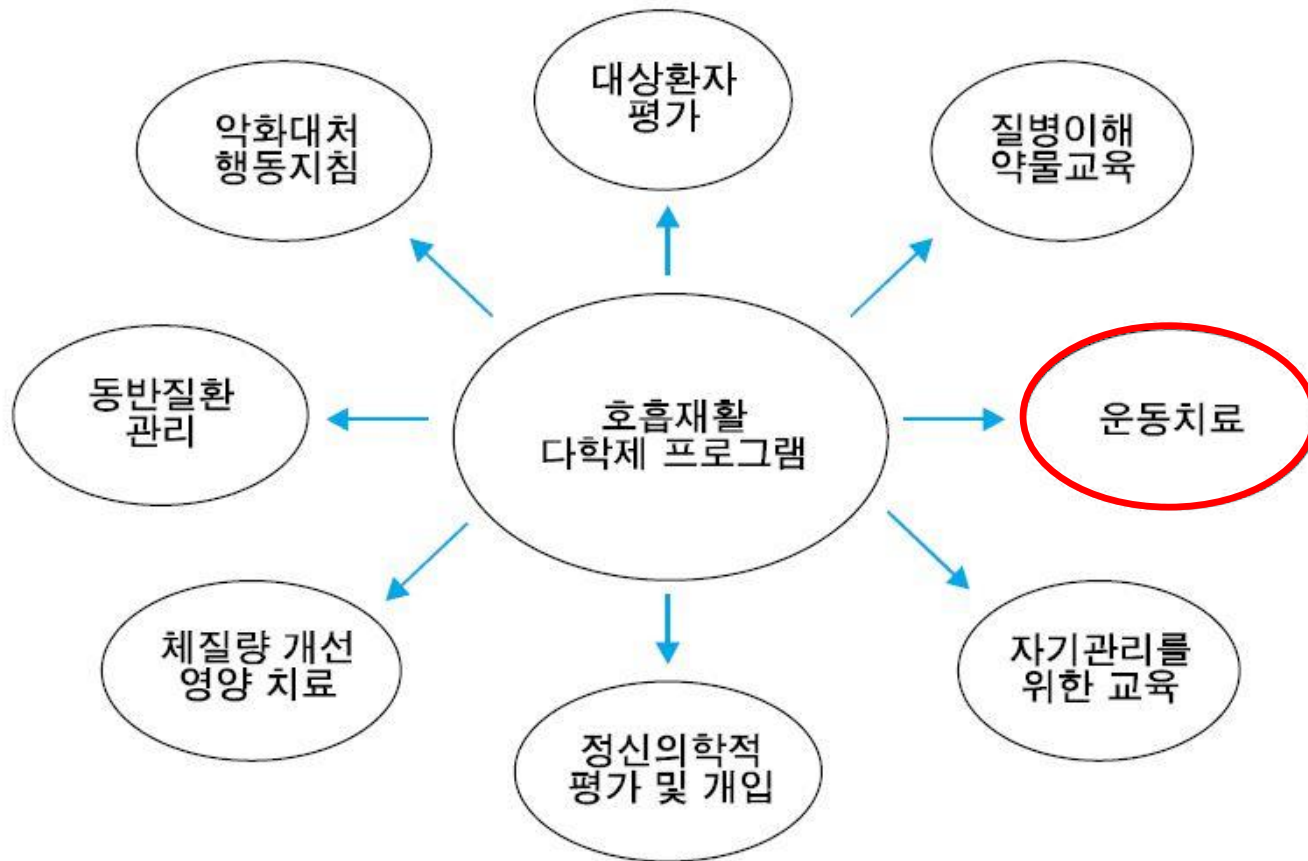
# Pulmonary Rehabilitation



**Figure 1.** Comprehensive pulmonary rehabilitation for interstitial lung disease.

The gears with red, green and yellow colour present expected PR outcomes, exercise training and nonexercise training, respectively. The green gear is bigger than the yellow gear, because exercise training has more evidence than nonexercise training. The cogs of gears indicate their components. Comprehensive intervention in PR can be accomplished when the gears mesh together and cogs work well. Cooperation and smooth connection of all gears are vital to make PR successful. HRQL, health-related quality of life; UL, upper limb; LL, lower limb; PR, pulmonary rehabilitation.

# Pulmonary Rehabilitation



**Exercise training** based on guideline

# Exercise intolerance in chronic respiratory disease

- **Ventilatory limitation**: dead-space ventilation ↑, flow limitation
- **Gas exchange limitation**: hypoxia
- **Cardiac limitation**: right ventricular afterload ↑, tachyarrhythmia
- **Skeletal muscle dysfunction**: weight loss, peripheral muscle wasting
- **Respiratory muscle dysfunction**
- Anxiety, depression, and poor motivation

# Exercise training

1. A **minimum of 20 sessions** should be given **at least three times per week** to achieve physiologic benefits; twice weekly supervised plus one unsupervised home session may also be acceptable.
2. **High-intensity exercise** produces greater physiologic benefit and should be encouraged; however, low-intensity training is also effective for those patients who cannot achieve this level of intensity.
3. **Interval training** may be useful in promoting higher levels of exercise training in the more symptomatic patients.
4. **Both upper and lower extremity training** should be utilized.
5. The combination of **endurance and strength training** generally has multiple beneficial effects and is well tolerated; strength training would be particularly indicated for patients with significant muscle atrophy.

# Exercise training

- Endurance training:
- Resistance/Strength training
- Interval training
- Flexibility training, Inspiratory muscle training

표 3-1. 운동훈련 세션의 구성요소 및 내용<sup>11</sup>

구성요소	내용	비고
준비운동	적어도 5~10분간의 저강도(<40% VO <sub>2</sub> max) 또는 중강도(40~60% VO <sub>2</sub> max) 의 활동	
스트레칭	준비운동 후 적어도 10분	
본운동	20~60분간의 지구성, 저항성, 유연성 운동 등의 신체 활동으로 10분간 누적하여 실시해도 무방	FITT의 원리 적용
정리운동	적어도 5~10분간의 저강도(<40% VO <sub>2</sub> max) 또는 중강도(40~60% VO <sub>2</sub> max) 의 심혈관 및 근지구력 활동	정리운동 후에도 스트레칭 실시

# Exercise training – Endurance training

- 운동치료의 framework (FITT): Frequency, Intensity, Time(duration), Type
- Frequency and Time: 20-60분, 주 3-5회
- Type: walking, bicycle ergometer, treadmill, arm ergometer 등



그림 3-1. 올바른 걷기



Treadmill



Ergometer

# Exercise training – Endurance training

- Intensity: 6MWD, VO<sub>2</sub>max, MET, Borg CR-10, Heart rate

표 3-5. 고강도 및 저강도 부하 비교

부하의 강도	고강도 부하	저강도 부하
정의	· 환자 개개인 VO <sub>2</sub> max의 60~80%의 부하	· 환자 개개인 VO <sub>2</sub> max의 40~60%의 부하
장점	· 동일한 운동 자극에 대한 운동 능력의 개선 및 생리학적 효과가 큼	· 운동 위험도가 낮아 집에서 쉽게 할 수 있음 · 운동 순응도가 유지되기 용이함
단점	· 모든 환자에게 시행하기 어려움(특히, 중증환자) · 위험도가 높기 때문에 주위의 지도나 감시가 필요함 · 운동 순응도가 유지되기 어려움	· 운동 능력의 개선 정도가 적음 · 운동효과가 나타나기까지 장시간의 운동시간이 필요함
적용	· 운동 욕구가 높은 환자 · 경증의 호흡부전	· 중증호흡부전이나 폐성심합병증 · 순응도가 낮은 환자 · 고령자

- Discontinuation: Borg CR-10 7 이상, 평소와 다른 호흡곤란, 흉통, 극도의 피로, 현기증 등의 증세, SpO<sub>2</sub> 90% 미만, 연령별 최대심박수(220-나이)의 85% 이상의 심박수

# Exercise training – Resistance/Strength training

- An exercise modality in which **local muscle groups** are trained by **repetitive lifting of relatively heavy loads**.
- **Intensity, Time, and Frequency: 최대근력의 60-70%의 강도, 10회 반복 세션, 주 2-3회**
  - 1) 각 운동을 10회 반복하고 휴식시간을 가진다.
  - 2) 해당 중량으로 2-3세트를 수행할 때까지 점차적으로 세트 수를 늘린다.
  - 3) 10-15번 반복하는 각 세트 사이의 휴식시간을 2분 미만으로 설정한다.
  - 4) 환자가 운동을 3세트 수행할 수 있다면 중량을 늘릴 수 있다.
- **Upper limb strengthening training**
- **Lower limb strengthening training**

# Exercise training – Resistance/Strength training

- Upper limb strengthening training: 아령, 탄력밴드 등

누워서 팔 뻗기



앉아서 팔들기



이두근 운동



외전운동



누워서 팔 벌리기

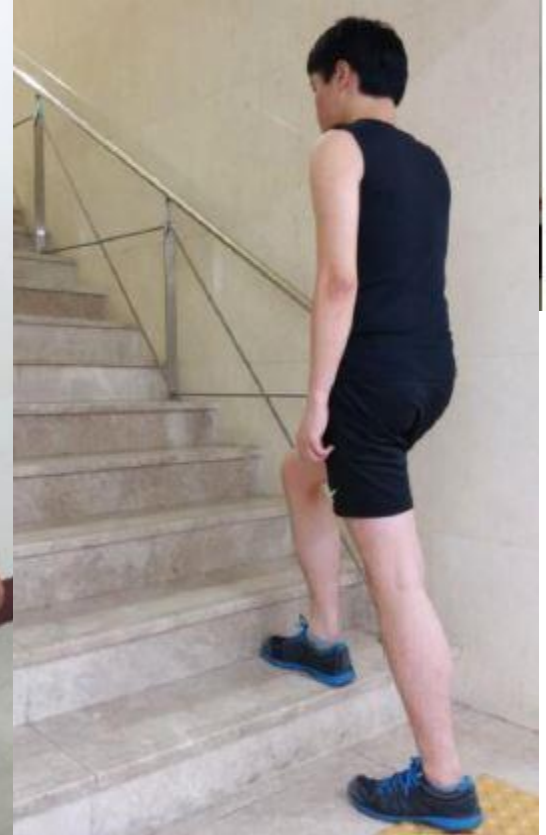


벽 팔굽혀펴기



# Exercise training – Resistance/Strength training

- Lower limb strengthening training:



# Exercise training – Resistance/Strength training

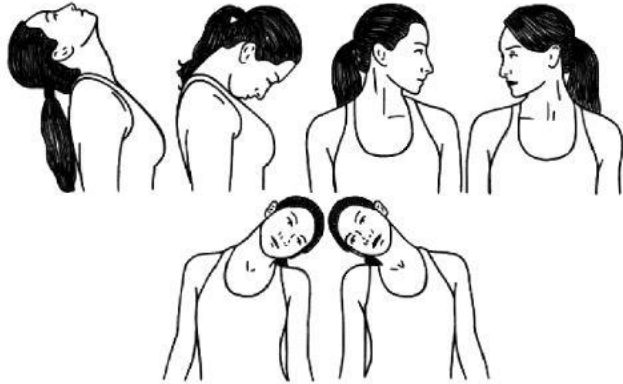
호흡재활치료법



# Exercise training – Flexibility exercise

- **요인:** 사지의 근력약화, 관절가동범위 제한, 몸통관절 주변 조직의 유연성 저하, 흉곽가동성 감소, 목, 어깨, 가슴 근육의 뻣뻣함.
- **종류:** 고유수용성신경근촉진법, 수축-이완기법, 흉곽가동운동, 스트레칭 또는 수동적 신장운동, 전기근육자극, 호흡조절과 함께하는 운동 프로그램

# Exercise training – Flexibility exercise



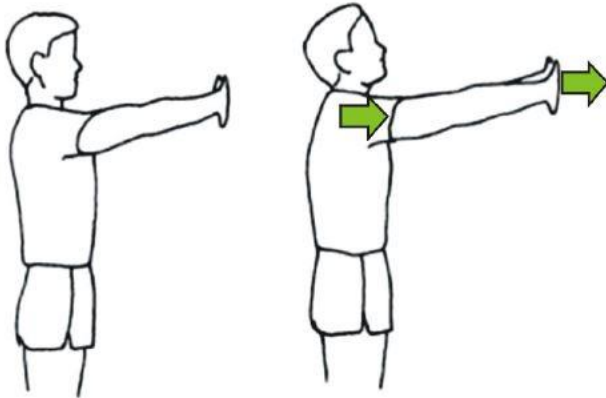
목갈비근, 흉쇄유돌근 스트레칭



시작 자세

끝 자세

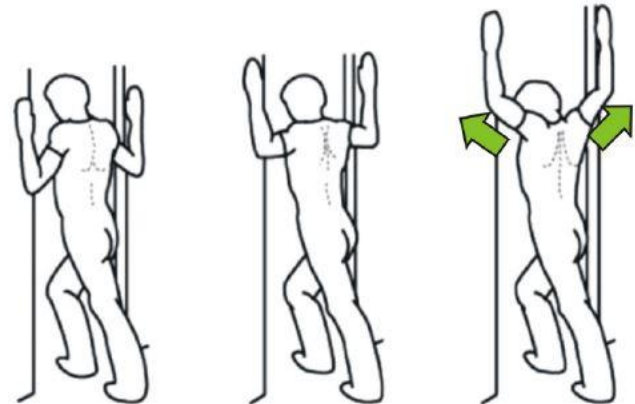
등세모근 스트레칭



시작 자세

끝 자세

마름모근 스트레칭



시작 자세

끝 자세

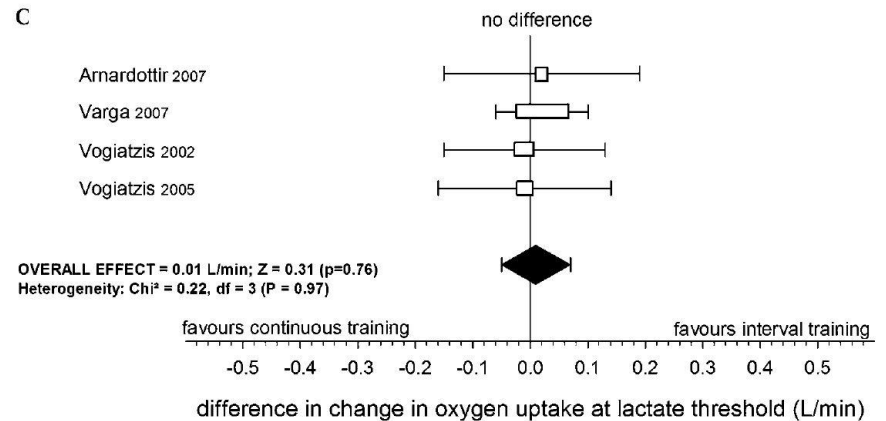
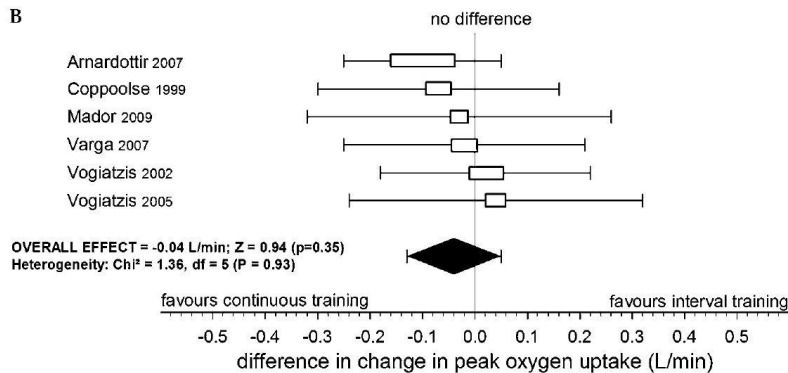
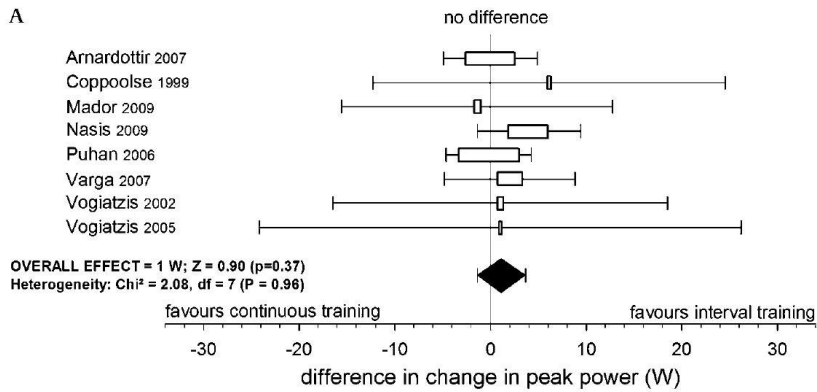
가슴근 스트레칭

그림 3-4. 호흡보조근육 스트레칭

# Exercise training – Interval training

## Interval versus continuous training in individuals with chronic obstructive pulmonary disease- a systematic review

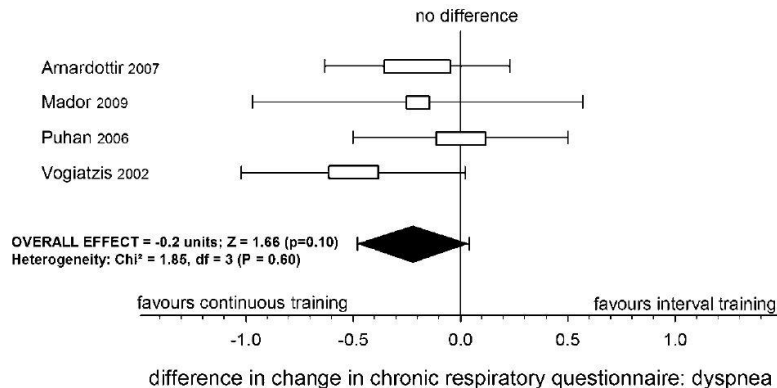
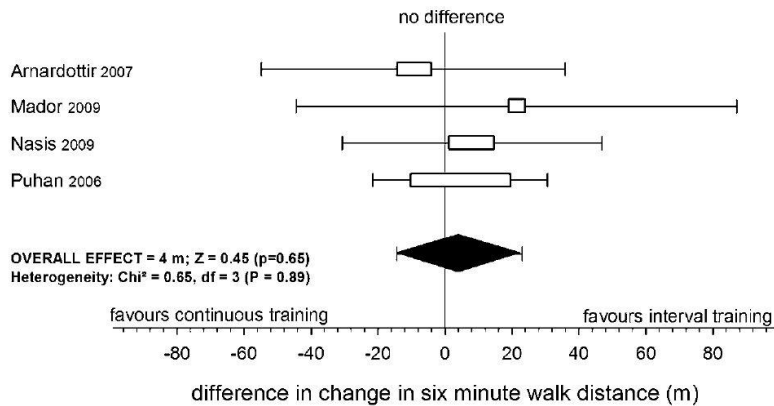
Marla K Beauchamp,<sup>1</sup> Mika Nonoyama,<sup>2</sup> Roger S Goldstein,<sup>2</sup> Kylie Hill,<sup>2</sup>  
 Thomas E Dolmage,<sup>3</sup> Sunita Mathur,<sup>4</sup> Dina Brooks<sup>4</sup>



# Exercise training – Interval training

## Interval versus continuous training in individuals with chronic obstructive pulmonary disease- a systematic review

Marla K Beauchamp,<sup>1</sup> Mika Nonoyama,<sup>2</sup> Roger S Goldstein,<sup>2</sup> Kylie Hill,<sup>2</sup> Thomas E Dolmage,<sup>3</sup> Sunita Mathur,<sup>4</sup> Dina Brooks<sup>4</sup>



- In ATS guideline...
- ✓ **Interval training** may be a useful alternative to continuous training, especially in **symptom-limited individuals** who are unable to tolerate high-intensity continuous training.
- ✓ When continuous training is curtailed by **severe dyspnea or oxyhemoglobin** desaturation, interval training may be a reasonable strategy to increase exercise intensity and training adaptations.

# Exercise training – Neuromuscular Electrical Stimulation

- Double-blind, placebo-controlled trial, randomized
- Severe COPD (FEV%  $\leq$  50% and MRC  $\geq$  4)
- Active NMES (n = 25) vs placebo NMES (n = 27)
- 6-week programme consisting of 30 min of daily bilateral NMES to the quadriceps
- Outcome: 6MWD, muscle function, daily activity, CRQ, SGRQ, EQ-5D

	Neuromuscular electrical stimulation (n=25)	Placebo (n=27)	Treatment difference	p value (two-sided t test)
Primary outcome: 6MWT distance (m)	29.9 (8.9 to 51.0)	-5.7 (-19.9 to 8.4)	35.7 (10.5 to 60.9)	0.005
Secondary outcomes: quadriceps MVC (kg)	3.43 (1.3 to 5.6)	0.34 (-1.5 to 2.0)	3.09 (0.30 to 5.90)	0.028
Quadriceps twitch (kg)	0.99 (0.2 to 1.8)	0.30 (-0.4 to 1.0)	0.70 (-0.4 to 1.80)	0.17
RF <sub>CSA</sub> (mm <sup>2</sup> )	73.3 (42.6 to 104.1)	3.7 (-32.1 to 39.4)	70.0 (23.5 to 115.9)	0.003
Fat-free mass (kg)	-1.49 (-4.3 to 1.3)	-0.02 (-2.0 to 1.9)	-1.46 (-4.8 to 1.9)	0.37
4MGS (m/s)	0.07 (0.0 to 0.1)	0.02 (0.0 to 0.1)	0.05 (0.0 to 0.1)	0.16
Daily step count	-53 (-369 to 264)	-89 (-485 to 307)	37 (-473 to 546)	0.65
Daily up-down transitions	-1.5 (-7.8 to 4.7)	3.1 (-1.8 to 8.0)	-4.6 (-12.5 to 3.2)	0.31
Daily time spent upright	0.08 (-0.5 to 0.7)	-0.37 (-1.1 to 0.4)	0.45 (-0.5 to 1.4)	0.21
CRQ total score*	0.26 (-1.4 to 1.9)	0.43 (-0.5 to 1.4)	-0.17 (-2.0 to 1.6)	0.77
SGRQ total score†	0.22 (-3.8 to 3.4)	0.07 (-3.1 to 3.2)	-0.30 (-5.0 to 4.4)	0.78
EQ-5D index*	-0.01 (-1.1 to 0.1)	-0.01 (-0.1 to 0.1)	-0.01 (-0.1 to 0.1)	0.78
EQ-5D HRQL VAS*	3.63 (-4.1 to 11.4)	-2.39 (-8.6 to 3.8)	7.3 (-3.7 to 15.7)	0.20

Data are mean (95% CI). Missing data were imputed using a Monte Carlo Markov chain method with 20 datasets and assuming a multivariate normal distribution. 6MWT=6-min walk test. MVC=maximum voluntary contraction. 4MGS=4 m gait speed. RF<sub>CSA</sub>=rectus femoris cross-sectional area. CRQ=Chronic Respiratory Questionnaire. SGRQ=St George's Respiratory Questionnaire. EQ-5D=EuroQol 5-dimension. EQ-5D HRQL VAS=EuroQol 5-dimension health-related quality of life visual analogue scale. \*Scale interpretation: higher score better. †Scale interpretation: lower score better.

**Table 2: Estimates of effect in primary and secondary outcome measures at 6 weeks**

# Exercise training – Neuromuscular Electrical Stimulation

- **Neuromuscular Electrical Stimulation** is a promising training modality within pulmonary rehabilitation, particularly for **severely disabled patients with COPD**. It remains unclear whether NMES is effective for individuals with COPD with a higher degree of baseline exercise tolerance.

# Exercise training

- **Inspiratory muscle training (IMT)**
- **Maximizing the effects of exercise training**
  - Bronchodilators, Anabolic hormonal supplementation, Oxygen supplements, Noninvasive ventilation, Breathing strategies, Walking aids

# Exercise training in ICU patients

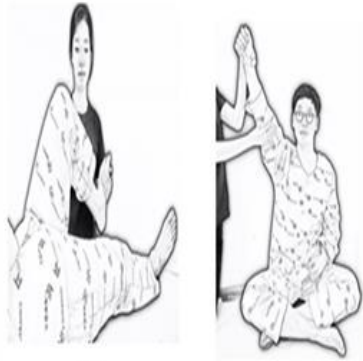



# Exercise training in ICU patients

- **Post Intensive Care syndrome (PICS)**: the collection of health disorders that are common among patients who survive critical illness and intensive care
  - physical, cognitive, psychiatric impairment
- **ICU-acquired weakness(ICUAW)**: muscle weakness that develops during an ICU stay  
(up to 50% of patients who stay in the ICU for at least one week)

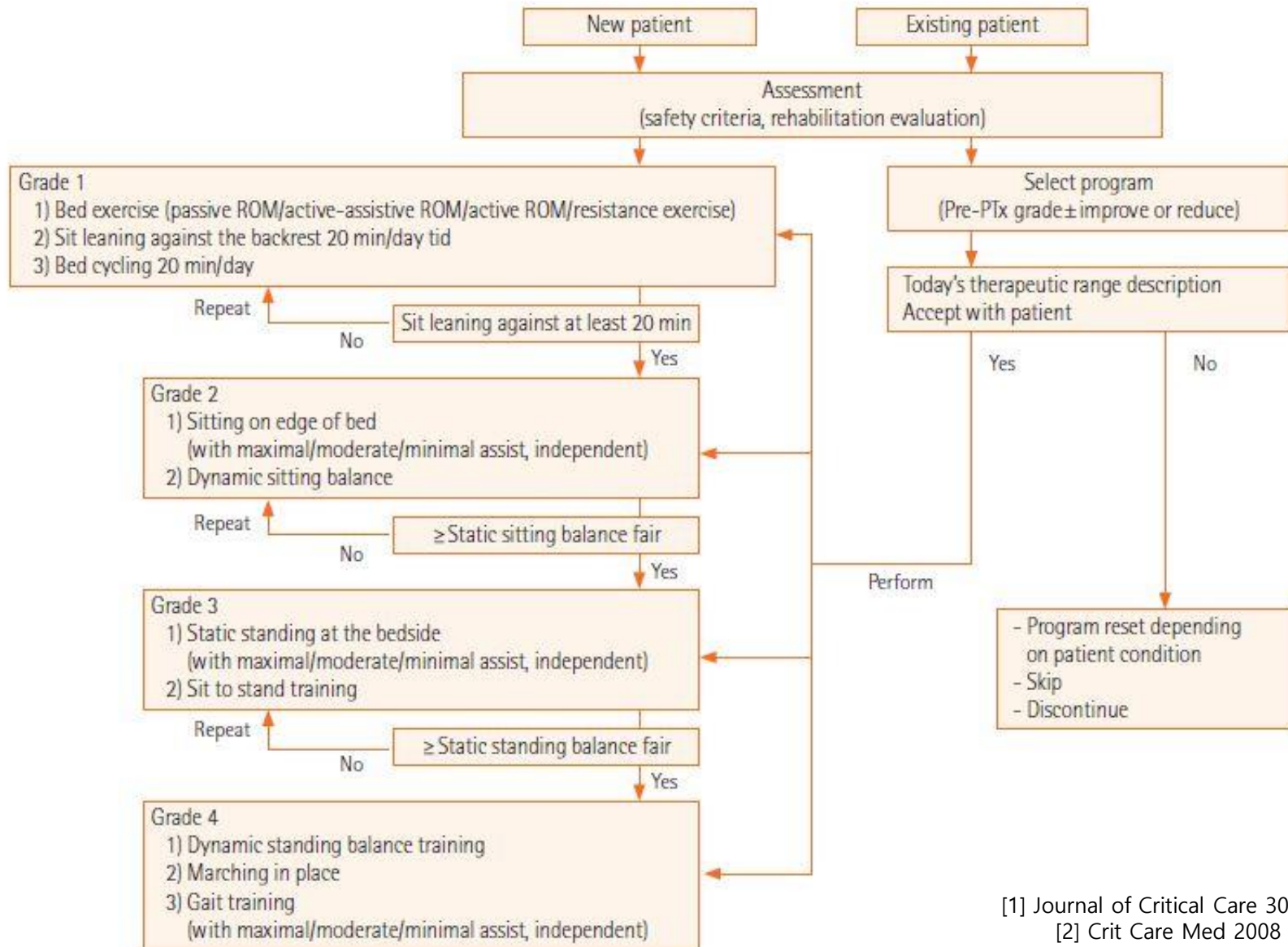
운동 (물리치료)	자가 관리 (작업치료)	의사소통 및 인지 (인지 치료)
수동관절가동운동 능동보조관절가동운동 침상 내 운동 앉은자세 및 선자세 시 균형잡기 침대 옆 의자로 이동 휠체어 보행 보행 훈련	먹기 마시기 목욕, 몸단장, 옷입기, 양말 신기 대변 및 소변 제어 용변 후 처리	듣기 시청하기 말하기/언어(trachoesostomy 환자에서 speaking valve 이용, 쓰기, 대화하기) 집중, 기억, 문제 해결, 안전 인지 지남력

# Exercise training in ICU patients

## 만성 호흡부전 재활치료 단계

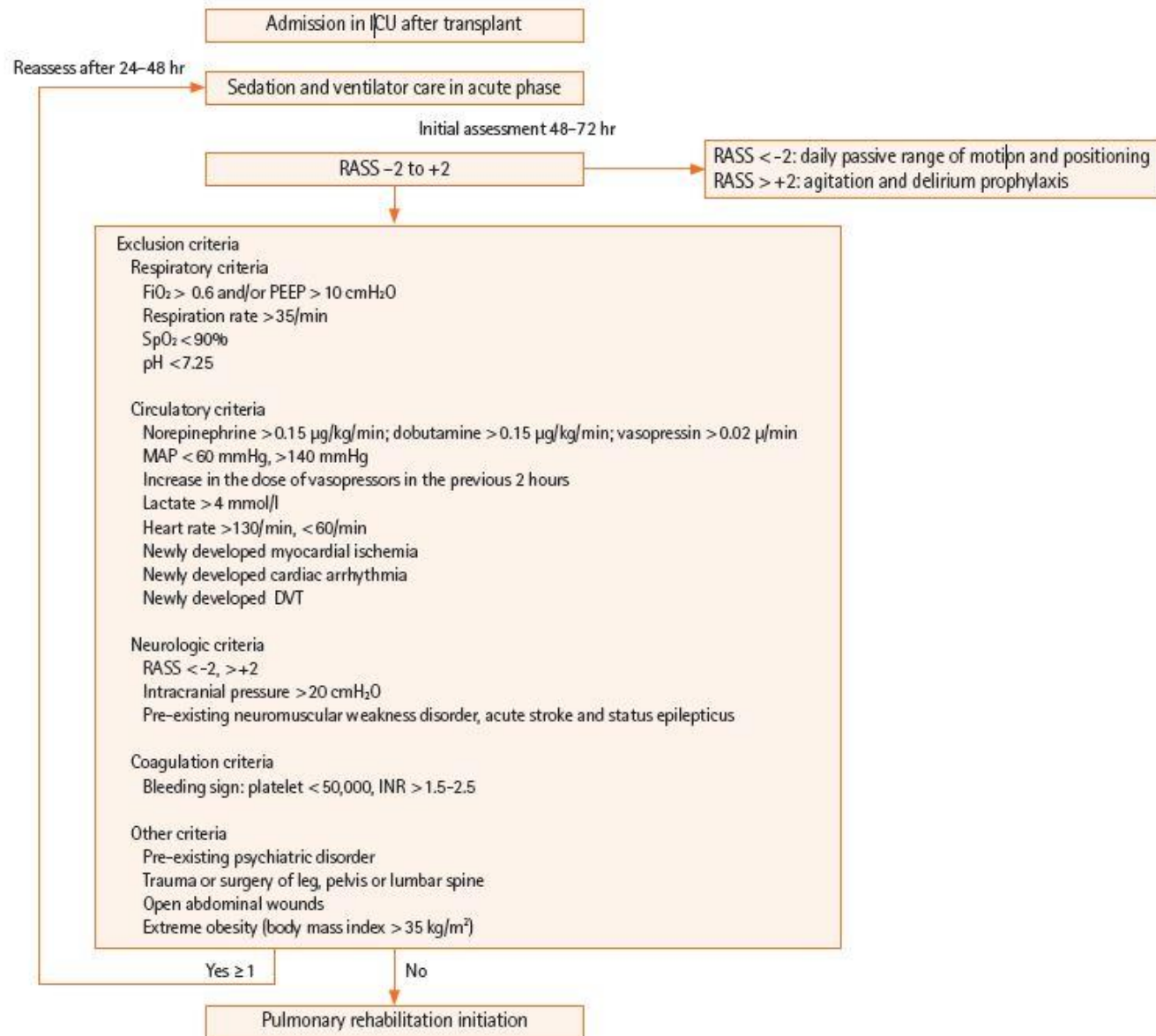
Grade 1		Grade 2	Grade 3			Grade 4		
Bedside PTx		Dangling	Standing			Gait		
<b>G1-1&gt;</b> Bed exercise - Passive ROM - Active-assistive ROM - Active ROM - Resistance exercise	<b>G1-2&gt;</b> Sit leaning against the backrest	<b>G2-1&gt;</b> Sitting on edge of bed	<b>G3-1&gt;</b> <u>Bobath</u> standing (standing 시 무릎, 골반, 상체의 지지가 필요한 경우)	<b>G3-2&gt;</b> Standing with walker	<b>G3-3&gt;</b> Standing without device	<b>G4-1&gt;</b> Marching in place	<b>G4-2&gt;</b> Gait with walker	<b>G4-3&gt;</b> Gait without device
								
G1-1                      G1-2		G2-1	G3-1                      G3-2                      G3-3	G4-2				

# Exercise training in ICU patients

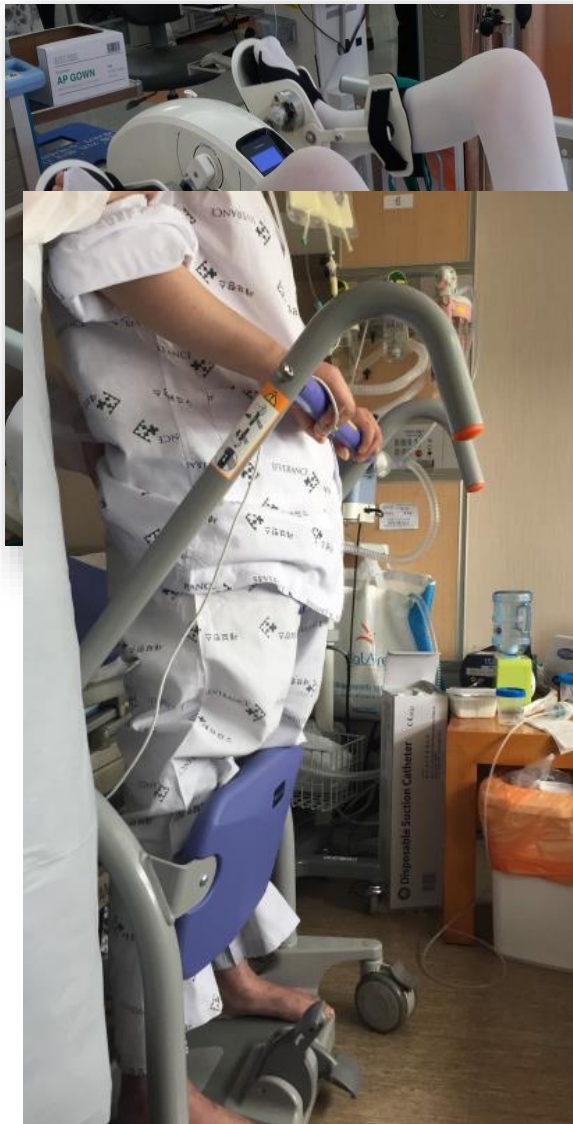


- [1] Journal of Critical Care 30 (2015) 13–18;  
 [2] Crit Care Med 2008 Vol. 36, No. 8;  
 [3] Crit Care Med 2013; 41:S69–S80;  
 [4] Physical therapy volume 92 number 12;

# Exercise training in ICU patients



# Exercise training in ICU patients



Sara Steady(기립 보조기)



Grillo(보행 보조기)



Standing Frame(전동 기립기)

# Exercise training in ICU patients



# Exercise training in ICU patients



# Exercise training in ICU patients



# Summary

- **Pulmonary rehabilitation** is a comprehensive intervention to improve the physical and psychological condition of people with chronic respiratory disease.
- **Exercise training:** Endurance training, Resistance training (upper&lower), Flexibility training, Interval training, NMES, IMT...
- A minimum of 20 sessions, **at least three times per week** to achieve physiologic benefits.
- Framework: FITT – **frequency, intensity, time, type**
- **Exercise training in critically ill patients:** ICUAW, 물리치료&작업치료&인지치료  
Safety criteria!!!

*Thank you for your attention!!*

