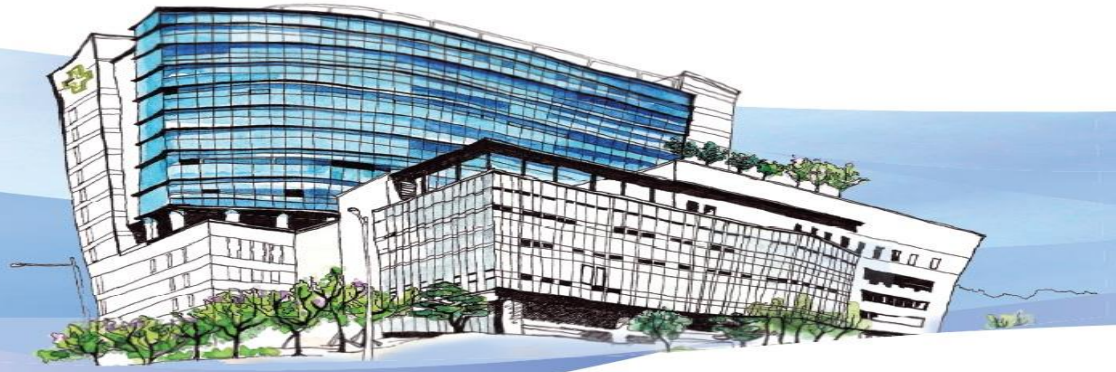


Pulmonary rehabilitation in ILD

해운대백병원

이재하

INJE UNIVERSITY
HAEUNDAE PAIK HOSPITAL

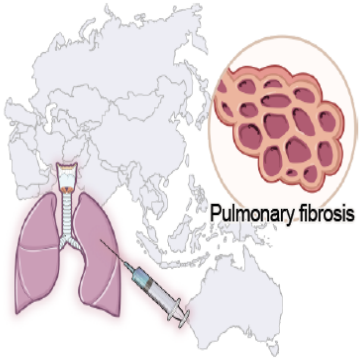
Contents

1. Pulmonary Rehabilitation in ILD – Established Benefits
2. Unresolved Questions: Is Supplemental Oxygen necessary?
3. Unresolved Questions: Beyond Completion → The importance of maintenance
4. Unresolved Questions: Can PR improve survival in ILD?

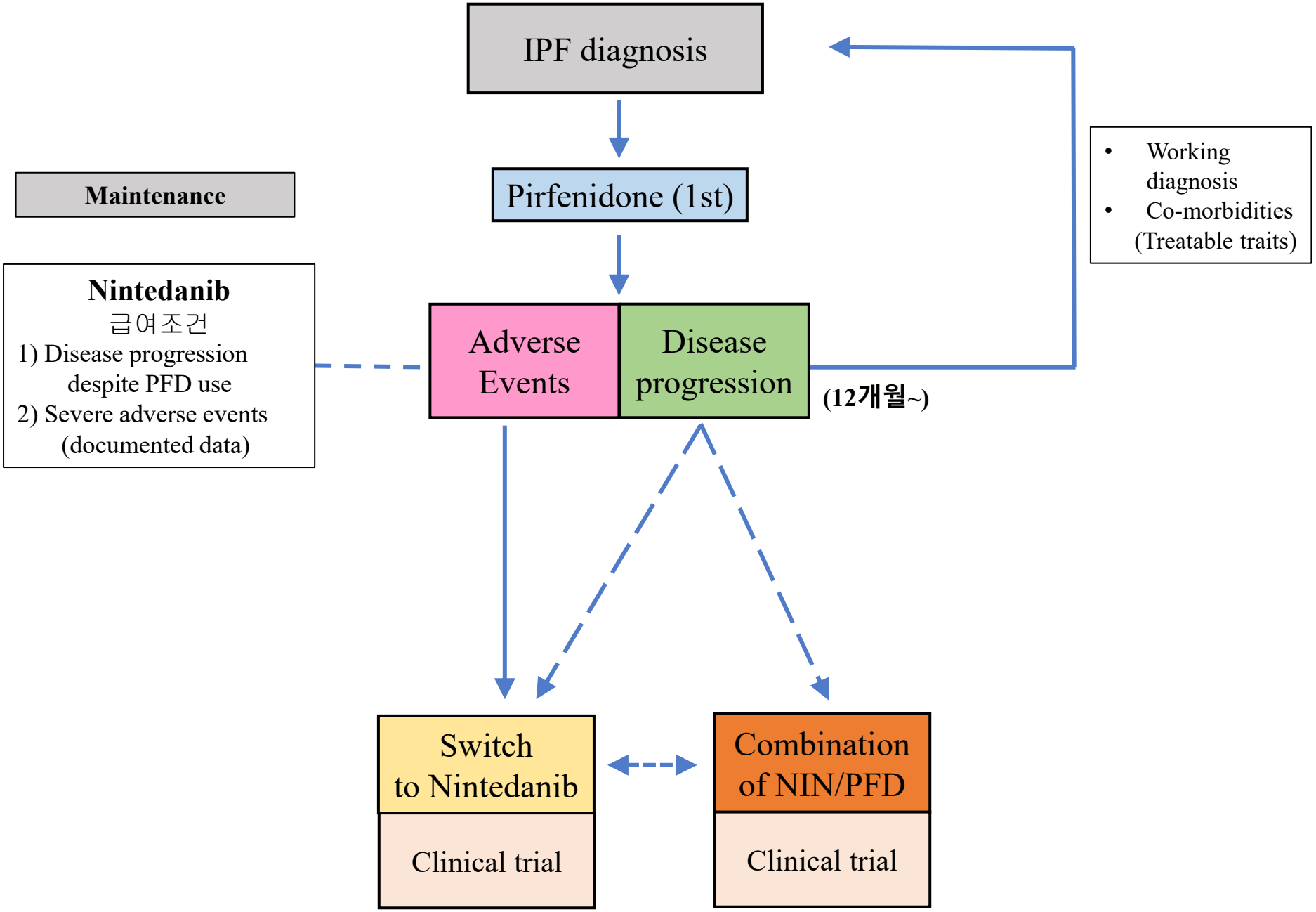
trd Tuberculosis & Respiratory Diseases

Pharmaco-economic Inequalities in Access to Antifibrotic Treatment for Interstitial Lung Disease in the Asia-Pacific Region

https://doi.org/10.4046/trd.2025.0056
ISSN: 1738-3536(Print)/
2005-6184(Online)
Tuberc Respir Dis 2025;88:673-686



	HIGH INCOME COUNTRIES	MIDDLE-HIGH INCOME COUNTRIES	MIDDLE-LOW INCOME COUNTRIES
	• Hong Kong SAR • South Korea • Singapore • Australia • Taiwan • New Zealand • Japan	• Thailand • Malaysia • Indonesia	• Philippines • Vietnam
Antifibrotic treatment schemes			
Public or govt. funded	Yes (except Taiwan)	**South Korea** • Antifibrotics – 10% on patient • Out-of-pocket: High (28%) • Reimbursement: Only Pirfenidone	No
Co-payment / Other	Hospital charity funds, medical schemes for civil servants/retirees		Pharma-subsidised programs
OOP expenditure	11.7% – 29.6%		40% – 44.7%
Completed HTA	6/7 countries (85.7%)		None
Reimbursed antifibrotic agents (no. of countries)	Both (5), pirfenidone (1) and nintedanib (1)		Nintedanib (2)

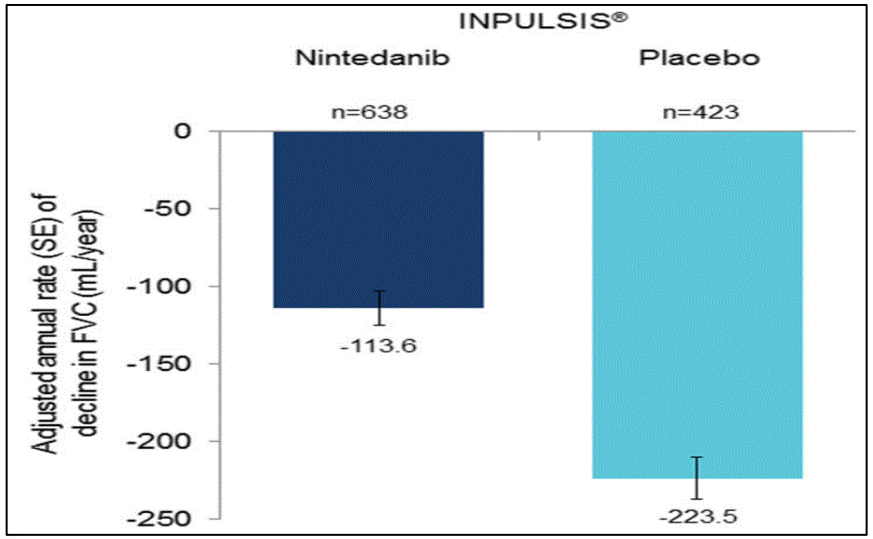


This is speaker's own contributed slide.

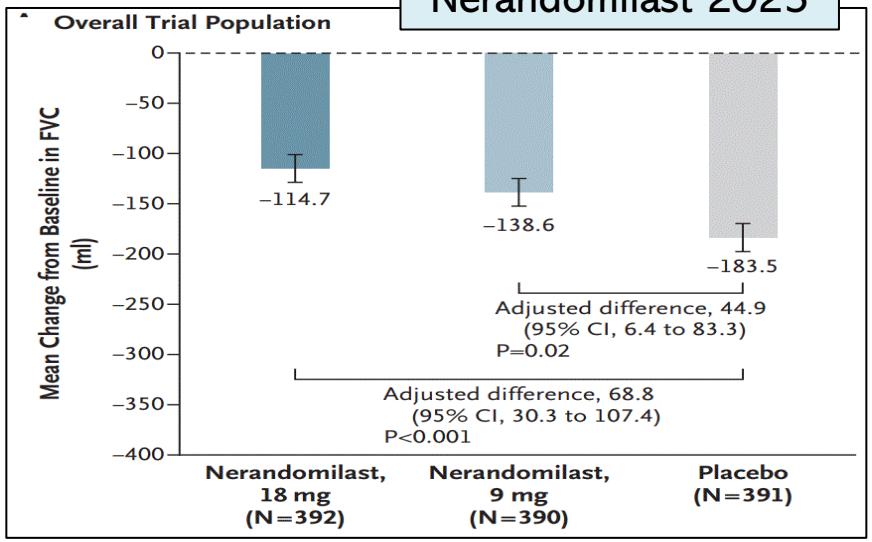
What can antifibrotics do?

- Reduction of lung function decline
- Reducing the risk of acute exacerbation
- Potential survival benefit

- Limited evidence about symptom relief and QOL
- No evidence about functional capacity
- Severe adverse events
- Insurance reimbursement burden



Nerandomilast 2025



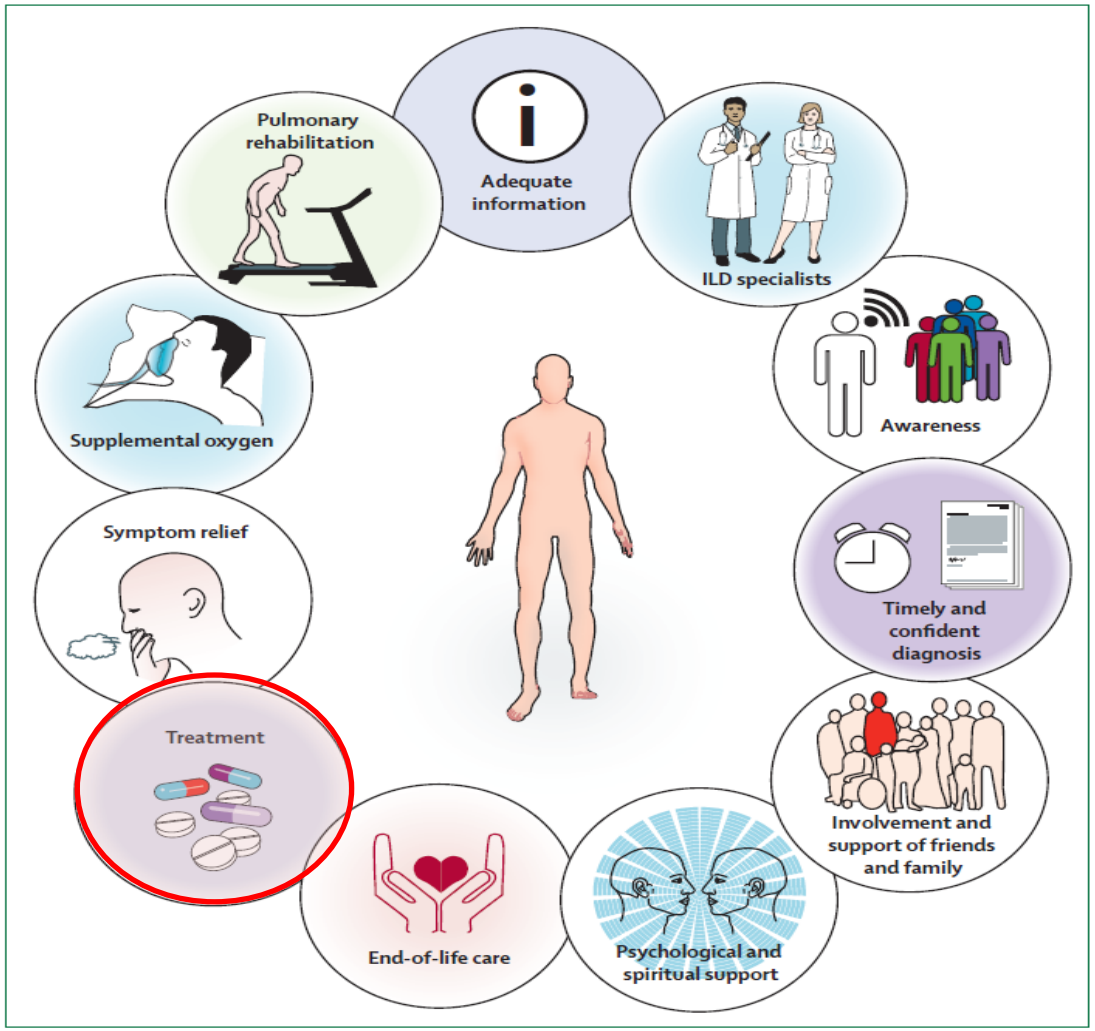
IPF 진단 후 1년, 외래진료

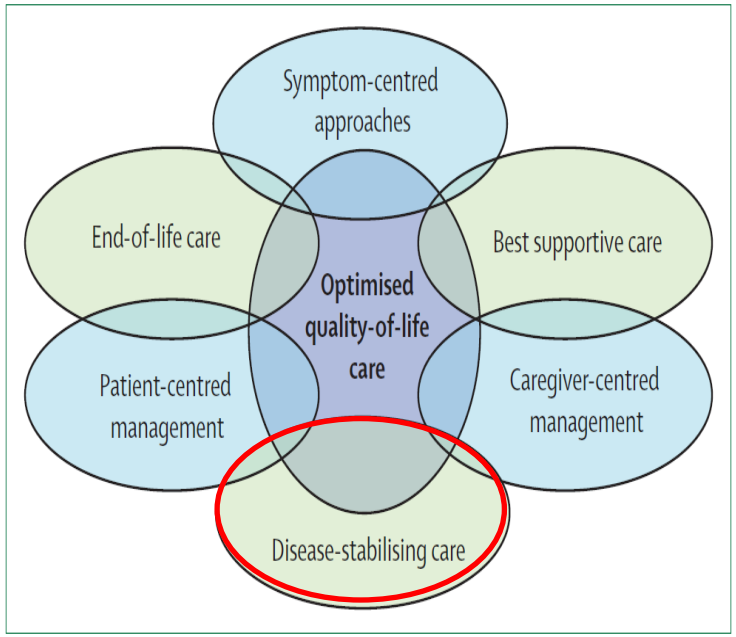
- 잘 지내시죠? 특발성 폐섬유증으로 항섬유화제를 시작한지 1년이 지났습니다. 약제에 의한 부작용이 있으신 가요? 호흡곤란이나 기침은요?
- 혈액검사와 흉부X선 검사는 이상이 없습니다.
- 1년 전에 비해서는 폐기능이 5% 정도 감소했지만, 효과가 있는 것이고 현재 약제의 용량이 최대여서 우선 유지하겠습니다.

IPF 진단 후 외래

- 기침과 활동 시 호흡곤란은 큰 차이가 없어도, 더 피곤하고 힘이 없습니다. 일상생활도 힘들고, 하루하루가 힘들어지는 느낌입니다.
- 폐기능이 1년사이에 5%나 줄었다는데…괜찮은 건가요?
- 지금 약제는 치료제가 아니고, 지연만 시키는 약물 아닌가요? 미국에서 신약, 치료제가 나왔다는데 언제 사용할 수 있나요?
- 약 말고 다른 방법은 없을까요?

Needs of patients with ILD



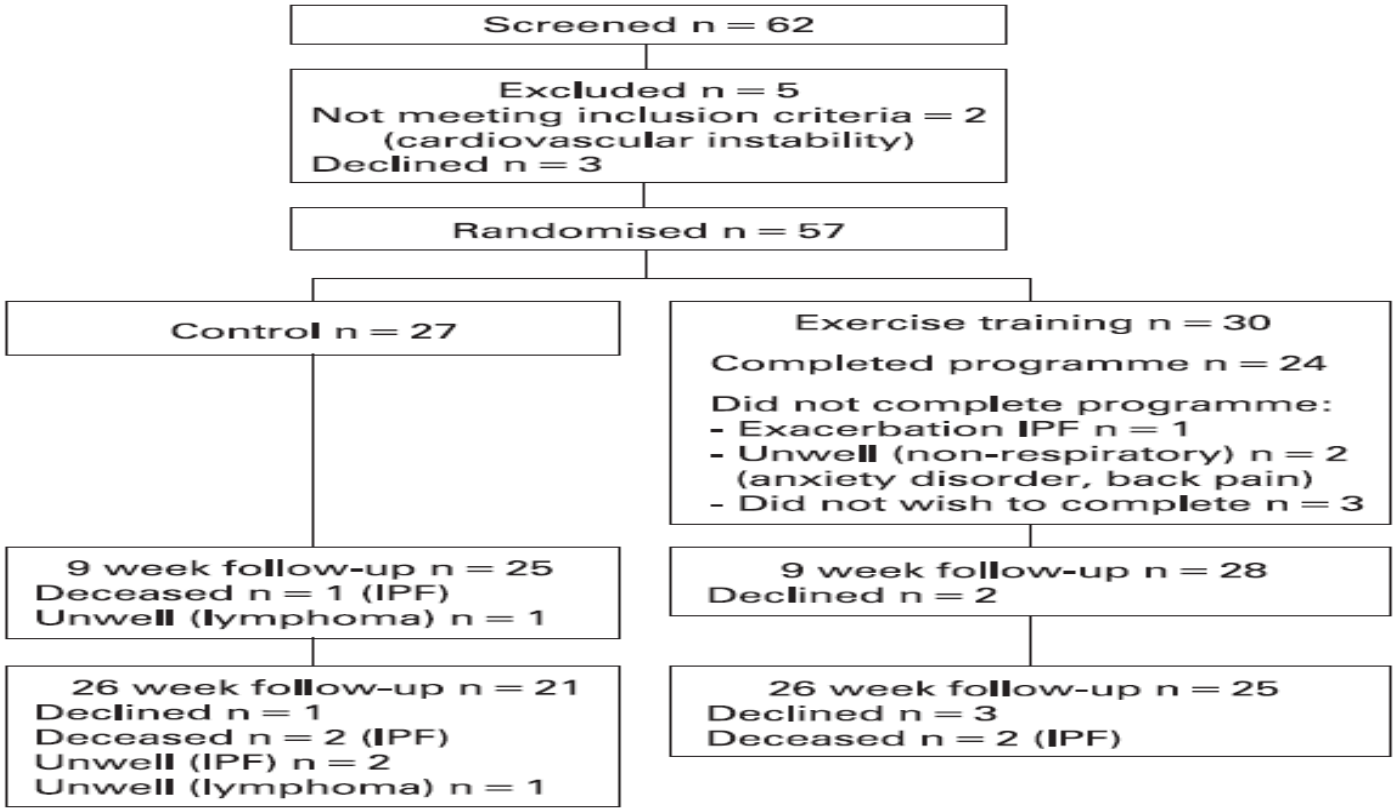


Lancet Respir Med 2017;5:968-80

Contents

Short term improvement in exercise capacity and symptoms following exercise training in interstitial lung disease

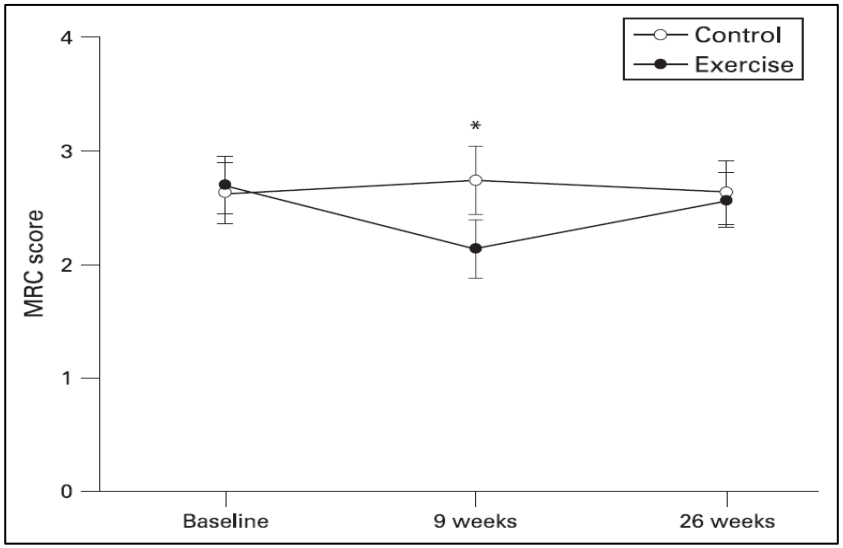
- A two center, randomized, single blinded controlled trial (**1st RCT**) in Australia
- 57 ILD patients (34 IPF)
- The intervention group - a supervised exercise training for 8 wees vs weekly telephone support

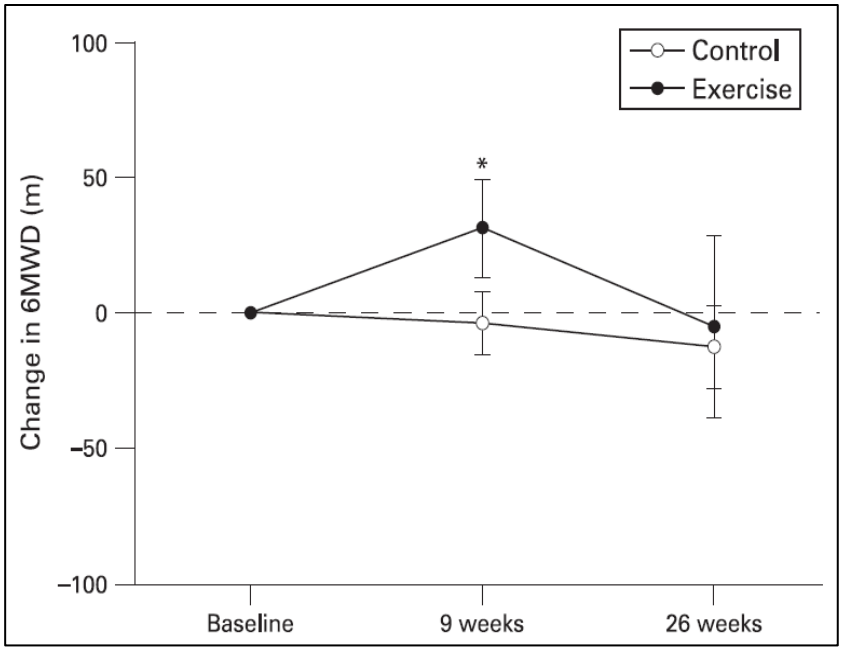


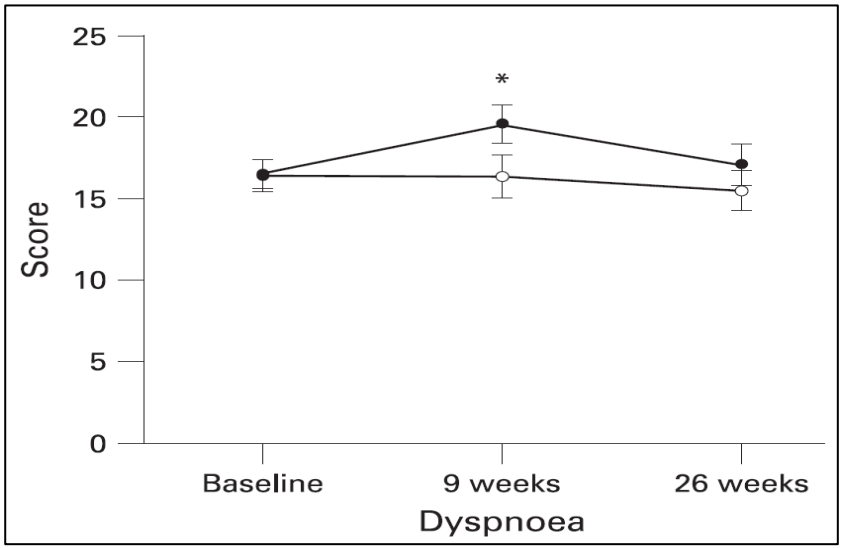
Thorax 2008;63: 554

Short term improvement in exercise capacity and symptoms following exercise training in interstitial lung disease

- PR for 8weeks - safe (80% completion & no adverse events)
- Short term improvement in functional capacity (MD: 35m, p = 0.01), dyspnea (mMRC by 0.7, p = 0.04), fatigue (CRDQ) at 9 weeks; not at 26 weeks
- No difference between IPF & no-IPF group







Thorax 2008;63: 554

ORIGINAL ARTICLE

The evidence of benefits of exercise training in interstitial lung disease: a randomised controlled trial

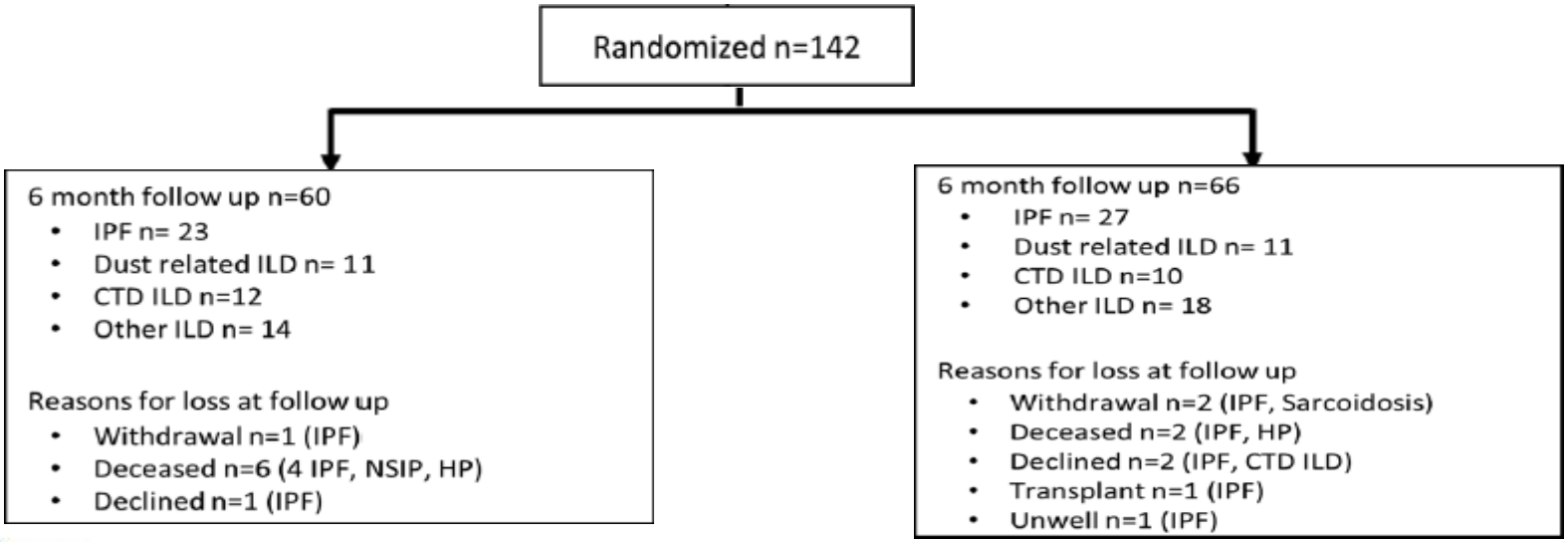
- A multicenter, randomized, assessor-blinded controlled trial in Australia (**The Largest RCT**)
- 142 ILD patients - 61 IPF, 22 Asbestosis, 23 CTD-ILD, 36 others
- The intervention group - a twice-weekly supervised outpatient exercise training for 8 weeks

→ Walking, cycling, upper and lower limb resistance training, home exercise program every week)

→ Supplemental oxygen to maintain SpO2 ≥ 88%

- Key question – Does 1) the etiology and 2) severity of ILD impact to the response to PR?

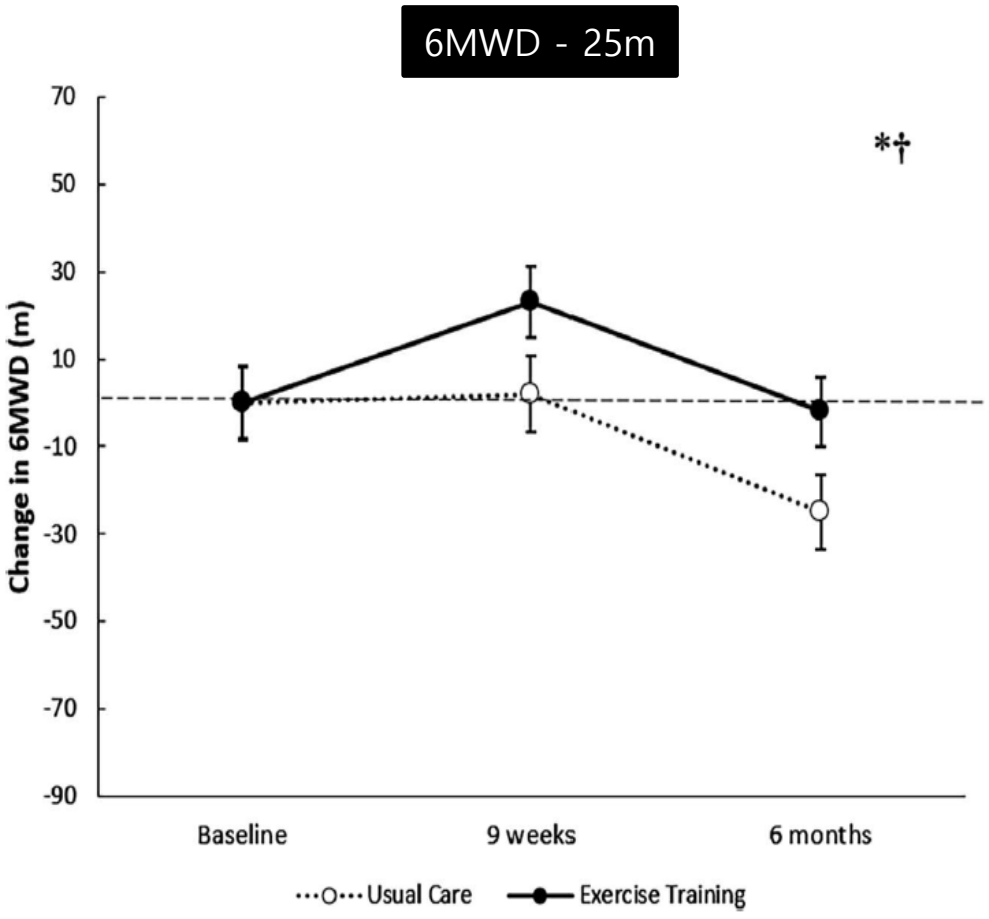
  - 3) Optimal time for PR to achieve maximal benefit?

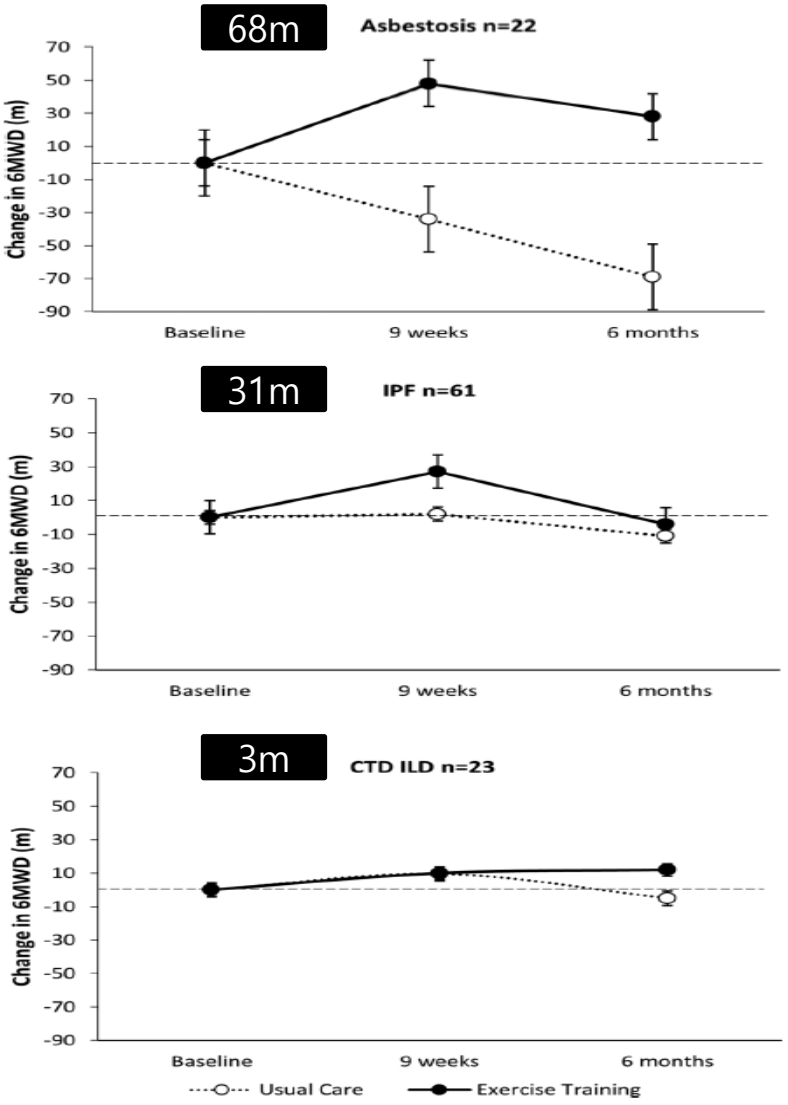


Thorax 2017;72: 610-619

ORIGINAL ARTICLE

The evidence of benefits of exercise training in interstitial lung disease: a randomised controlled trial





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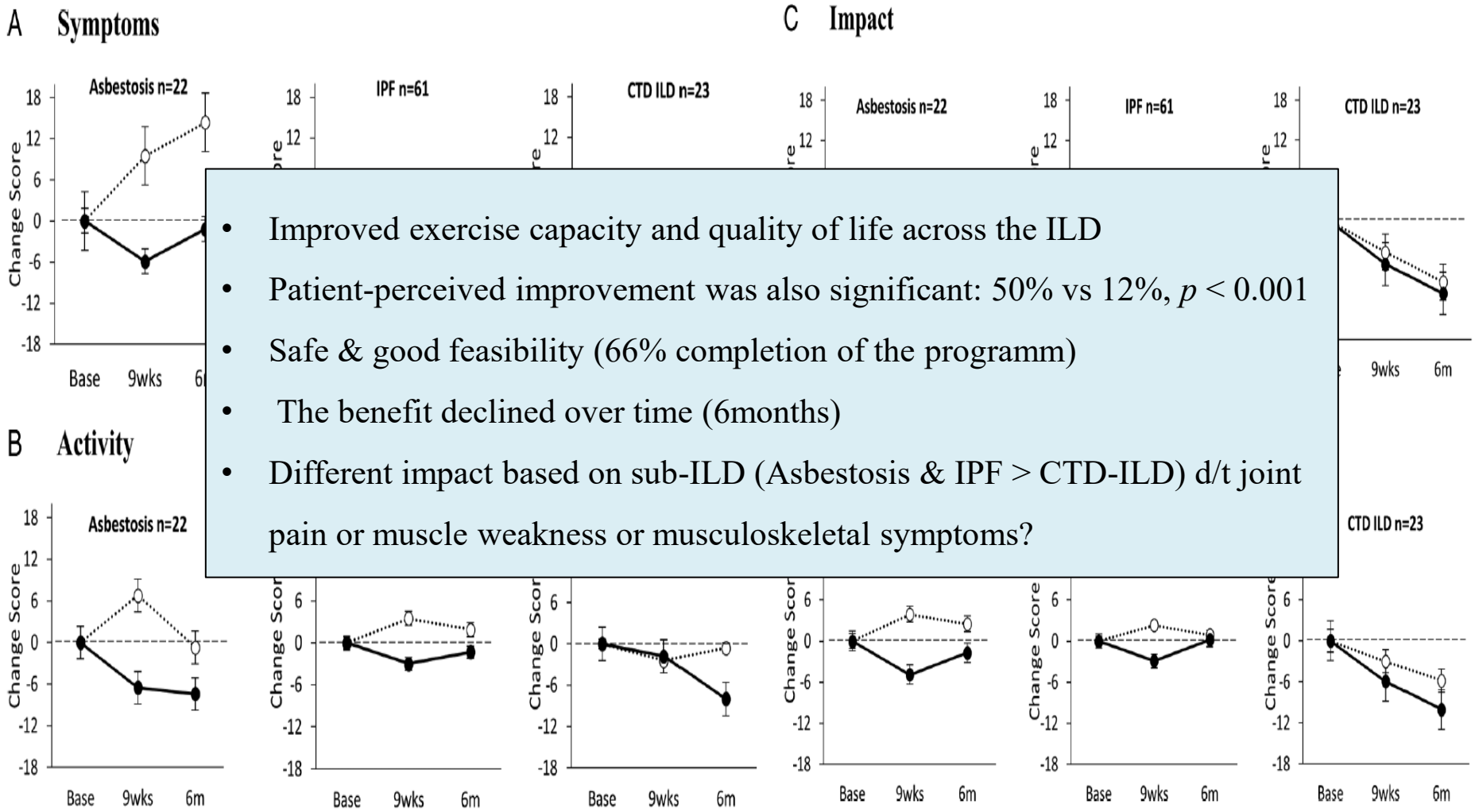
Thorax 2017;72: 610-619

ORIGINAL ARTICLE

The evidence of benefits of exercise training in interstitial lung disease: a randomised controlled trial



- Improved exercise capacity and quality of life across the ILD
- Patient-perceived improvement was also significant: 50% vs 12%, $p < 0.001$
- Safe & good feasibility (66% completion of the programm)
- The benefit declined over time (6months)
- Different impact based on sub-ILD (Asbestosis & IPF > CTD-ILD) d/t joint pain or muscle weakness or musculoskeletal symptoms?

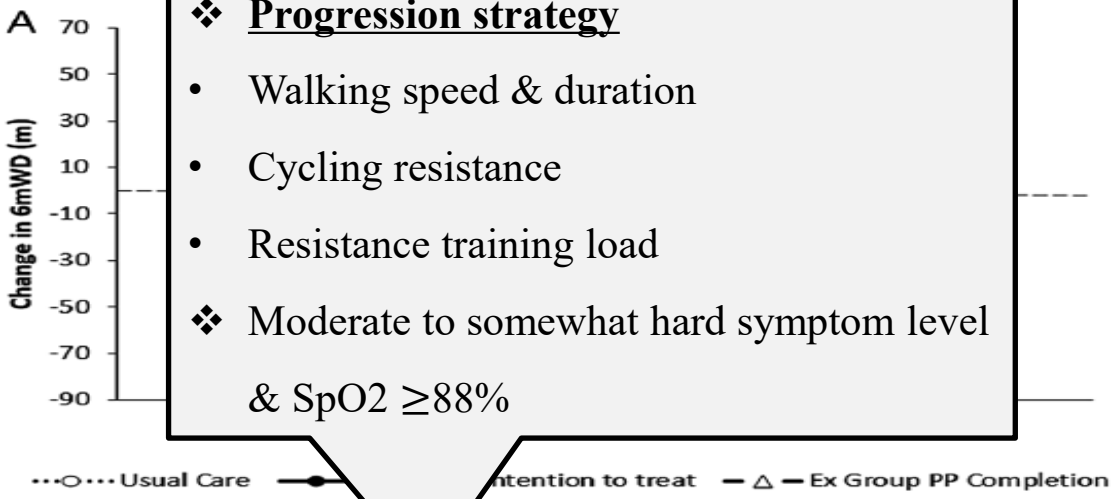
Thorax 2017;72: 610-619

Optimal PR intensity for maximal benefit?

❖ **Progression strategy**

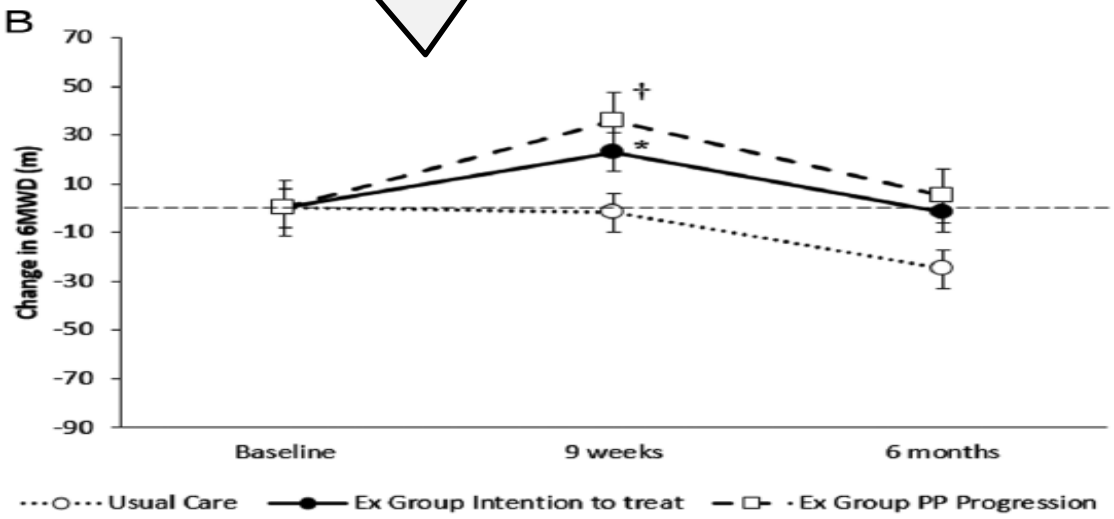
- Walking speed & duration
- Cycling resistance
- Resistance training load

❖ Moderate to somewhat hard symptom level & SpO2 ≥88%



- Intention to treat Vs. Per protocol completion
- No definite difference

MD: (ITT-25m) vs. PP(27m)



- Intention to treat Vs. Per protocol Progression
- MD: PP completion (27m)

PP progression (37m)

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Thorax 2017;72: 610-619

Univariate relationships between baseline predictors and response to rehabilitation

	Short term response			Long term response		
	Change in 6MWD	Change in CRDQ dyspnoea	Change in CRDQ fatigue	Change in 6MWD	Change in CRDQ dyspnoea	Change in CRDQ fatigue
Age (years)	-0.07	0.10	-0.04	-0.14	**-0.31***	-0.20
TLC (%pred)	-0.05	0.01	0.04	**0.34***	0.18	0.03
FVC (ml)	0.02	-0.15	0.01	**0.32***	-0.01	-0.10
FVC (%pred)	0.05	-0.02	-0.04	**0.36***	0.08	-0.07
TLCO (%pred)	-0.15	0.04	0.12	0.16	**0.30***	0.07
PASP (mmHg)	-0.02	0.02	-0.16	**-0.27†**	-0.07	**-0.38***
Nadir SpO_2 (%) on 6MWT	0.06	0.13	0.26	**0.29***	**0.28†**	**0.26†**
Baseline 6MWD (m)	**-0.28†**	-0.16	-0.11	0.12	0.03	-0.03
Baseline CRDQ dyspnoea		**-0.35***	-0.22		**-0.30***	0.04
Baseline CRDQ fatigue		-0.22	**-0.52***		**-0.28†**	**0.40***

Thorax 2017;72: 610-619

Stepwise multiple linear regression model for change in 6MWD following intervention

	B	SE of B	Standardised β	p Value	R^2 (%)
Change from baseline to 9 weeks					
Constant	58.468	21.572		**0.008**	
Group	36.595	11.722	−0.296	**0.002**	
Baseline 6MWD (m)	−0.141	0.045	0.297	**0.002**	15
Change from baseline to 6 months					
Constant	−12.182	36.166		0.737	
PASP (mm Hg)	−1.544	0.637	−0.266	**0.018**	13
FVC (mL)	0.021	0.010	0.224	**0.044**	

Independent predictors for 6MWD improvement

- Short-term: PR itself + Lower 6MWT
- Long-term: Higher FVC + Lower RVSP

In the 9-week model

- PR group showed improvement of 6MWD by 36.5m
- For every 1m higher baseline 6MWD

→ the 9-week improvement is 0.141m smaller

In the 6months model

- For every 1mmHg higher PASP

→ The 6-month 6MWD change is 1.54m worse

- For every baseline FVC 100mg higher

→ The 6-month 6MWD change is 2.1m better

Thorax 2017;72: 610-619

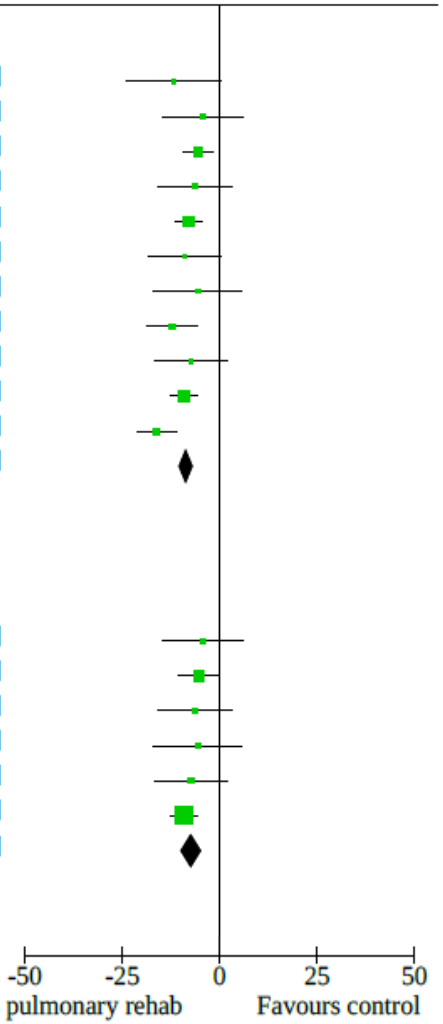
PR significantly improved functional capacity (6MWD) in ILD

Study or Subgroup	Pulmonary rehabilitation Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
1.1.1 All participants								
Dale 2014	71	25.7	7	13	34.4	4	3.6%	58.00 [19.28 , 96.72]
De Las Heras 2019	4.3	24	11	-35.2	47.4	10	5.1%	39.50 [6.88 , 72.12]
Dowman 2017	23	68	74	-2	69.2	68	10.6%	25.00 [2.40 , 47.60]
He 2016	58.7	26.2	15	25.5	25.8	15	15.7%	33.20 [14.59 , 51.81]
Holland 2008	31.2	48.6	30	-3.7	59.8	27	6.7%	34.90 [6.42 , 63.38]
Jackson 2014	-6.2	86.91	11	-15.3	42.89	10	1.6%	9.10 [-48.73 , 66.93]
Jarosch 2020	54.68	85.88	34	-3.83	38.02	17	4.7%	58.51 [24.45 , 92.57]
Ku 2017	27	30.8	20	3.2	29.1	20	15.7%	23.80 [5.23 , 42.37]
Naz 2018	47	33.5	9	-22.6	75.4	9	1.9%	69.60 [15.70 , 123.50]
Nishiyama 2008	42	50.8	13	-4	57.7	15	3.4%	46.00 [5.81 , 86.19]
Perez Bogerd 2018	49	80.4	30	-23	80.4	30	3.3%	72.00 [31.31 , 112.69]
Vainshelboim 2014	70.4	77	15	-10.6	35.4	17	3.0%	81.00 [38.56 , 123.44]
Xiao 2019	53.42	31.9	40	6.97	32.9	34	24.7%	46.45 [31.62 , 61.28]
Subtotal (95% CI)			**309**			**276**	**100.0%**	**40.07 [32.70 , 47.44]**
Heterogeneity: $Chi^2 = 16.25$, df = 12 (P = 0.18); $I^2 = 26\%$								
Test for overall effect: Z = 10.66 (P < 0.00001)								
1.1.2 Idiopathic pulmonary fibrosis only								
De Las Heras 2019	4.3	24	11	-35.2	47.4	10	11.6%	39.50 [6.88 , 72.12]
Dowman 2017	27	68	32	-3.3	71	29	10.1%	30.30 [-4.67 , 65.27]
He 2016	58.7	26.2	15	25.5	25.8	15	35.5%	33.20 [14.59 , 51.81]
Holland 2008	25.05	54.1	20	8.93	33.3	14	14.2%	16.12 [-13.32 , 45.56]
Jackson 2014	-6.2	86.91	11	-15.3	42.89	10	3.7%	9.10 [-48.73 , 66.93]
Jarosch 2020	54.68	85.88	34	-3.83	38.02	17	10.6%	58.51 [24.45 , 92.57]
Nishiyama 2008	42	50.8	13	-4	57.7	15	7.6%	46.00 [5.81 , 86.19]
Vainshelboim 2014	70.4	77	15	-10.6	35.4	17	6.8%	81.00 [38.56 , 123.44]
Subtotal (95% CI)			**151**			**127**	**100.0%**	**37.25 [26.16 , 48.33]**
Heterogeneity: $Chi^2 = 9.00$, df = 7 (P = 0.25); $I^2 = 22\%$								
Test for overall effect: Z = 6.58 (P < 0.00001)								

*Cochrane Database of Systematic Review*2021;1:CD013040

PR significantly improved quality of life(SGRQ total) in ILD

Study or Subgroup	Pulmonary rehabilitation Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
1.12.1 All participants								
Dale 2014	-6.2	14.3	7	6.4	7.3	4	1.9%	-12.60 [-25.38 , 0.18]
De Las Heras 2019	-7	14	11	-2.5	11.5	10	2.6%	-4.50 [-15.42 , 6.42]
Dowman 2017	-4.8	11.8	74	1.1	11.9	68	20.6%	-5.90 [-9.80 , -2.00]
Gaunaurd 2014	-4.1	14.7	11	2.7	8.2	10	3.1%	-6.80 [-16.86 , 3.26]
Ku 2017	-8.89	3.6	20	-0.47	7.6	20	23.1%	-8.42 [-12.11 , -4.73]
Naz 2018	-15.4	13.2	9	-5.9	8	9	3.1%	-9.50 [-19.58 , 0.58]
Nishiyama 2008	-2.9	14.13	13	3.1	18.25	15	2.2%	-6.00 [-18.01 , 6.01]
Perez Bogerd 2018	-7	13.4	30	6	13.4	30	6.8%	-13.00 [-19.78 , -6.22]
Shen 2016	-9.2	13.5	16	-1.4	14.3	15	3.3%	-7.80 [-17.60 , 2.00]
Vainshelboim 2014	-6.9	6.5	15	2.8	3.6	17	22.9%	-9.70 [-13.41 , -5.99]
Xiao 2019	-18.13	12.6	40	-1.02	11.6	34	10.3%	-17.11 [-22.63 , -11.59]
Subtotal (95% CI)			**246**			**232**	**100.0%**	**-9.29 [-11.06 , -7.52]**
Heterogeneity: Chi² = 13.64, df = 10 (P = 0.19); I² = 27%								
Test for overall effect: Z = 10.27 (P < 0.00001)								
1.12.2 Idiopathic pulmonary fibrosis only								
De Las Heras 2019	-7	14	11	-2.5	11.5	10	5.9%	-4.50 [-15.42 , 6.42]
Dowman 2017	-3	10.4	32	2.7	10.9	29	24.3%	-5.70 [-11.06 , -0.34]
Gaunaurd 2014	-4.1	14.7	11	2.7	8.2	10	6.9%	-6.80 [-16.86 , 3.26]
Nishiyama 2008	-2.9	14.13	13	3.1	18.25	15	4.8%	-6.00 [-18.01 , 6.01]
Shen 2016	-9.2	13.5	16	-1.4	14.3	15	7.3%	-7.80 [-17.60 , 2.00]
Vainshelboim 2014	-6.9	6.5	15	2.8	3.6	17	50.8%	-9.70 [-13.41 , -5.99]
Subtotal (95% CI)			**98**			**96**	**100.0%**	**-7.91 [-10.55 , -5.26]**
Heterogeneity: Chi² = 2.07, df = 5 (P = 0.84); I² = 0%								
Test for overall effect: Z = 5.86 (P < 0.00001)								



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*Cochrane Database of Systematic Review*2021;1:CD013040

Cochrane Library

Cochrane Database of Systematic Reviews

Pulmonary rehabilitation for interstitial lung disease (Review)

Dowman L, Hill CJ, May A, Holland AE

Current Established Role of PR in ILD

The best-established benefits are improvements

- Exercise capacity (with endurance time)
- Dyspnea
- Health-related quality of life

→ PR is a core non-pharmacologic treatment in PR

AMERICAN THORACIC SOCIETY DOCUMENTS

Pulmonary Rehabilitation for Adults with Chronic Respiratory Disease

An Official American Thoracic Society Clinical Practice Guideline

3. Should adults with ILD undertake pulmonary rehabilitation?	For adults with ILD, we recommend participation in pulmonary rehabilitation	Strong Moderate

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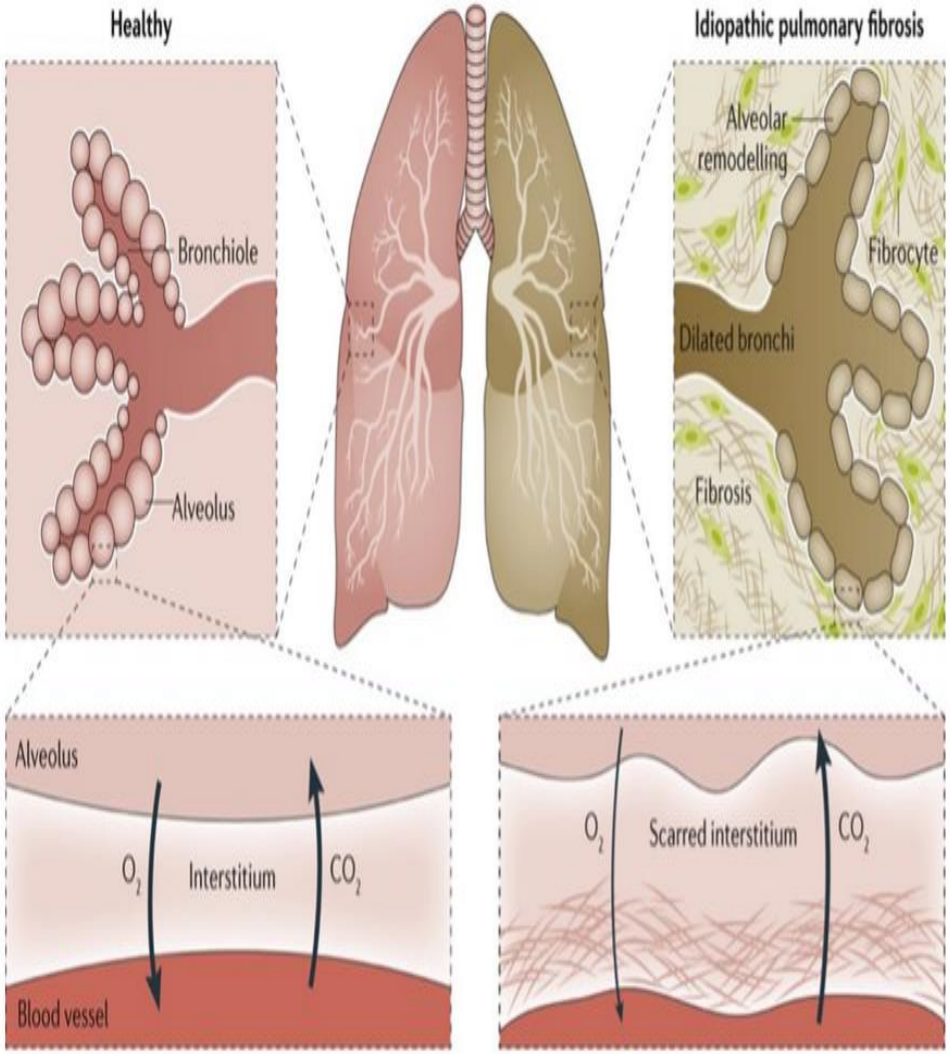
*Cochrane Database of Systematic Review*2021;1:CD013040

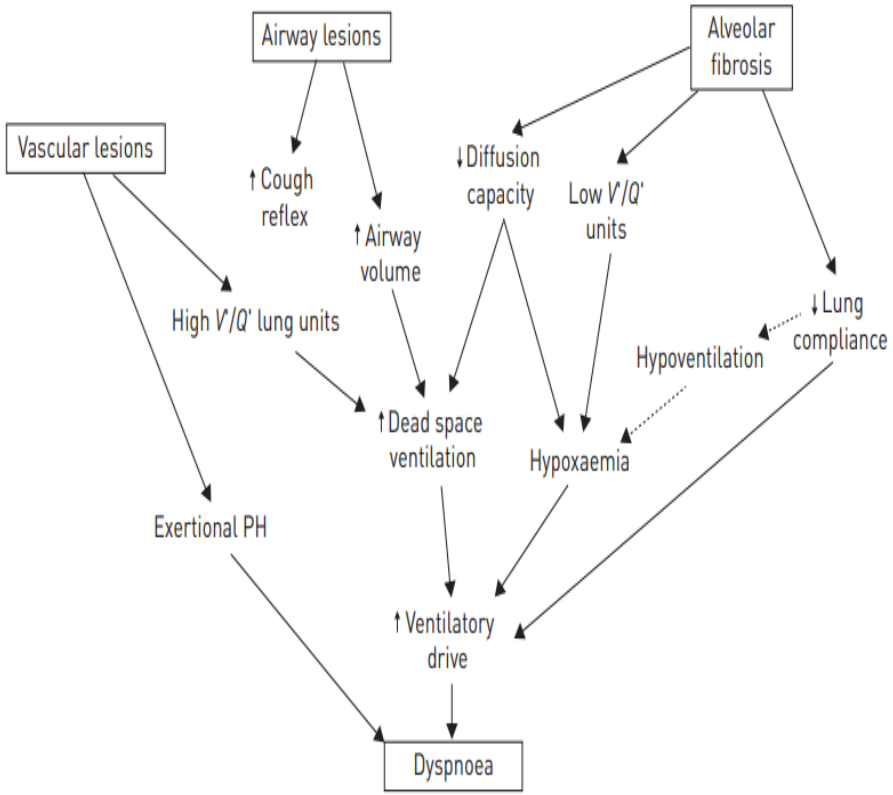
Contents

1. Pulmonary Rehabilitation in ILD – Established Benefits
2. **Unresolved Questions: Is Supplemental Oxygen necessary?**
3. Unresolved Questions: Beyond Completion → The importance of maintenance
4. Unresolved Questions: Can PR improve survival in ILD?

Pathophysiology and cycle of reduced physical activity and hypoxemia in ILD



Prominent diffusion limitation (thick alveolar-capillary membrane) with compounded pulmonary vascular abnormalities and reduced capillary transit time during exercise than COPD & other CRDs.



Front. Rehabilit. Sci. 2;744102

CHEST

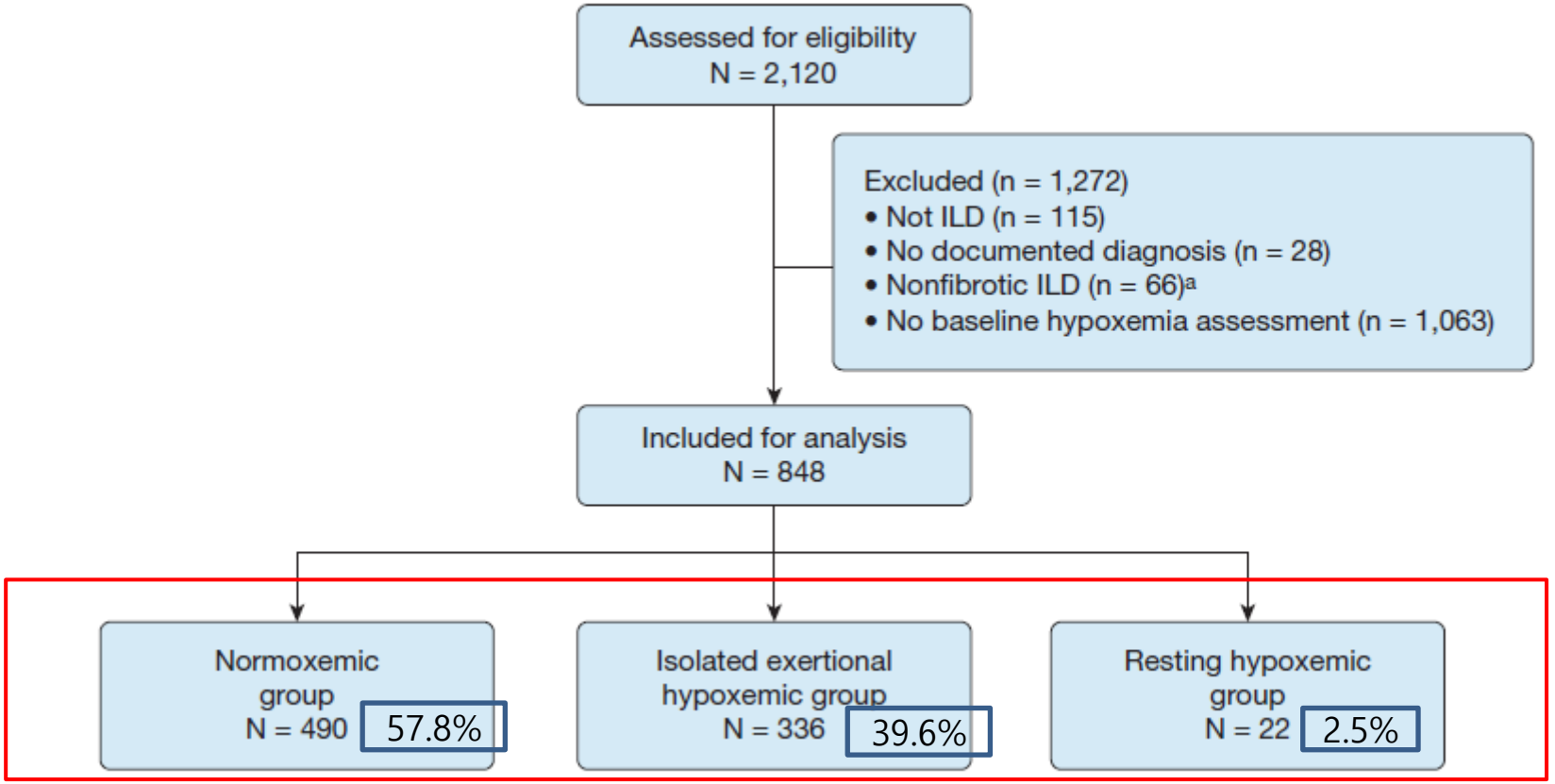
Incidence and Prognostic Significance of Hypoxemia in Fibrotic Interstitial Lung Disease

An International Cohort Study

Check for updates

- International retrospective multicenter study – Three countries, 848 patients with fibrotic ILD (258 IPF)
- Definition: Exertional hypoxemia – nadir SpO2 <88% during 6MWT on room air

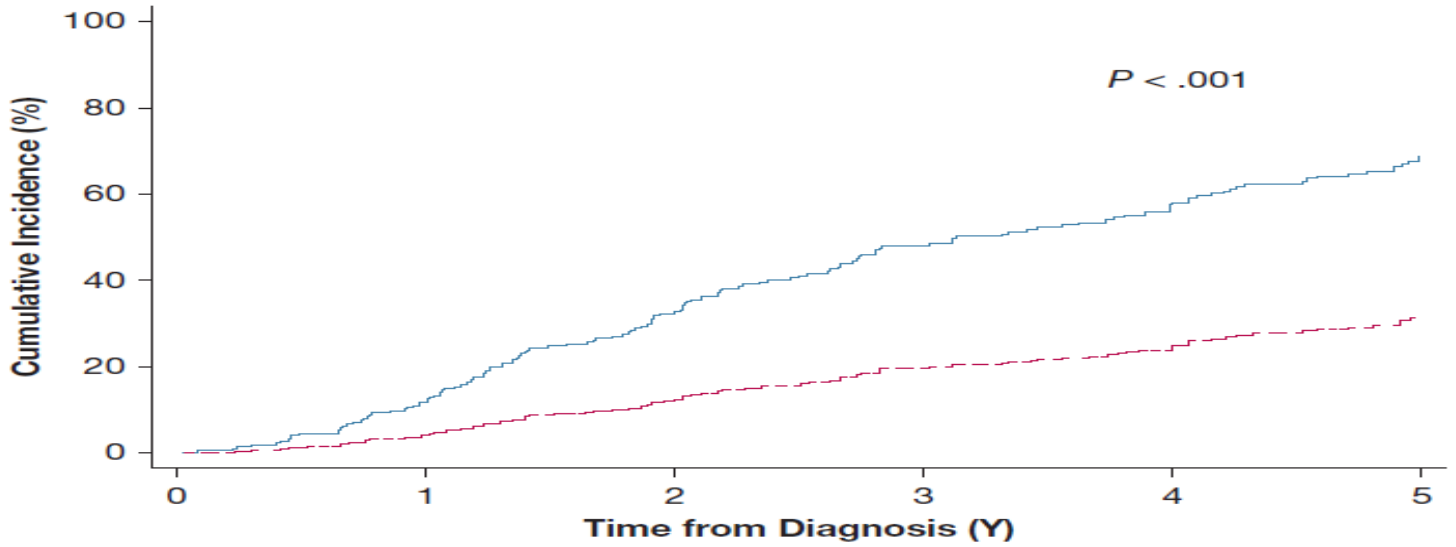
  Resting hypoxemia – SpO2 <88% or PaO2 ≤55mmHg



CHEST 2021; 160(3):994-1005

Cumulative incidence of exertional hypoxemia from time of diagnosis

- Among normoxemic group (n=490) – 5 year cumulative incidences: IPF (58.3%) vs non-IPF (35.7%)
- 1 year - 6.1%
- 2 years - 17.3%
- 3 years - 40.1%



Number at risk						
IPF:	120	93	51	33	19	11
Non-IPF:	370	319	252	191	154	120
Cumulative incidence						
IPF:		8.0%	24.1%	37.4%	47.0%	58.3%
Non-IPF:		4.1%	13.0%	20.7%	26.9%	35.7%

Non-IPF IPF

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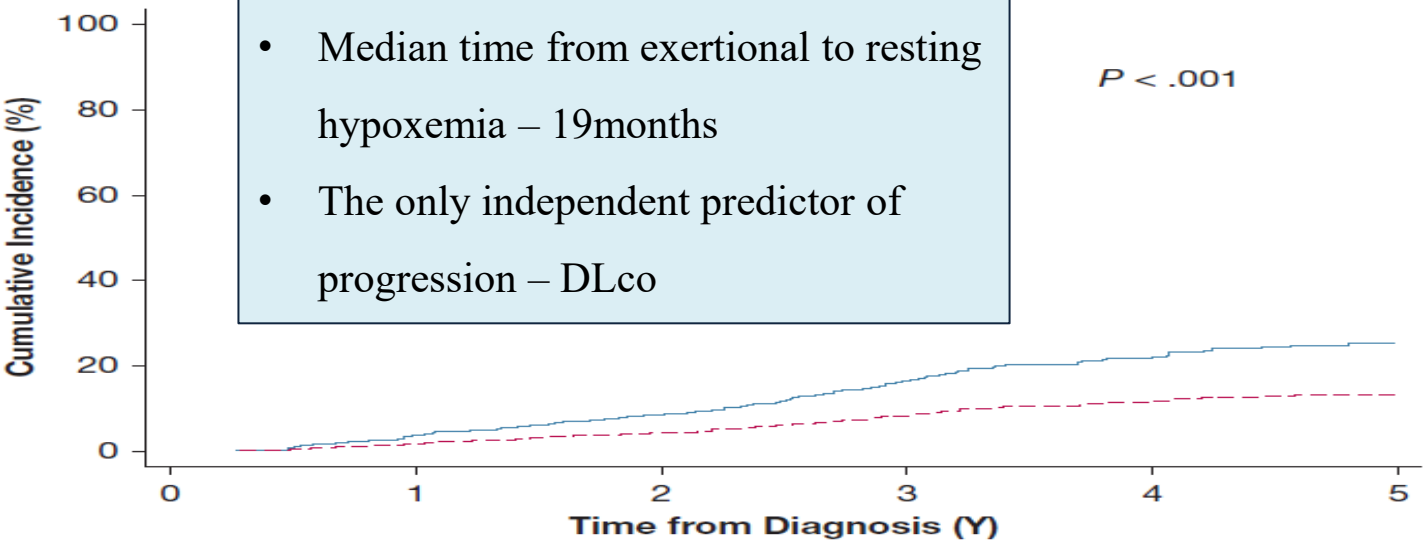
CHEST 2021; 160(3):994-1005

Cumulative incidence of resting hypoxemia from time of diagnosis

- 5 year cumulative incidences: IPF (22.8%) vs non-IPF (11.4%)
- 1 year - 2.4%
- 2 years - 5.6%
- 3 years – 16.5%

- Median time from exertional to resting hypoxemia – 19months
- The only independent predictor of progression – DLco



Number at risk						
IPF:	234	206	161	107	66	41
Non-IPF:	592	544	469	352	270	211
Cumulative incidence						
IPF:		2.7%	7.1%	14.1%	19.1%	22.8%
Non-IPF:		1.2%	3.4%	6.8%	9.4%	11.4%

Non-IPF IPF

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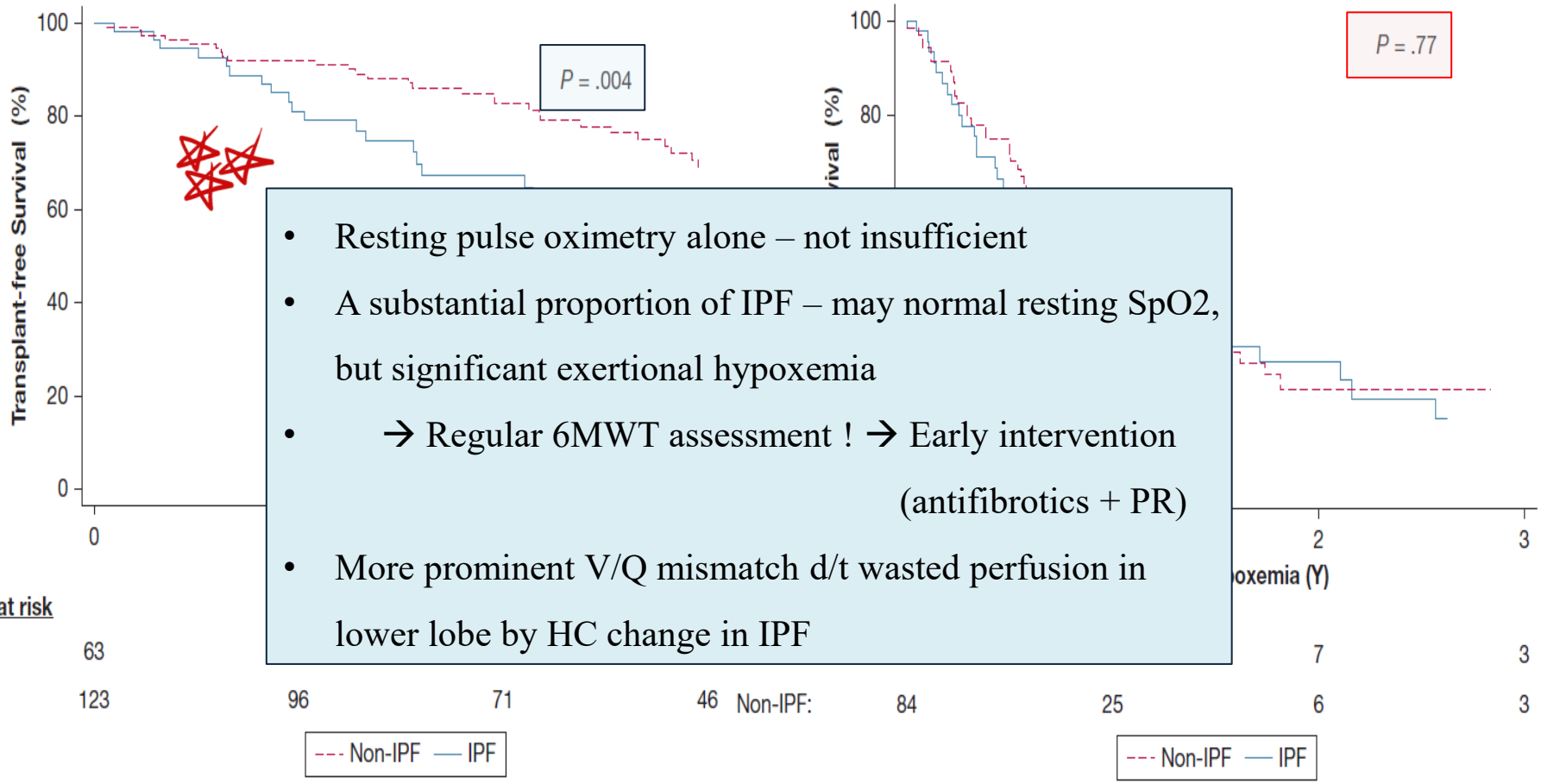
Prognostic significance of hypoxemia between IPF and non-IPF

- Survival after new-onset exertional hypoxemia
- 1-year: 96%, 2-year: 92%, 3-year: 84%

- Survival after new-onset resting hypoxemia
- 1-year: 58%, 2-year:44%, 3-year: 28%



- Resting pulse oximetry alone – not insufficient
- A substantial proportion of IPF – may normal resting SpO2, but significant exertional hypoxemia
- → Regular 6MWT assessment ! → Early intervention (antifibrotics + PR)
- More prominent V/Q mismatch d/t wasted perfusion in lower lobe by HC change in IPF

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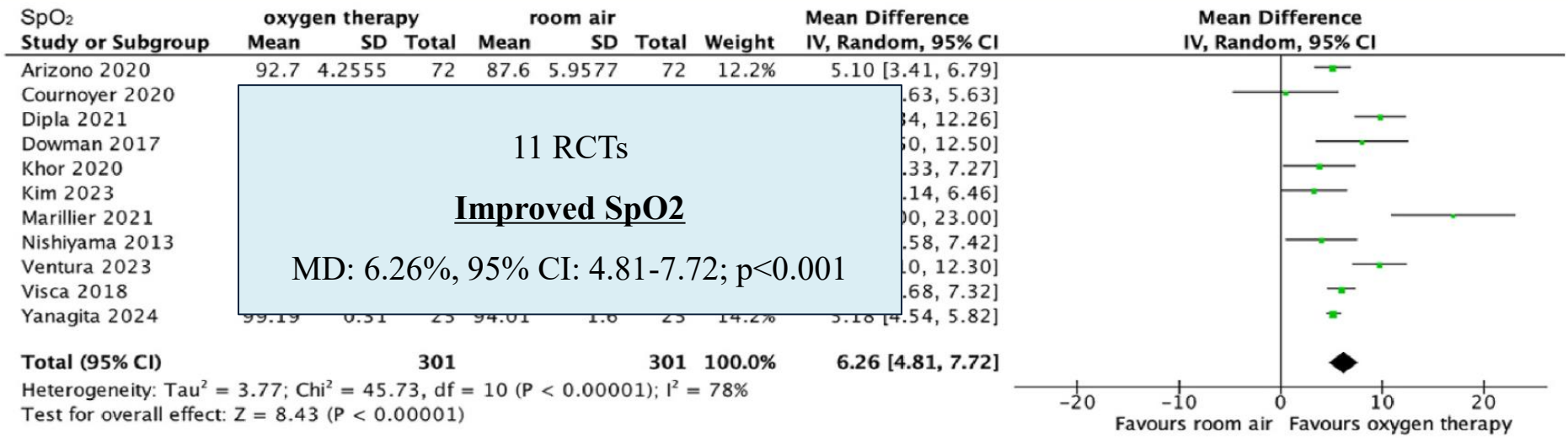
CHEST 2021; 160(3):994-1005

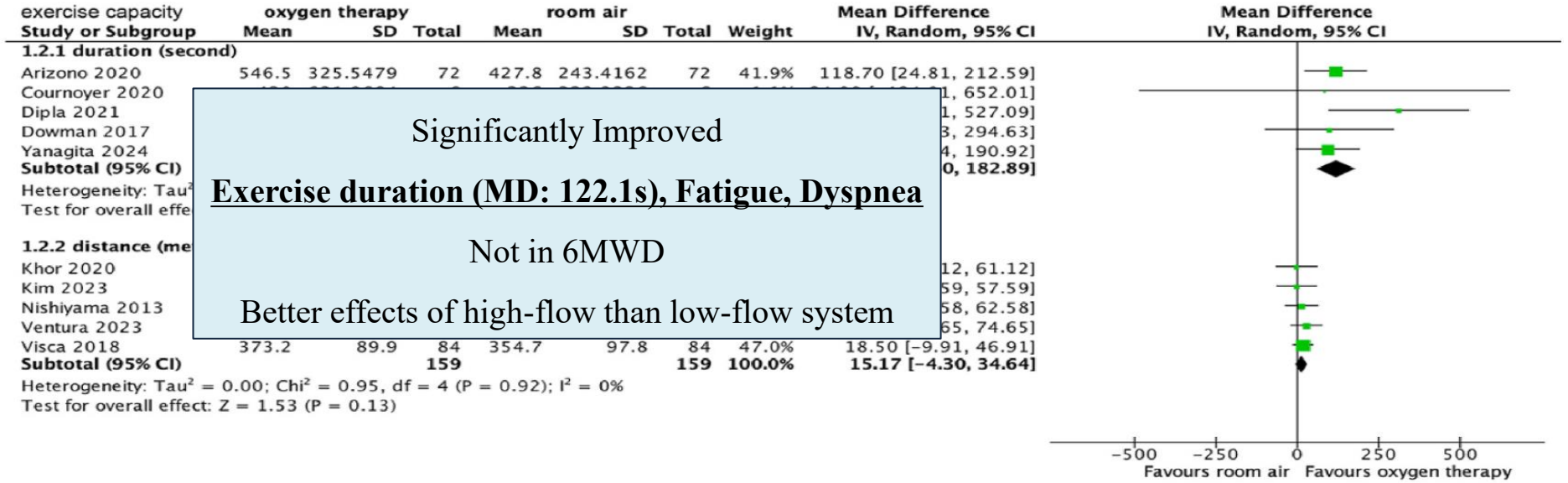
Oxygen therapy for exercise capacity in fibrotic interstitial lung disease: A systematic review and meta-analysis of randomised controlled trials



11 RCTs

Improved SpO2

MD: 6.26%, 95% CI: 4.81-7.72; p<0.001



Significantly Improved

Exercise duration (MD: 122.1s), Fatigue, Dyspnea

Not in 6MWD

Better effects of high-flow than low-flow system

CHEST 2021; 160(3):994-1005

Oxygen Therapy in ILD
: A Pulmonary Rehabilitation–Centered Approach

Exercise Oxygen in ILD

Exertional hypoxemia is common in ILD, especially in IPF

Mechanisms include:
- Diffusion limitation
- Increased oxygen demand during exercise
- Reduced gas-exchange time
- V/Q mismatch
- Pulmonary vascular involvement

Clinical Consequences:
- ✓ Dyspnea
- ✓ Fatigue
- ✓ Reduced exercise tolerance
- ✓ Activity limitation
- ✓ Impaired quality of life

Oxygen supplementation during exercise is essential
in pulmonary rehabilitation

Assess even without resting hypoxemia:
- 6MWT • 6MWT
- CPET • CPET

Be cautious of

Inaccurate SpO_2 Monitoring

Titrate Oxygen Individually:

- Nasal Cannula O_2

or

- ✓ HFNC
- ✓ Mask

Maintain Adequate Exercise O_2

Step 1. Baseline Screening
Screen for High Risk
- Resting $SpO_2 \leq 95\%$
- Reduced DLco
- Advanced ILD or IPF
- Exertional inapproriate symptoms

Step 2. Exercise Assessment
- Nadir SpO_2 in 6MWT or CPET

Step 3. Oxygen Prescription & Titration
- Maintain $SpO_2 \geq 88–90\%$
- Start: **Nasal Cannula 2–6 L/min**
- or Mask, HFNC

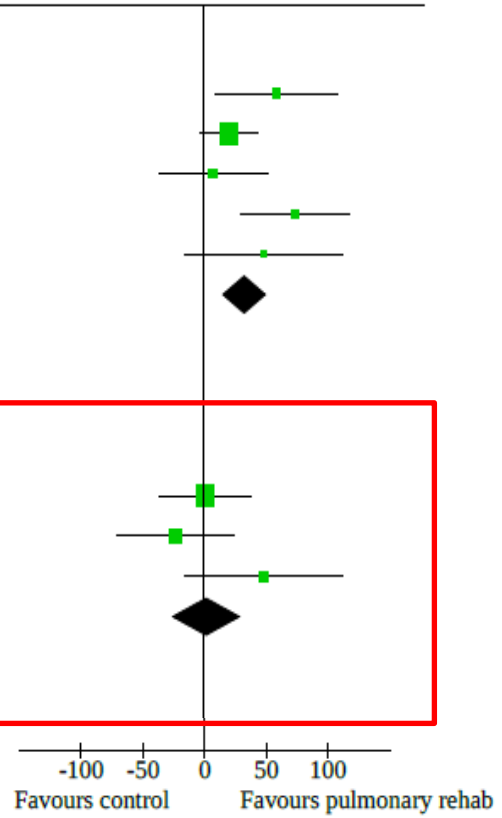
Step 4. Monitoring & Reassessment
- Exercise SpO_2, Symptoms
- Endurance Time
- Walking Distance
- Recovery Time

Step 5. Long-Term Oxygen Strategy
After Pulmonary Rehab

Contents

PR significantly improved functional capacity (6MWD) at long-term follow-up period?

Study or Subgroup	Pulmonary rehabilitation Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
1.2.1 All participants								
Dale 2014	39.5	29.21	6	-19	44.38	4	11.6%	58.50 [9.13 , 107.87]
Dowman 2017	-4	71.4	74	-24	70.5	68	52.0%	20.00 [-3.35 , 43.35]
Holland 2008	-5.2	89.8	30	-12.6	79	27	14.8%	7.40 [-36.42 , 51.22]
Perez Bogerd 2018	39	87.3	30	-35	87.3	30	14.5%	74.00 [29.82 , 118.18]
Vainshelboim 2014	-1	86	14	-49	86	14	7.0%	48.00 [-15.71 , 111.71]
Subtotal (95% CI)			**154**			**143**	**100.0%**	**32.43 [15.58 , 49.28]**
Heterogeneity: Chi² = 7.04, df = 4 (P = 0.13); I² = 43%								
Test for overall effect: Z = 3.77 (P = 0.0002)								
1.2.2 Idiopathic pulmonary fibrosis only								
Dowman 2017	-11	72	32	-12	75	29	51.5%	1.00 [-35.98 , 37.98]
Holland 2008	-19.15	101.25	20	3.93	32.41	14	31.2%	-23.08 [-70.59 , 24.43]
Vainshelboim 2014	-1	86	14	-49	86	14	17.3%	48.00 [-15.71 , 111.71]
Subtotal (95% CI)			**66**			**57**	**100.0%**	**1.64 [-24.89 , 28.17]**
Heterogeneity: Chi² = 3.08, df = 2 (P = 0.21); I² = 35%								
Test for overall effect: Z = 0.12 (P = 0.90)								



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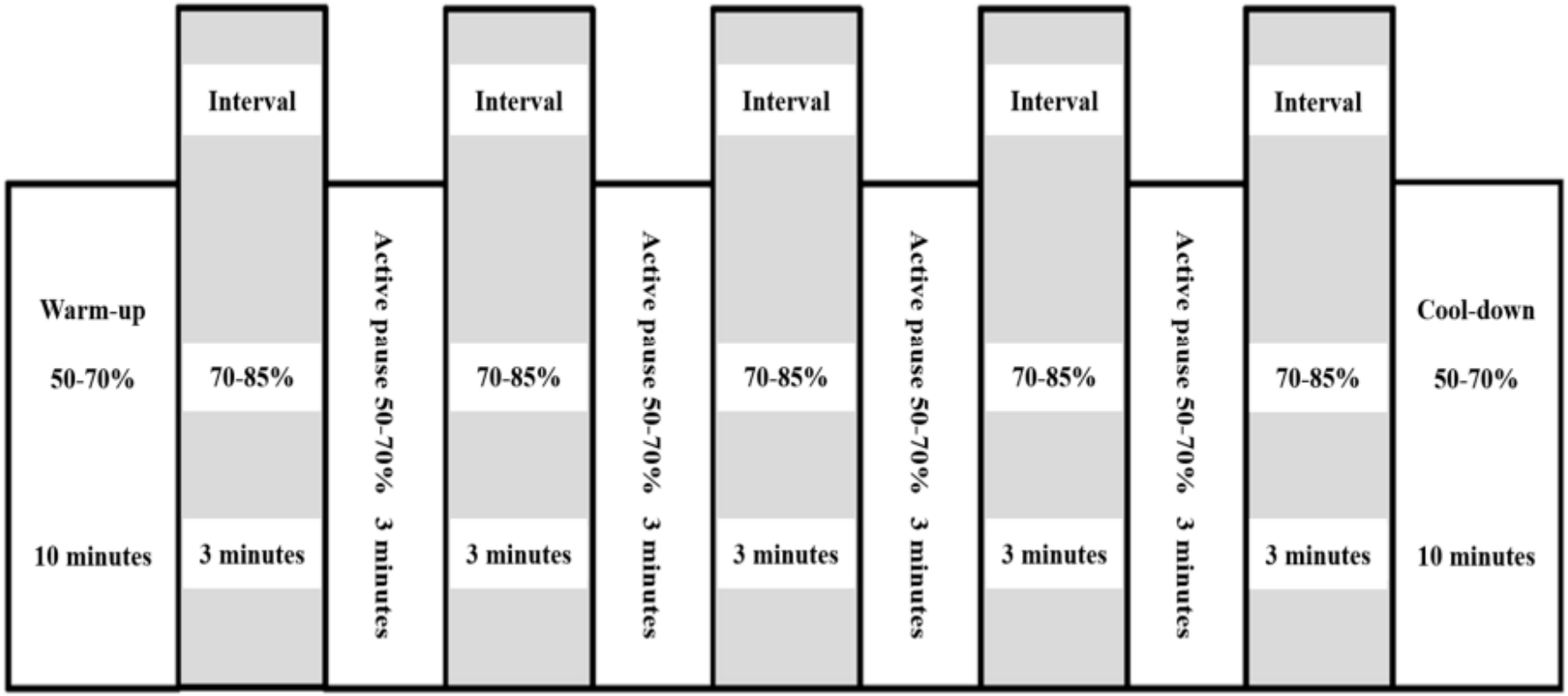
*Cochrane Database of Systematic Review*2021;1:CD013040

Long-term effect of Center-based PR in ILD

- A prospective, interventional, single-center study in Haeundae Paik Hospital between 2019 and 2021
- 26 IPF patients
- Aim: To evaluate the efficacy of center-based PR for eight-weeks in patients with IPF



Life 2023, 13, 403

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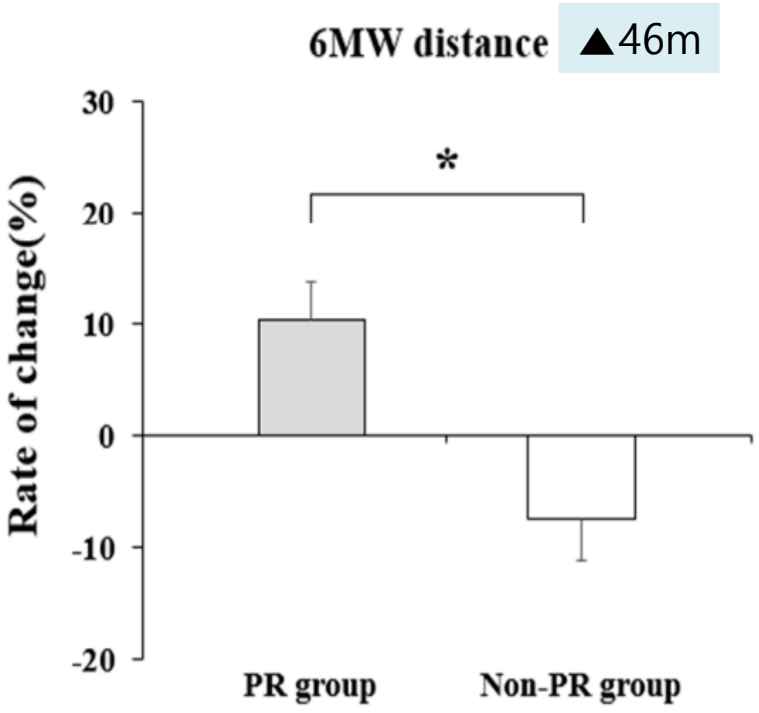
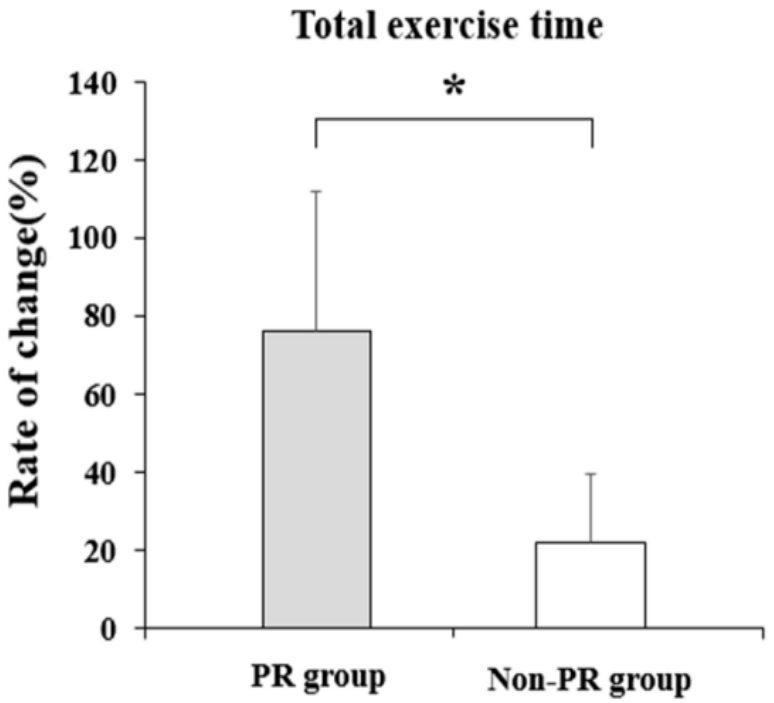
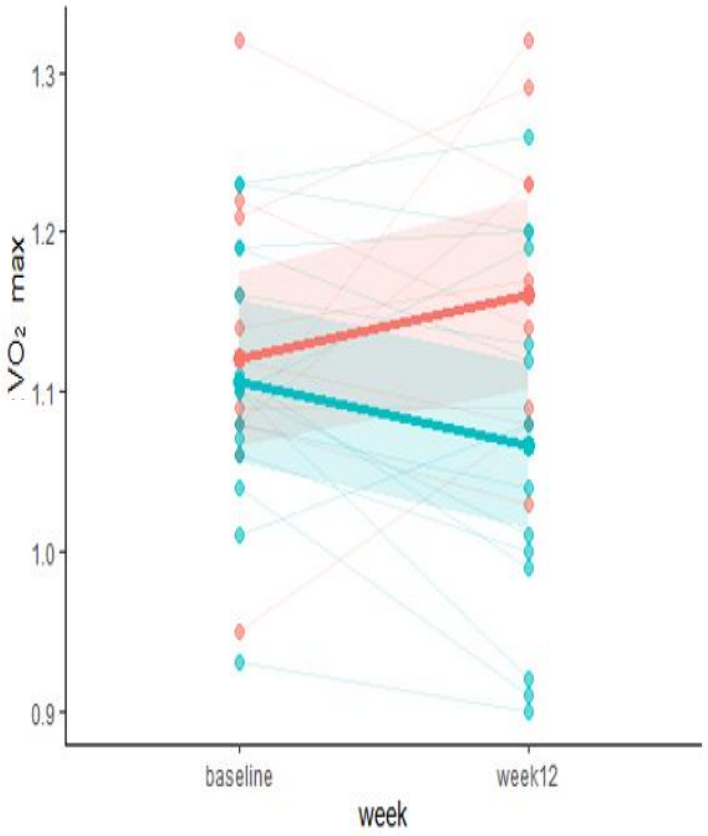


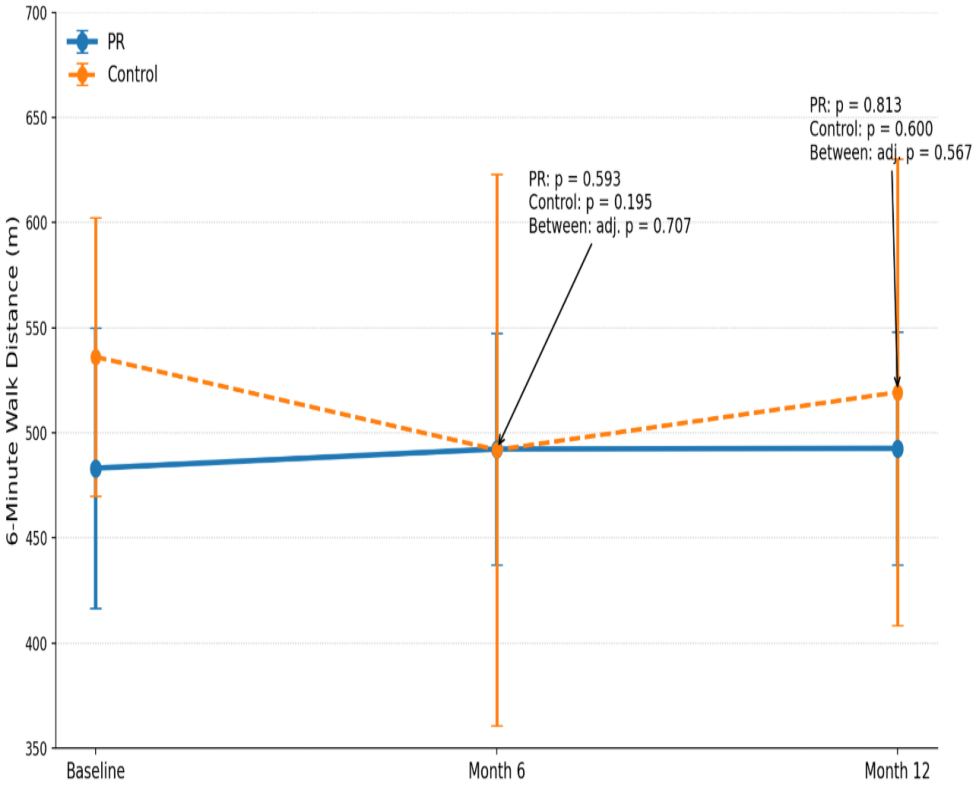


Life 2023, 13, 403

Long-term effect of Center-based PR in ILD

- A prospective, interventional, single-center study in Haeundae Paik Hospital between 2022 and 2024
- 28 IPF patients (13 PR Vs. 15 Control group)
- Aim: To evaluate the long-term efficacy of center-based PR for eight-weeks in patients with IPF

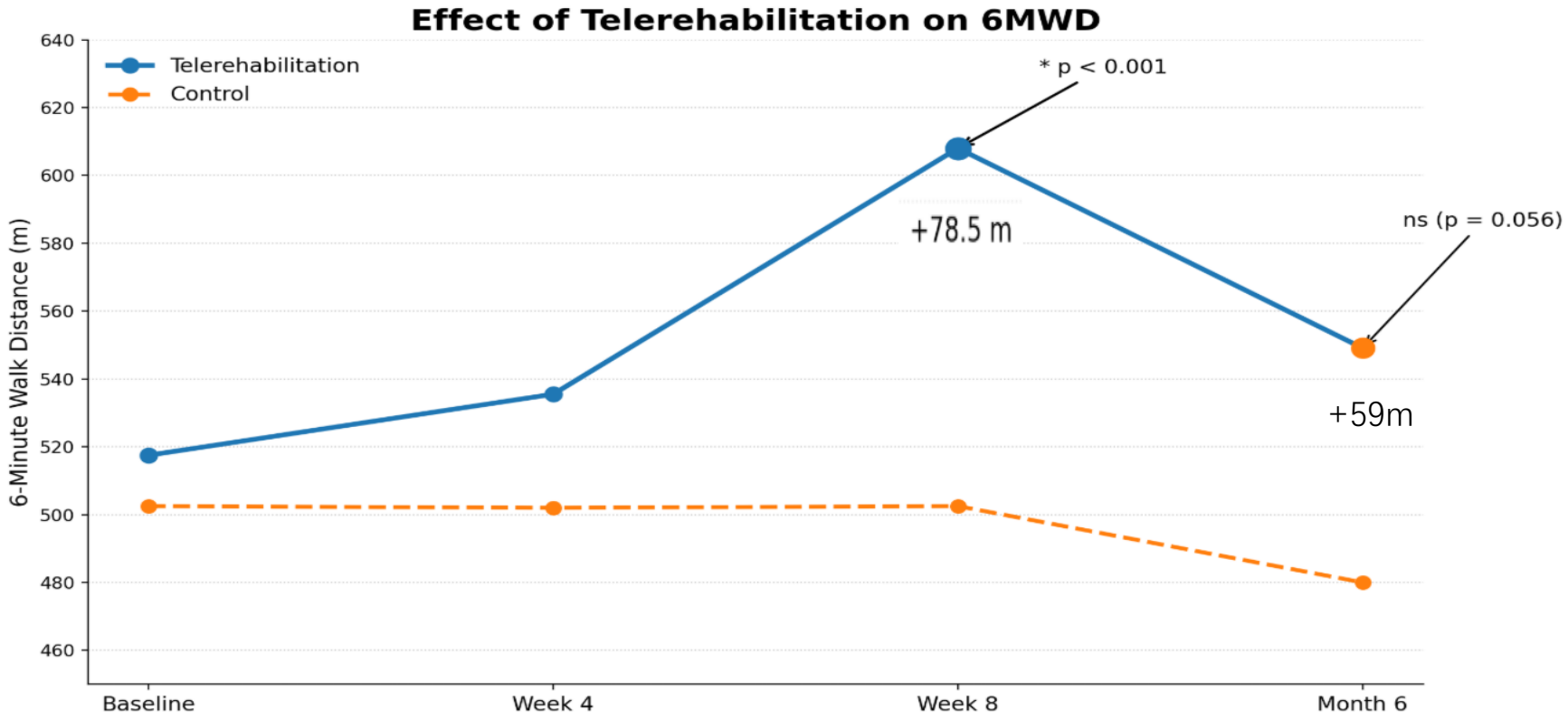




In submission

Long-term effect of Telerehabilitation in ILD

- A prospective, parallel-group, randomized controlled trial at multi-centers
- Total of 84 patients with ILD (26 ILD patients, 16 IPF)
- Aim: To evaluate the efficacy of home-based PR in patients with ILD and the long-term effects after eight weeks of PR



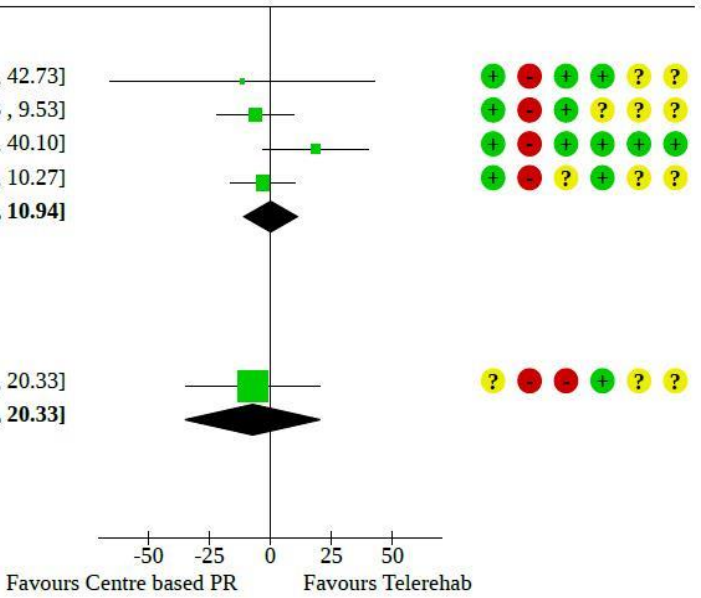
Telerehabilitation vs Center-based pulmonary rehabilitation: 6MWD & Dyspnea

6MWT

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.1.1 Randomised controlled trials - Primary rehabilitation								
Bourne 2017	433.6	102.9	64	445.1	124.9	26	3.9%	-11.50 [-65.73 , 42.73]
Hansen 2020	17.2	46.7368	67	23.5	46.7368	67	33.3%	-6.30 [-22.13 , 9.53]
Holland 2017	29.39	66.4713	72	10.82	67.1306	76	20.8%	18.57 [-2.96 , 40.10]
Maltais 2008	8	47.4716	89	11	44.1804	95	42.0%	-3.00 [-16.27 , 10.27]
Subtotal (95% CI)			**292**			**264**	**100.0%**	**0.06 [-10.82 , 10.94]**
Heterogeneity: Tau² = 27.45; Chi² = 3.82, df = 3 (P = 0.28); I² = 22%								
Test for overall effect: Z = 0.01 (P = 0.99)								
1.1.2 Randomised controlled trials - Maintenance rehabilitation								
Vasilopoulou 2017	420.2	74.9	47	427.5	63	50	100.0%	-7.30 [-34.93 , 20.33]
Subtotal (95% CI)			**47**			**50**	**100.0%**	**-7.30 [-34.93 , 20.33]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.52 (P = 0.60)								
Test for subgroup differences: Chi² = 0.24, df = 1 (P = 0.63), I² = 0%								

Mean Difference IV, Random, 95% CI

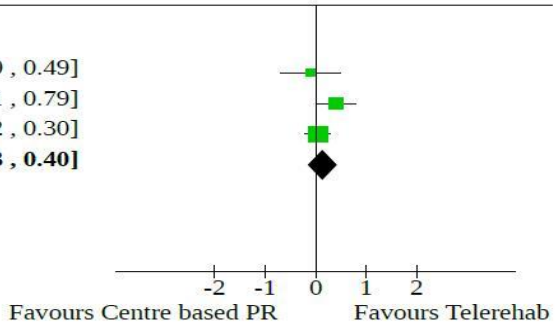
Risk of Bias: A B C D E F



Dyspnea

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.8.1 Randomised controlled trials - Primary rehabilitation								
Chaplin 2017	0.7	1.2	22	0.8	1	40	16.8%	-0.10 [-0.69 , 0.49]
Holland 2017	0.9	1.2	72	0.5	1.2	76	31.9%	0.40 [0.01 , 0.79]
Maltais 2008	0.82	0.9913	107	0.78	0.9481	109	51.3%	0.04 [-0.22 , 0.30]
Subtotal (95% CI)			**201**			**225**	**100.0%**	**0.13 [-0.13 , 0.40]**
Heterogeneity: Tau² = 0.02; Chi² = 2.91, df = 2 (P = 0.23); I² = 31%								
Test for overall effect: Z = 0.97 (P = 0.33)								
Test for subgroup differences: Not applicable								

Mean Difference IV, Random, 95% CI



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*Cochrane Database of Systematic Review*2021;1:CD013040

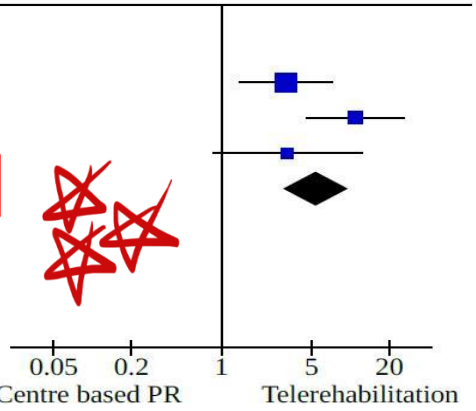
Telerehabilitation vs Center-based PR : Adherence/Completion

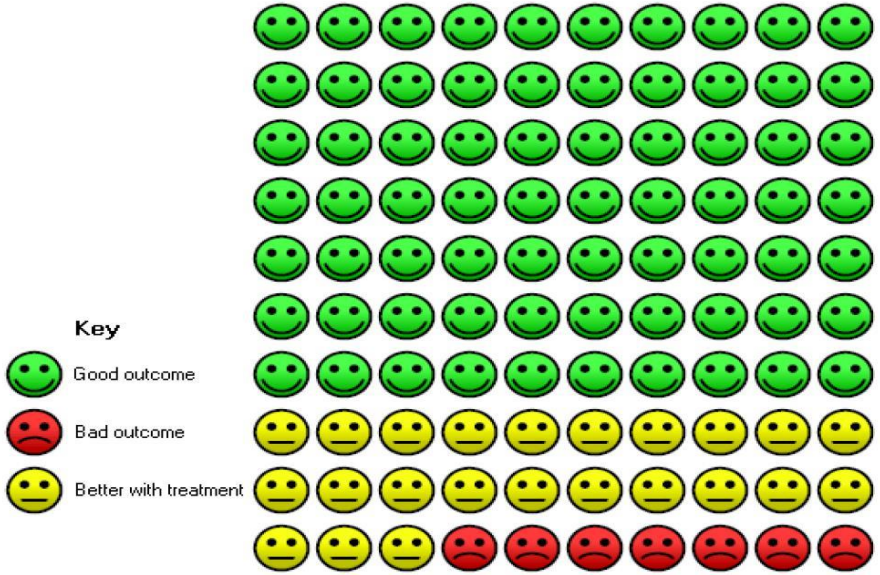
Study or Subgroup	Telerehabilitation Events	Total	Centre based PR Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
1.28.1 Randomised controlled trials - primary rehabilitation						
Hansen 2020	57	67	43	67	50.6%	3.18 [1.38 , 7.35]
Holland 2017	73	80	42	86	27.9%	10.93 [4.52 , 26.43]
Maltais 2008	106	109	98	107	21.5%	3.24 [0.85 , 12.33]
Subtotal (95% CI)		**256**		**260**	**100.0%**	**5.36 [3.12 , 9.21]**
Total events:	236		183			

Heterogeneity: Chi² = 4.53, df = 2 (P = 0.10); I² = 56%

Test for overall effect: Z = 6.08 (P < 0.00001)

Test for subgroup differences: Not applicable





*Cochrane Database of Systematic Review*2021;1:CD013040

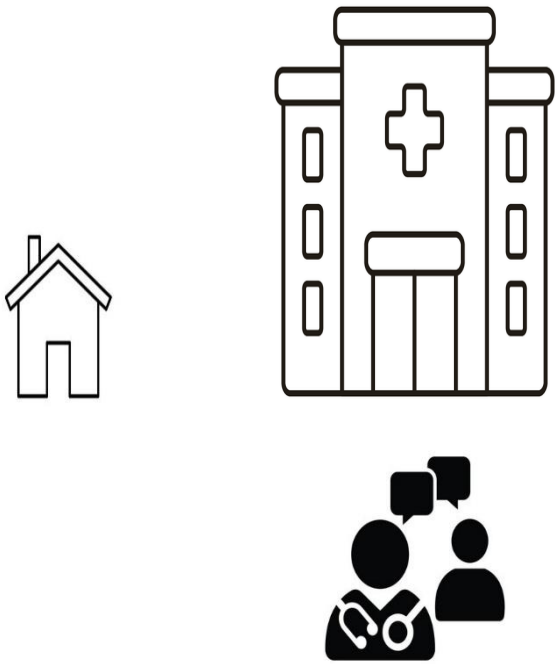
Long-term and Maintenance PR in ILD
Delivery Method

- Loss of PR benefit after 6months
- Rapid progression or disease severity in ILD (short median survival in IPF)
- Delivery models: 1) Center-based 2) Home-based 3) Remote or Tele-PR
- Needs for monitoring and supplying oxygen during PR and benefit of supervised PR
- Unmet needs and barriers of center or home-based PR from the patient prospective, caregiver and socio-economic perspective
- Remote PR in ILD is not simply home exercise instruction → Must be an oxygen-aware, safety-structured rehabilitation model
- Remote PR in ILD should not be viewed as a complete replacement for conventional PR, but rather as part or essential component of a hybrid care model

J Thorac Dis 2024;16(12):8379-8388

How to implement PR

Traditional center-based



Center-based

Alternative models

1. Home-based non-digital

Written material supported by remote supervision

2. Home-based web platform

Supported by a web-based platform or app

3. Video or Telerehabilitation

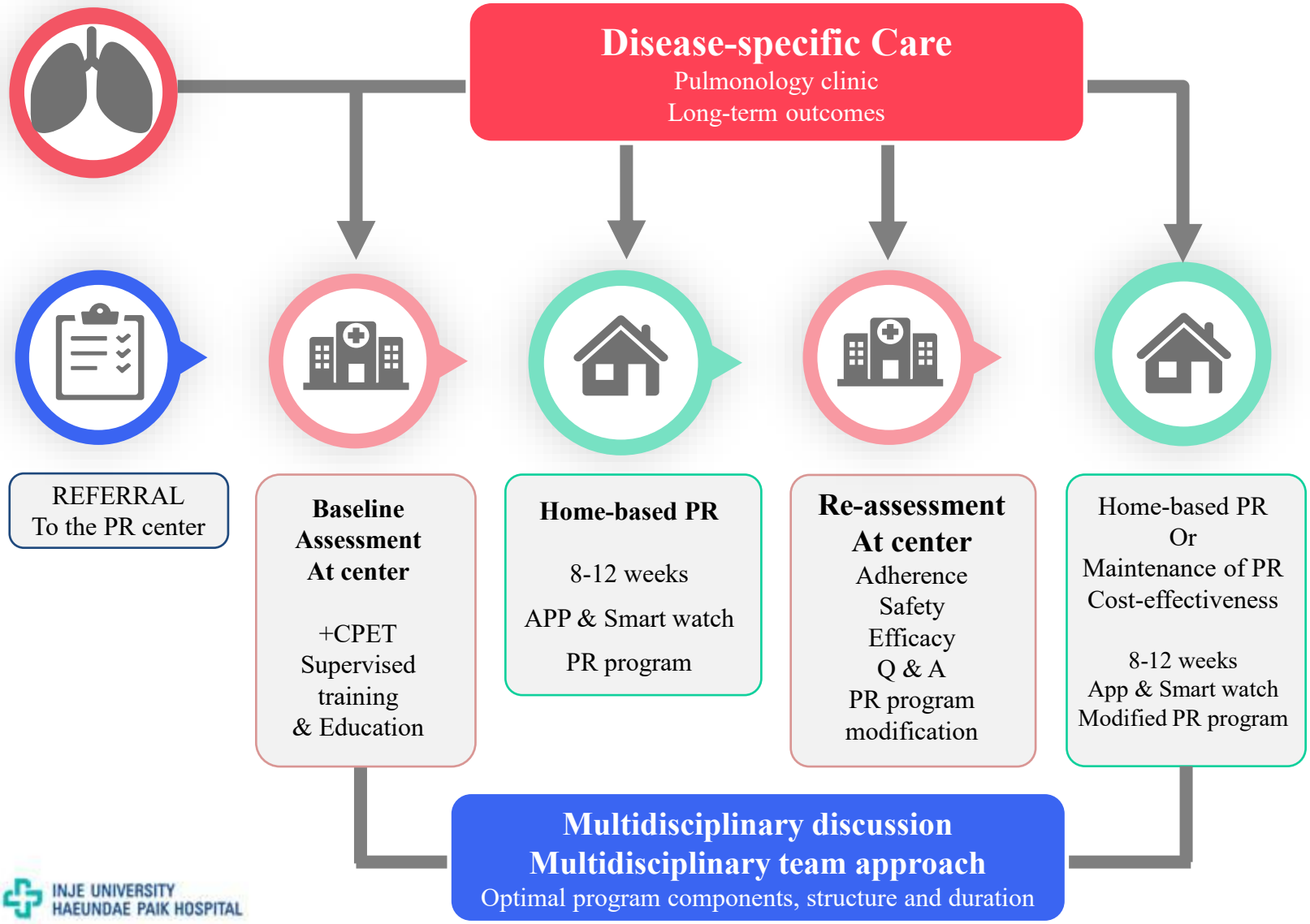
Synchronous real-time PR supported by videoconferencing

4. Self-directed or Unsupervised PR

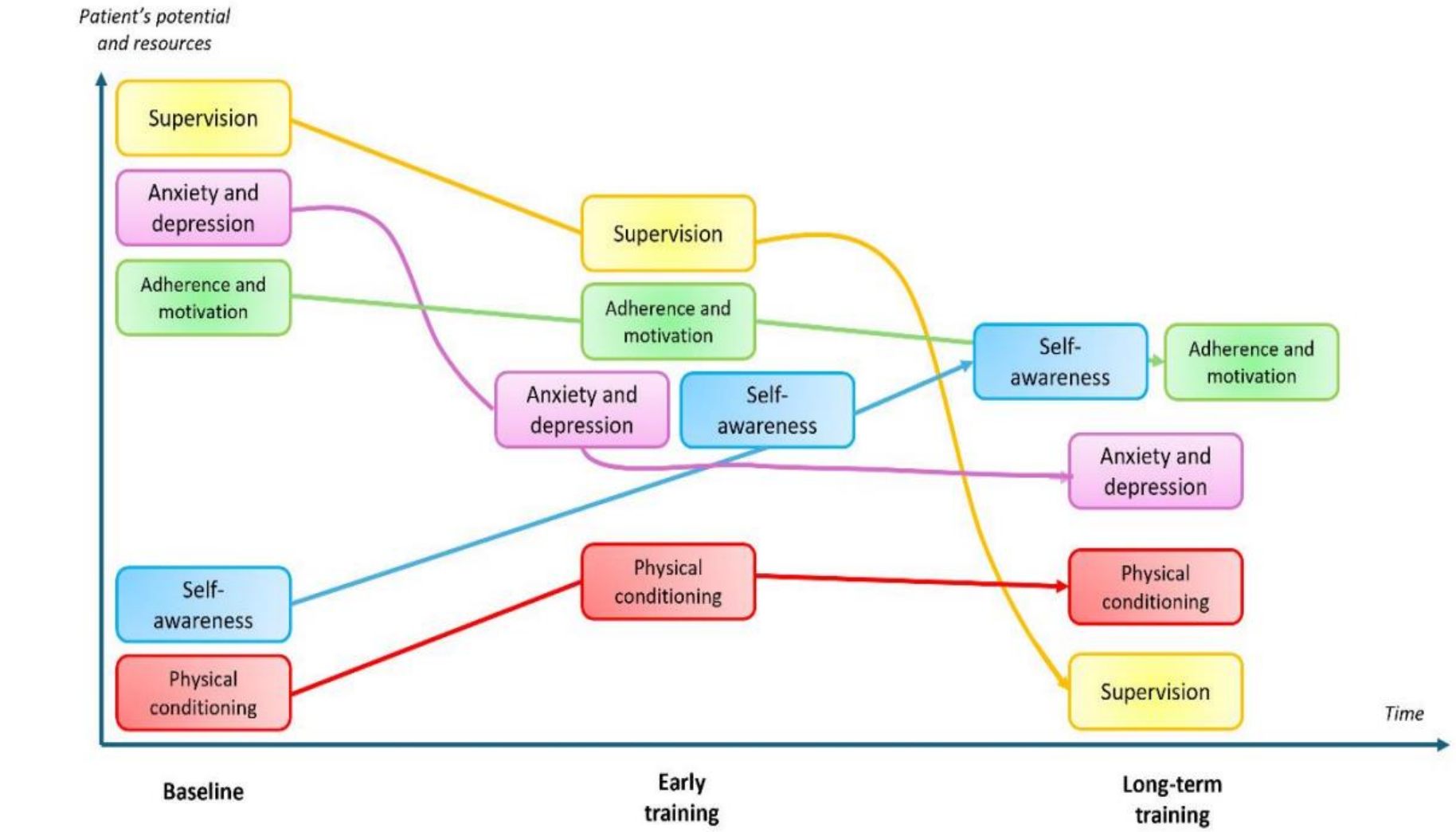
Early ILD or Young patients with ILD

Home-based

Implementing a successful telerehabilitation: practical suggestion in Korea



Expected trajectories in Remote-PR



BMJ Open Respir Res 2024;11:e002061

Contents

1. Pulmonary Rehabilitation in ILD – Established Benefits
2. Unresolved Questions: Is Supplemental Oxygen necessary?
3. Unresolved Questions: Beyond Completion → The importance of maintenance
4. **Unresolved Questions: Can PR improve survival in ILD?**

CHEST

Impact of Pulmonary Rehabilitation on Survival in People With Interstitial Lung Disease

Check for updates

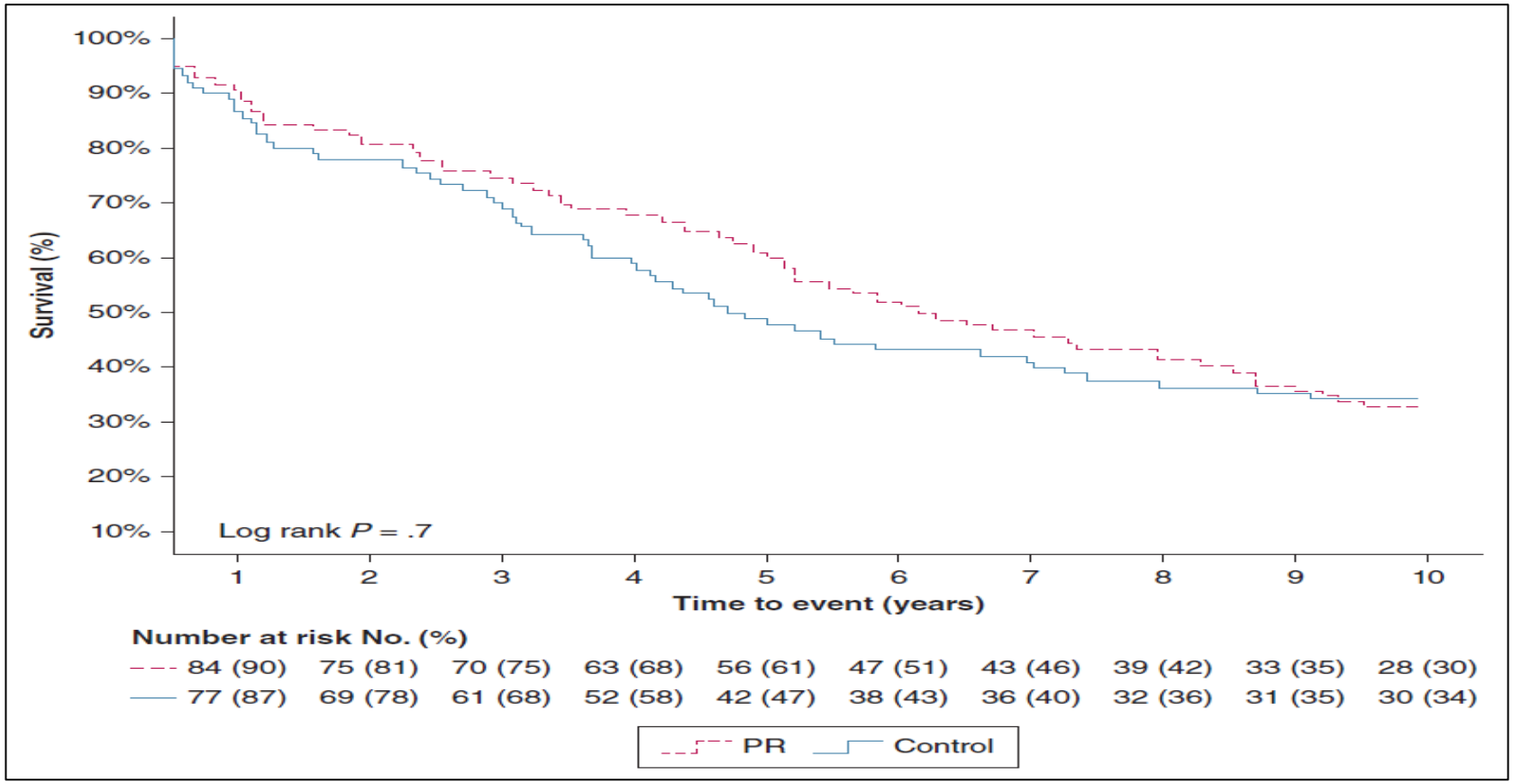
- A secondary pooled analysis of data from the first and the largest previous RCTs (182 ILD)
- Method – *Kaplan-Meier & Cox Proportional Regression Analysis*
- Primary endpoints – Death and Lung transplantation for 5 or 10 years

Characteristic	Pulmonary Rehabilitation (n = 93)	Control Group (n = 89)
Age, y	69 [10]	69 [11]
Sex, male	53 (63)	56 (60)
Diagnosis		
IPF	44 (47)	43 (48)
CTD ILD	13 (14)	14 (16)
Dust ILD	10 (11)	14 (16)
HP	8 (9)	4 (5)
Sarcoidosis	4 (4)	3 (3)
CPFE	3 (3)	3 (3)
Other ILD	11 (12)	8 (9)
FVC % predicted[a]	75 [20]	76 [21]
TLCO % predicted[b]	49 [18]	48 [15]
RVSP, mm Hg[c]	33 [14]	36 [12]
6MWD, m	446 [122]	426 [145]
Nadir Spo_2 on 6MWD	86 [7]	86 [8]

CHETS 2025;167(6): 1696-1704

Result of Kaplan-Meier Analysis

- Median survival period: PR group vs Control (6.1 years vs 4.7 years, not significant)
- At 5 years – Survival rate: PR group vs Control (61% vs 47%, $p = 0.70$)
- At 10 years – Survival rate: PR groups vs control(30% vs 34%)



CHETS 2025;167(6): 1696-1704

Result of Cox Proportional Regression

- Adjusted for baseline variables including age, sex, FVC, 6MWD, nadir SpO2 in 6MWD, IPF diagnosis
- At 5 years – Survival rate: PR group vs Control (61% vs 47%, **HR 0.56, *p* = 0.01**)
- At 10 years – Survival rate: PR groups vs control (30% vs 34%, HR 0.80, *p* = 0.30)

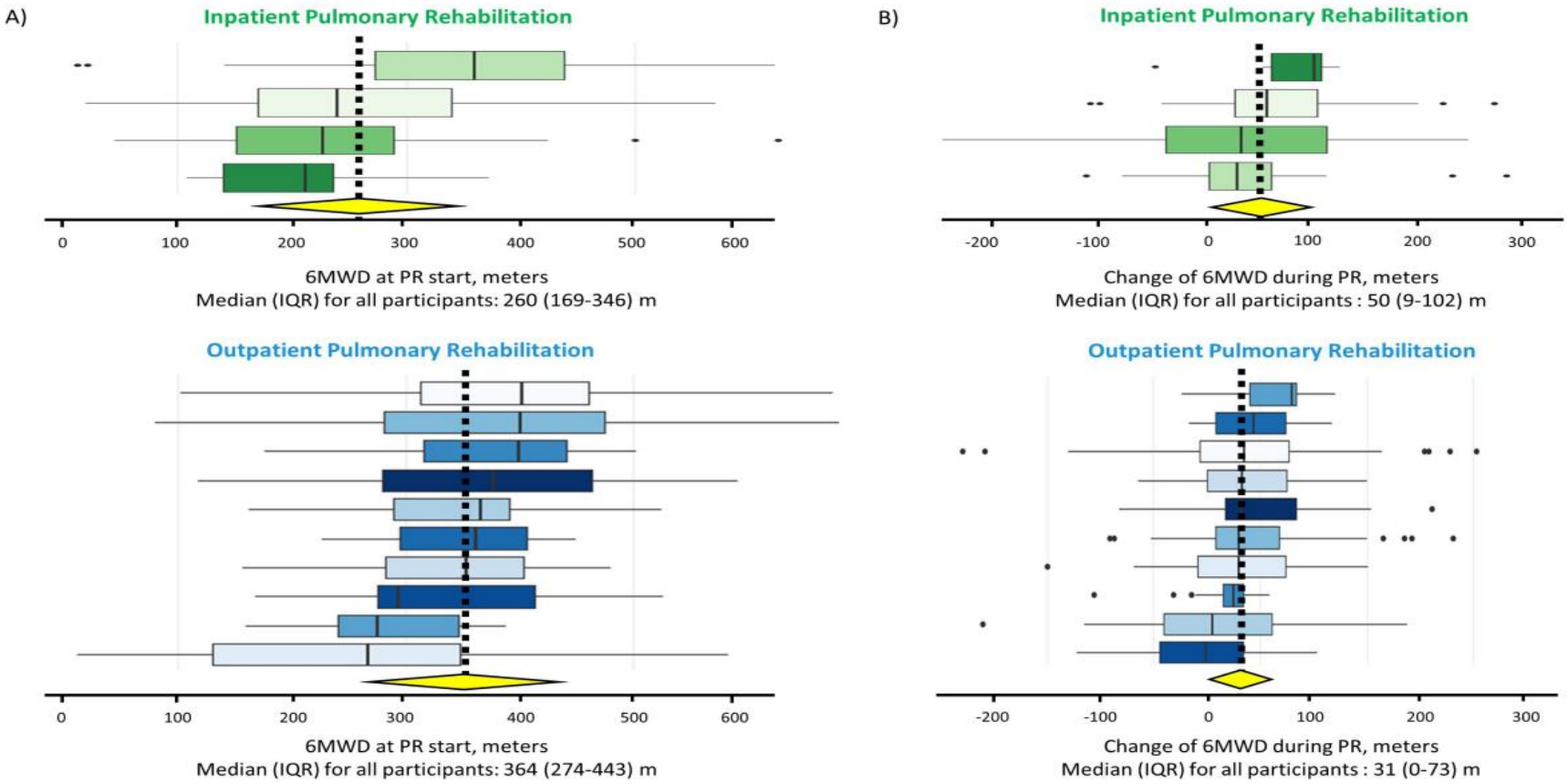
Variables	5 y		10 y	
	HR (95% CI)	*P* Value	HR (95% CI)	*P* Value
Group allocation				
Control	NA		NA	
PR	0.56 (0.23-0.88)	.01	0.8 (0.56-1.18)	.30
Diagnosis				
IPF	NA		NA	
Non-IPF ILD	0.68 (0.43-1.08)	.10	0.56 (0.41-0.88)	.01
Age[a]	1.03 (0.99-1.06)	.07	1.04 (1.02-1.07)	.001
Sex				
Male	NA		NA	
Female	0.38 (0.23-0.63)	.01	0.42 (0.28-0.63)	< .001
Nadir Spo_2				
≤ 85%	NA		NA	
> 85%	0.22 (0.14-0.37)	< .001	0.24 (0.16-0.36)	< .001
FVC				
% predicted < 50%	NA		NA	
% predicted 50%-79%	0.55 (0.28-1.08)	.08	0.48 (0.26-0.90)	.02
% predicted > 80%	0.23 (0.12-0.61)	.002	0.38 (0.19-0.79)	.009
6MWD, m				
< 250	NA		NA	
250-350	0.29 (0.13-0.55)	.003	0.37 (0.218-0.75)	.006
350-450	0.28 (0.14-0.54)	< .001	0.31 (0.18-0.56)	< .001
> 450	0.21 (0.093-0.47)	< .001	0.32 (0.12-0.50)	< .001

CHETS 2025;167(6): 1696-1704

Original research

Survival after inpatient or outpatient pulmonary rehabilitation in patients with fibrotic interstitial lung disease: a multicentre retrospective cohort study

- Retrospective cohort study in 12 sites of Canada, USA, and Europe since 2000
- 701 Fibrotic ILD (IPF=64%, HP=7%, NSIP=6%, Unclassifiable ILD=14%)
- Inpatient PR: stay for 2-4 weeks, Outpatient PR: for 6-12 weeks



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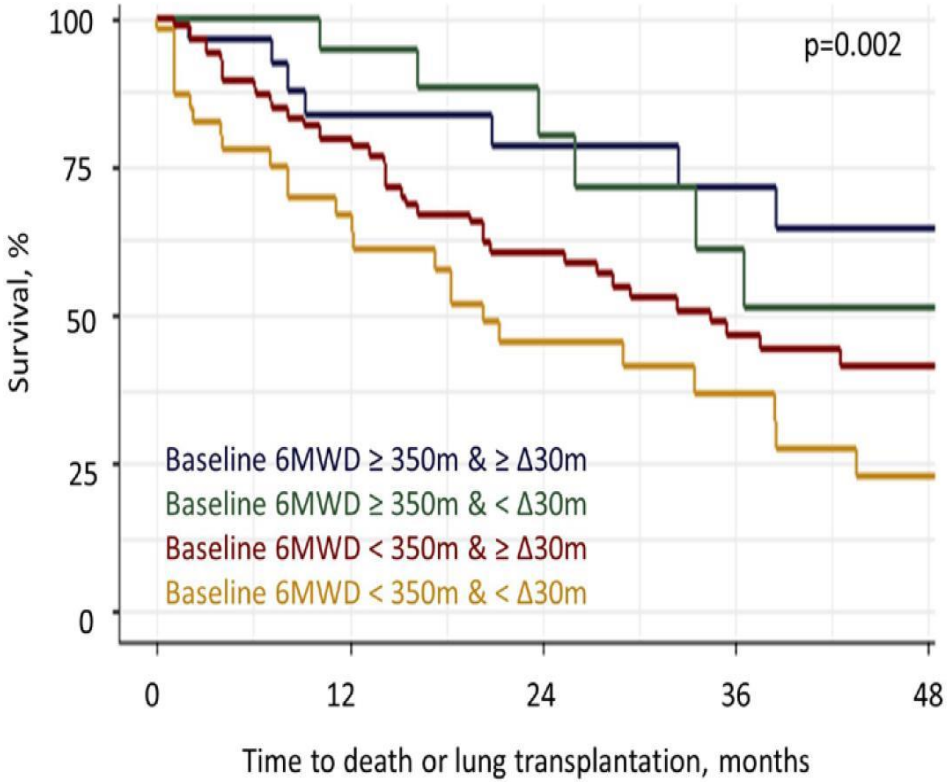
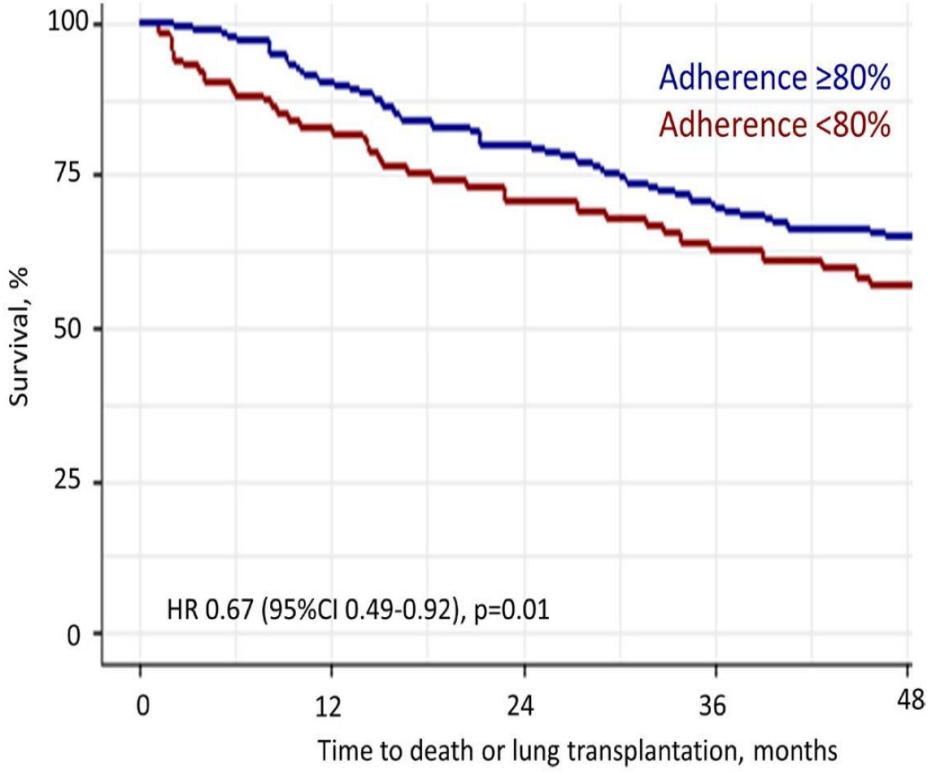
Thorax 2022;77:589-595

Improved physical performance and survival benefit after PR

- During f/u period of 25 months, 267(35%) patients died and 33 received lung transplantation
- Mean change in 6MWD: Inpatient PR(55m) + any increase 79% and Outpatient PR(34m) + any increase 76%
- Improvement in 6MWD was associated with lower hazard rates for death or lung transplantation [Inpatient PR – HR per 10m 0.94, p<0.001, Outpatient PR – HR 0.97, p<0.001]





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Thorax 2022;77:589-595

특발성폐섬유증 (Idiopathic Pulmonary Fibrosis)

IT/의학 > 병을 이겨내는 사람들

사실상 '사망선고' 받았던 가수 유열, 폐이식 후 '삶'을 찾았다[병을 이겨내는 사람들]

동아일보 | 업데이트 2025-05-03 09:15

폐섬유종으로 10년간 투병 이어온 유열, 폐이식 후 불후의 명곡으로 돌아오기까지

2017년 건강검진, 첫 의심 소견... 2년 후 폐렴, 정밀검사로 확진

항섬유화 약물 말곤 치료법 없어... 숨차고 기침, 체중도 65kg→50kg

기적같이 폐 이식받고 10개월째... 재활치료-훈련 지속, 건강 좋아

"은혜 갚으려고 사후 장기 기증"

IPF - Lung Transplantation

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Pulmonary rehabilitation improves survival in patients with idiopathic pulmonary fibrosis undergoing lung transplantation

- Retrospective single-center study of 89 IPF patients between 2007 and 2015
- PR group – completion of 3 sessions a week (total 36 weeks)
- Control group – noncompletion (median 10 sessions)

Variables	Total (N = 89)	Control (n = 53)	PRP (n = 36)	*p*
Male	57 (64%)	32 (60.3%)	25 (69.4%)	0.500
Age, y	55.93 ± 10.93	56.79 ± 10.84	54.67 ± 11.08	0.958
BMI, kg/m^2	25.42 ± 3.870	25.44 ± 4.110	25.39 ± 3.550	0.371
FEV_1, L	1.33 ± 0.54	1.26 ± 0.51	1.44 ± 0.56	0.119
FVC, L	1.61 ± 0.50	1.56 ± 0.47	1.69 ± 0.54	0.220
FEV_1, %	46.16 ± 15.23	43.76 ± 15.02	49.65 ± 15.07	0.078
FVC, %	44.33 ± 12.55	43.70 ± 12.14	45.25 ± 13.25	0.570
FEV_1/FVC	82.33 ± 21.43	81.22 ± 24.05	83.97 ± 17.03	0.556
PASP, mmHg	45.80 ± 15.55	46.37 ± 16.50	44.97 ± 14.25	0.682
6MWD, meters	359.36 ± 133.18	327.92 ± 140.78	404.78 ± 107.79	0.007
Oxygen flow, L/min	5.19 ± 1.65	5.02 ± 1.40	5.52 ± 2.04	0.206
Median time in list, months	5.1 [2.4–10.7]	2.7 [1.4–10.7]	7.6 [4.5–11.4]	0.133
Follow-up time, years	2.1 [0.3–4.1]	1.9 [0.1–3.6]	2.7 [0.5–4.5]	0.405

▲6MWD → 43M

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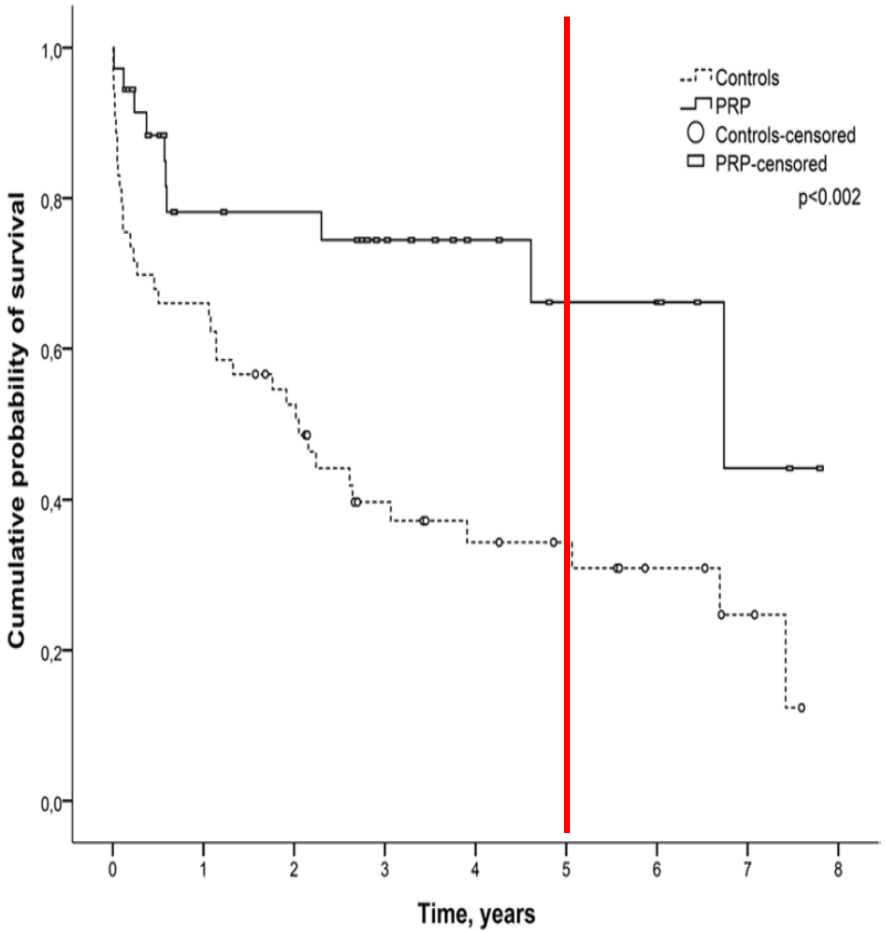
Kaplan-Meier curve of cumulative survival



Cox regression analysis for mortality

Variables	Crude analysis HR (95% CI)[a]	*p*	Adjusted analysis HR (95% CI)[b]	*p*
PRP	0.352 (0.176–0.703)	0.003	0.464 (0.222–0.970)	0.041
Male	1.151 (0.626–2.115)	0.517		
Age, y	1.007 (0.977–1.037)	0.630		
BMI, kg/m^2	0.972 (0.977–1.003)	0.526		
FEV_1, %	0.979 (0.959–1.000)	0.130		
FVC, %	0.987 (0.959–1.015)	0.373		
FEV_1/FVC	0.991 (0.987–1.003)	0.175		
6MWD, meters	0.998 (0.996–1.001)	0.314		
Oxygen flow, L/min	1.083 (0.913–1.286)	0.357		
Time on waiting list, days	1.000 (0.977–1.001)	0.741		
IMV > 24 hours	2.551 (1.400–4.650)	0.002	1.881 (1.009–5.308)	0.047
LOS in ICU, days	1.002 (0.975–1.030)	0.851		
LOS in hospital, days	1.004 (0.987–1.020)	0.627		

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Primary and Secondary outcomes after LT

Variables	Total (N = 89)	Control (n = 53)	PRP (n = 36)	*p*
IMV > 24 hs.	45 (50.6%)	37 (69.8%)	8 (22.2%)	0.001
Days in ICU	6 [4.5–13]	7 [5–19]	5 [4–7.5]	0.004
Days in hospital	23 [19–33]	25 [20–39]	20 [17.7–26]	0.046
Mortality				
ICU	18 (20.2)	16 (18.0)	2 (2.2)	0.006
1 year after LTx	25 (28.1)	18 (20.2)	7 (7.9)	0.156
5 years after LTx	42 (47.2)	33 (37.1)	9 (10.1)	<0.001
Total study time	46 (51.7)	36 (40.4)	10 (11.2)	<0.001

Summary

- Role of PR is not just functional capacity improvement in short period
- PR may improve survival after LT
  - Better pre-transplant conditioning
  - Reduced mechanical ventilation(Liberation) and ICU stay
  - Faster recovery

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Summary

- PR – One of the standard care for ILD, alongside antifibrotics
- PR improve exercise capacity, symptoms, and QOL
- Due to marked exertional hypoxemia, careful monitoring and appropriate supporting of oxygen is essential during PR
- For survival benefit, long-term maintenance and early consideration of PR is important
- Individualized PR strategies tailing each baseline characteristics and ILD sub-type

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