Airway Clearance
– update 및 실제 적용 –

이세원

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Bronchiectasis

- Morphologic term used to describe abnormal, **irreversibly dilated and thick-walled bronchi**

- Represent the end stage of a variety of pathologic process that cause destruction of the bronchial wall and its surrounding supporting tissues

- Anatomic definition that evolved from **Lannec**'s original description in 1891 of ectatic bronchi in pathologic specimens

Fishman's pulmonary diseases

Bronchiectasis: Definition in guidelines

This guideline refers to the investigation and management of patients with **symptoms of persistent or recurrent bronchial sepsis** related to **irreversibly damaged and dilated bronch**i - namely, clinical bronchiectasis

Pasteur et al., Thorax.2010;65 Suppl 1:i1-58

Bonchiectasis is a **suppurative lung disease** with heterogeneous phenotypic features. Bronchiectasis is diagnosed on axial images of HRCT scans

McShane et al., Am J Respir Crit Care Med. 2013;188(6):647-56

Bronchiectasis is a chronic respiratory disease characterized by a clinical syndrome of **cough, sputum production, and bronchial infection**, and radiologically by **abnormal and permanent dilatation of the bronchi**

Polverino et al., Eur Respir J. 2017;50(3).

Definition of BE: Observational Cohorts in Europe

- **Inclusion criteria**
  - Aged 18 years and older
  - Radiological diagnosis made on **HRCT**
  - **Clinical history** consistent with **bronchiectasis**

- **Exclusion criteria**
  - Patients with cystic fibrosis or traction BE due to pulmonary fibrosis were all excluded in all four cohort

Rogers et al., Lancet Respir Med. 2015;3(4):e15

Europe Bronchiectasis Registry (EMBARC)

ERJ open research

CrossMark

STUDY PROTOCOL
BRONCHIECTAS

The EMBARC European Bronchiectasis Registry: protocol for an international observational study

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The European Bronchiectasis Registry will recruit 10 000 patients over 5 years.

The inclusion criteria of this study are:

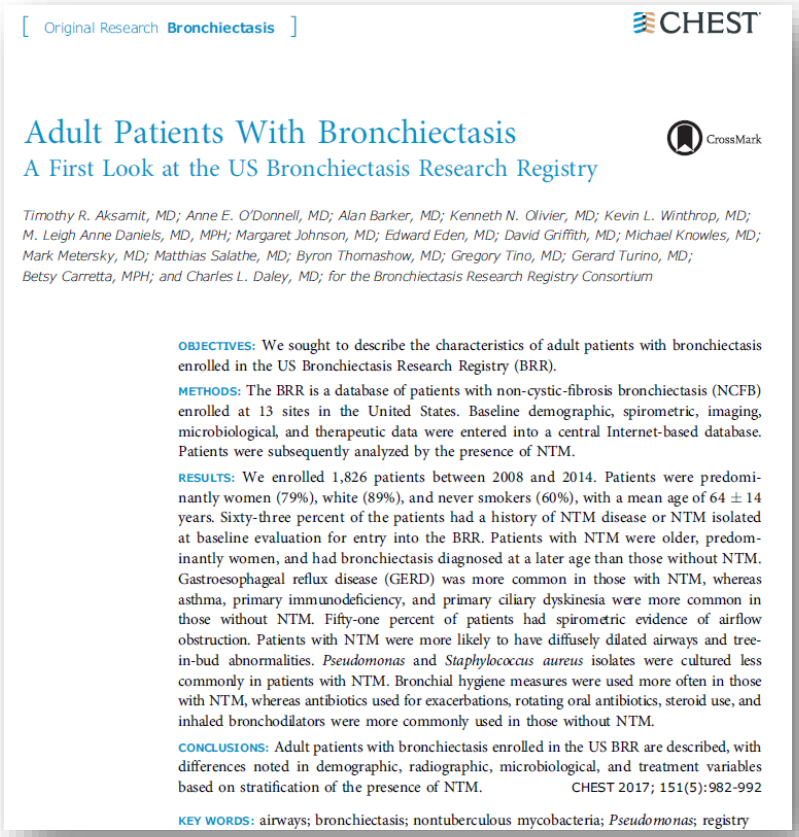
- a **clinical history** consistent with bronchiectasis (**cough, chronic sputum production** and/or **recurrent respiratory infections**)
- **computed tomography** of chest demonstrating bronchiectasis (bronchial dilatation) affecting one or more lobes.

The exclusion criteria are:

- bronchiectasis due to known cystic fibrosis;
- age <18 years

ERJ Open Res. 2016;2. 81-2015-81-2015.

US Bronchiectasis Registry



[Original Research **Bronchiectasis**]

CHEST

Adult Patients With Bronchiectasis
A First Look at the US Bronchiectasis Research Registry

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OBJECTIVES: We sought to describe the characteristics of adult patients with bronchiectasis enrolled in the US Bronchiectasis Research Registry (BRR).

METHODS: The BRR is a database of patients with non-cystic-fibrosis bronchiectasis (NCFB) enrolled at 13 sites in the United States. Baseline demographic, spirometric, imaging, microbiological, and therapeutic data were entered into a central Internet-based database. Patients were subsequently analyzed by the presence of NTM.

RESULTS: We enrolled 1,826 patients between 2008 and 2014. Patients were predominantly women (79%), white (89%), and never smokers (60%), with a mean age of 64 ± 14 years. Sixty-three percent of the patients had a history of NTM disease or NTM isolated at baseline evaluation for entry into the BRR. Patients with NTM were older, predominantly women, and had bronchiectasis diagnosed at a later age than those without NTM. Gastroesophageal reflux disease (GERD) was more common in those with NTM, whereas asthma, primary immunodeficiency, and primary ciliary dyskinesia were more common in those without NTM. Fifty-one percent of patients had spirometric evidence of airflow obstruction. Patients with NTM were more likely to have diffusely dilated airways and tree-in-bud abnormalities. *Pseudomonas* and *Staphylococcus aureus* isolates were cultured less commonly in patients with NTM. Bronchial hygiene measures were used more often in those with NTM, whereas antibiotics used for exacerbations, rotating oral antibiotics, steroid use, and inhaled bronchodilators were more commonly used in those without NTM.

CONCLUSIONS: Adult patients with bronchiectasis enrolled in the US BRR are described, with differences noted in demographic, radiographic, microbiological, and treatment variables based on stratification of the presence of NTM. CHEST 2017; 151(5):982-992

KEY WORDS: airways; bronchiectasis; nontuberculous mycobacteria; *Pseudomonas*; registry

Adult patients with a **physician-established diagnosis of bronchiectasis**

The exclusion of patients with primary CF was established based on clinical history, previous sweat chloride test results, genetic testing results, or a combination

Patients registered with an NTM patient advocacy group and participating in online surveys are not necessarily representative of the general bronchiectasis population and may be skewed toward patients with NTM disease.

Chest. 2017;151(5):982-992.

KMBARC
(Korean Multicenter Bronchiectasis Audit and Research Collaboration)

Open access Protocol

BMJ Open

KMBARC registry: protocol for a multicentre observational cohort study on non-cystic fibrosis bronchiectasis in Korea

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ABSTRACT

Introduction Despite the significant disease burden of bronchiectasis in Korea, no large-scale, representative prospective cohort studies have been conducted to evaluate the clinical characteristics of Korean patients with bronchiectasis, indicating an urgent need for cohort studies on bronchiectasis.

Methods and analysis The Korean Multicenter Bronchiectasis Audit and Research Collaboration (KMBARC) is a prospective, non-interventional observational cohort study on bronchiectasis in Korea. The inclusion criteria of this registry are as follows: (1) adult patients (aged ≥18 years) with or without respiratory symptoms (cough, chronic sputum and/or recurrent respiratory infection) and chest computed tomography revealing bronchiectasis affecting one or more lobes and (2) stable status at the time of registration: patients with bronchiectasis who were admitted for a respiratory aetiology can be enrolled at least 4 weeks after hospital discharge. The exclusion criteria are as follows: (1) bronchiectasis due to cystic fibrosis; (2) traction bronchiectasis associated with interstitial lung disease; (3) patients actively being treated for pneumonia, pulmonary tuberculosis or non-tuberculous mycobacterial infection; (4) patients who are unable or unwilling to provide informed consent; and (5) pregnant patients. Although the KMBARC questionnaires for baseline and annual follow-up data are similar to the European Multicentre Bronchiectasis Audit and Research Collaboration questionnaires, KMBARC has distinctive features such as use of Bronchiectasis Health Questionnaires, measurement with fatigue and depression scales, blood tests, use of consensus definition of exacerbations and information on emergency room or hospitalisation.

We aim to recruit at least 1200 patients over the study period from more than 26 hospitals in South Korea. Patients will undergo a detailed baseline and yearly assessment for up to 5 years. The study objectives of the KMBARC registry are as follows: (1) uncovering the natural course of bronchiectasis; (2) aiding in establishing evidence-based bronchiectasis guidelines in Korea; and (3) encouraging and facilitating studies on bronchiectasis in Korea.

Ethics and dissemination This study received necessary approval from the Institutional Review Boards of all participating institutions. The Asan Medical Center Institutional Review Board gave overall approval for the study. Results will be disseminated via peer-reviewed publications and conference presentations.

Trial registration number KCT0003088.

Strengths and limitations of this study

- ► This is the first prospective cohort study on patients with bronchiectasis in Korea.
- ► We will recruit and follow-up patients with bronchiectasis annually using a standardised protocol to improve the quality of data collection.
- ► Sharing similar case-reporting forms with European Multicentre Bronchiectasis Audit and Research Collaboration (EMBARC) will allow collaboration studies with EMBARC.
- ► Distinctive features of the Korean Multicenter Bronchiectasis Audit and Research Collaboration registry (KMBARC) will provide several novel findings of bronchiectasis, which might be difficult to be elucidated using other registries.
- ► This study is limited by a lack of collecting patient samples.

INTRODUCTION

Bronchiectasis is a chronic respiratory disease characterised by irreversible bronchial dilatation.[1] Patients with bronchiectasis often develop chronic respiratory

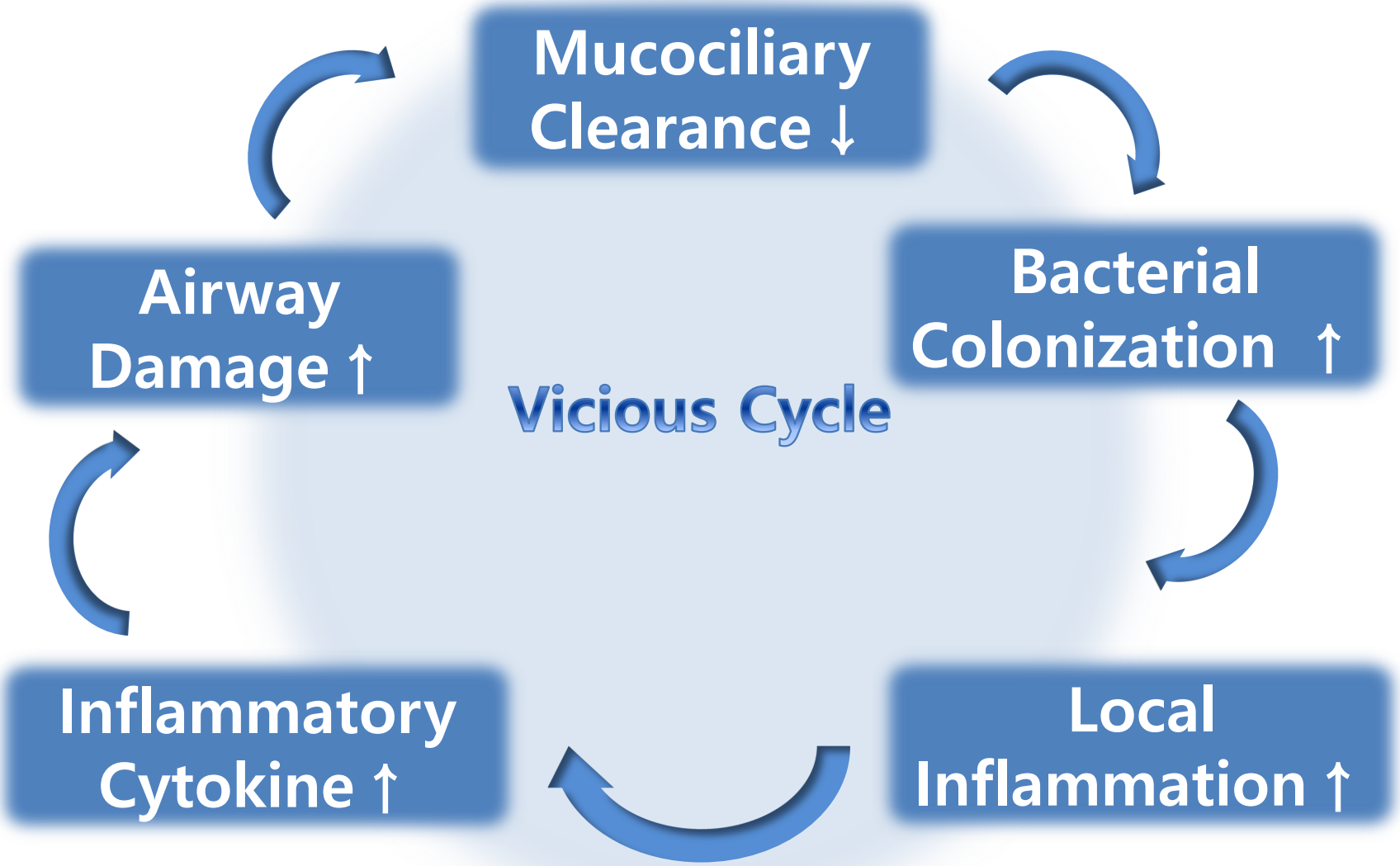
Inclusion

- Adult patients (aged ≥18 years) with or without respiratory symptoms (**cough, chronic sputum and/or recurrent respiratory infection**)
- Chest CT: bronchiectasis affecting one or more lobes
- Stable status at the time of registration

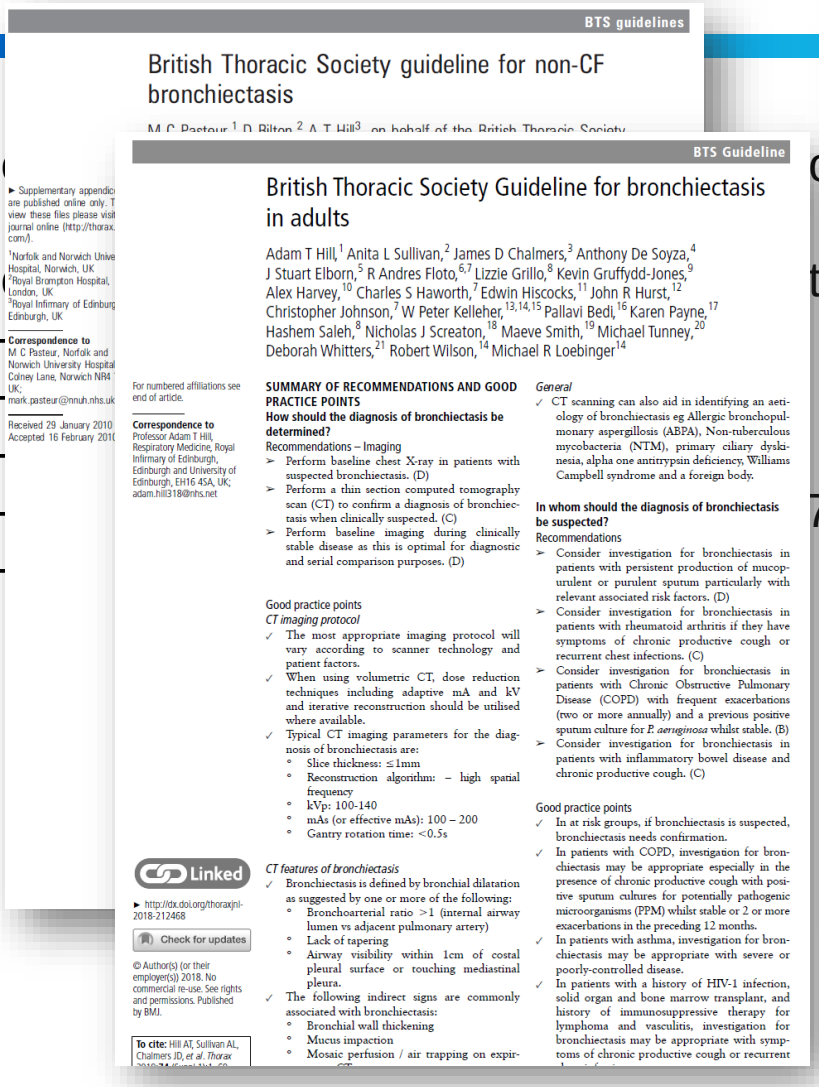
Exclusion

- Bronchiectasis due to cystic fibrosis
- Traction bronchiectasis associated with ILD
- Actively being treated for pneumonia, TB or NTM

Pathogenesis: Vicious cycle hypothesis



Guidelines



BTS guidelines

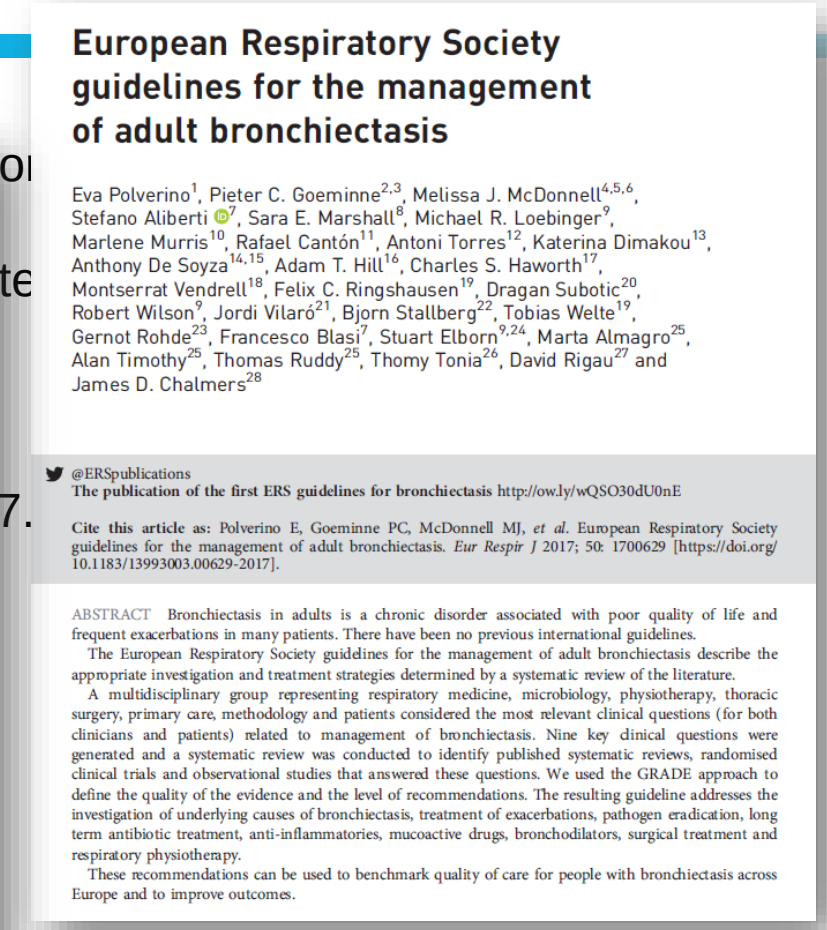
British Thoracic Society guideline for non-CF bronchiectasis

M C Pasteur,[1] D Bilton,[2] A T Hill[3] on behalf of the British Thoracic Society

BTS Guideline

British Thoracic Society Guideline for bronchiectasis in adults

Adam T Hill,[1] Anita L Sullivan,[2] James D Chalmers,[3] Anthony De Soyza,[4] J Stuart Elborn,[5] R Andres Floto,[6,7] Lizzie Grillo,[8] Kevin Gruffydd-Jones,[9] Alex Harvey,[10] Charles S Haworth,[7] Edwin Hiscocks,[11] John R Hurst,[12] Christopher Johnson,[7] W Peter Kelleher,[13,14,15] Pallavi Bedi,[16] Karen Payne,[17] Hashem Saleh,[8] Nicholas J Screaton,[18] Maeve Smith,[19] Michael Tunney,[20] Deborah Whitters,[21] Robert Wilson,[14] Michael R Loebinger[14]



European Respiratory Society guidelines for the management of adult bronchiectasis

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@ERSpublications
The publication of the first ERS guidelines for bronchiectasis http://ow.ly/wQSO30dU0nE

Cite this article as: Polverino E, Goeminne PC, McDonnell MJ, *et al*. European Respiratory Society guidelines for the management of adult bronchiectasis. *Eur Respir J* 2017; 50: 1700629 [https://doi.org/10.1183/13993003.00629-2017].

ABSTRACT Bronchiectasis in adults is a chronic disorder associated with poor quality of life and frequent exacerbations in many patients. There have been no previous international guidelines.

The European Respiratory Society guidelines for the management of adult bronchiectasis describe the appropriate investigation and treatment strategies determined by a systematic review of the literature.

A multidisciplinary group representing respiratory medicine, microbiology, physiotherapy, thoracic surgery, primary care, methodology and patients considered the most relevant clinical questions (for both clinicians and patients) related to management of bronchiectasis. Nine key clinical questions were generated and a systematic review was conducted to identify published systematic reviews, randomised clinical trials and observational studies that answered these questions. We used the GRADE approach to define the quality of the evidence and the level of recommendations. The resulting guideline addresses the investigation of underlying causes of bronchiectasis, treatment of exacerbations, pathogen eradication, long term antibiotic treatment, anti-inflammatories, mucoactive drugs, bronchodilators, surgical treatment and respiratory physiotherapy.

These recommendations can be used to benchmark quality of care for people with bronchiectasis across Europe and to improve outcomes.

Non-pharmacologic Treatment of Bronchiectasis

- Active cyclic breathing
- Oscillating positive expiratory devices
- Postural drainage
- Forced expiration technique
- Pulmonary rehabilitation
- Inspiratory muscle training

Non-pharmacologic Treatment of Bronchiectasis

- Active cyclic breathing
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Evidence A in BTS guideline 2010

: ACBT with OPAP is emphasized

- The **active cycle of breathing techniques** (plus postural drainage) and **oscillating positive expiratory devices** (plus postural drainage and the forced expiration technique) should be considered when offering individuals with non-CF bronchiectasis effective airway clearance techniques.

- Recombinant human DNase should not be used in adults with bronchiectasis.

- The evidence base remains weak for the majority of interventions used in daily clinical practice.

Evidence B in BTS guideline 2010

: Physiotherapy is also emphasized

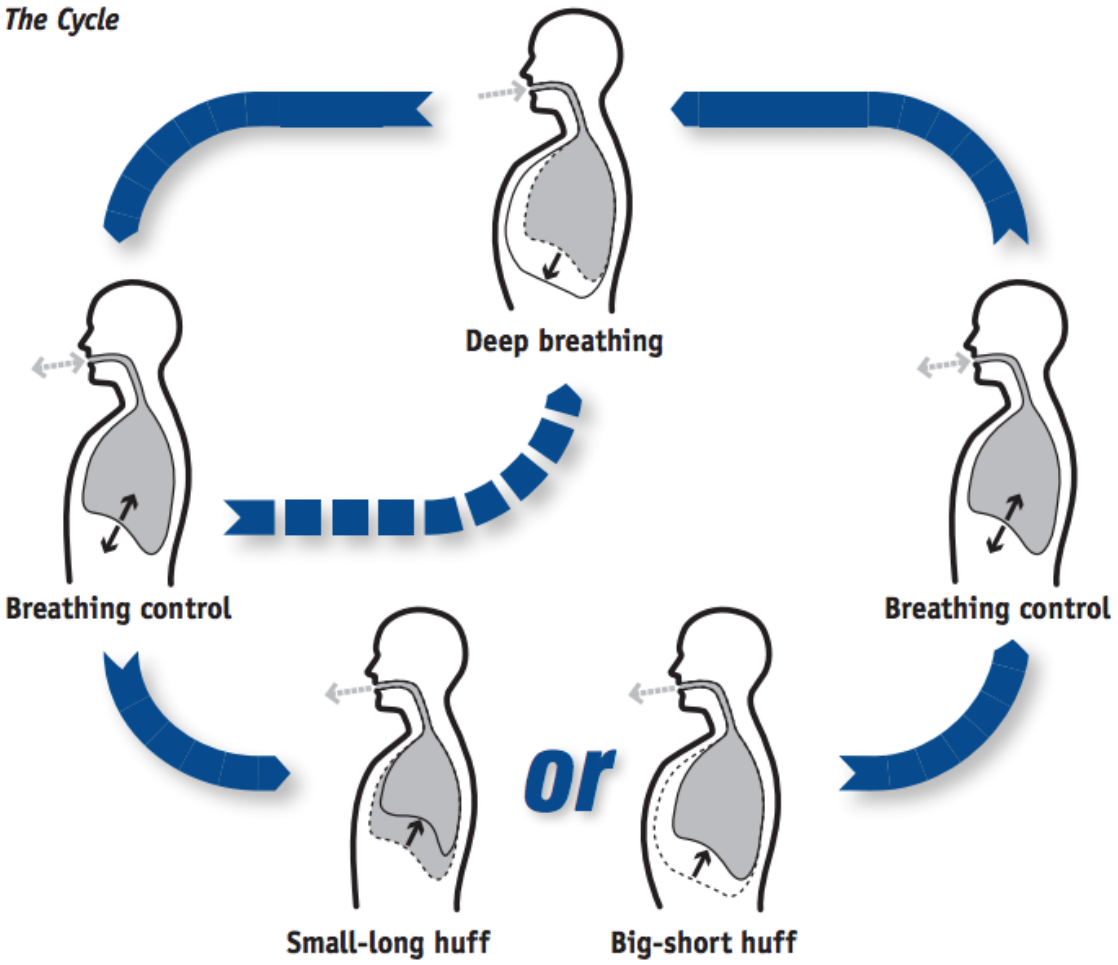
- The inclusion of **postural drainage** should be considered for all airway clearance techniques.

- The inclusion of **the forced expiration technique** should be considered for all airway clearance techniques.

Physiotherapy

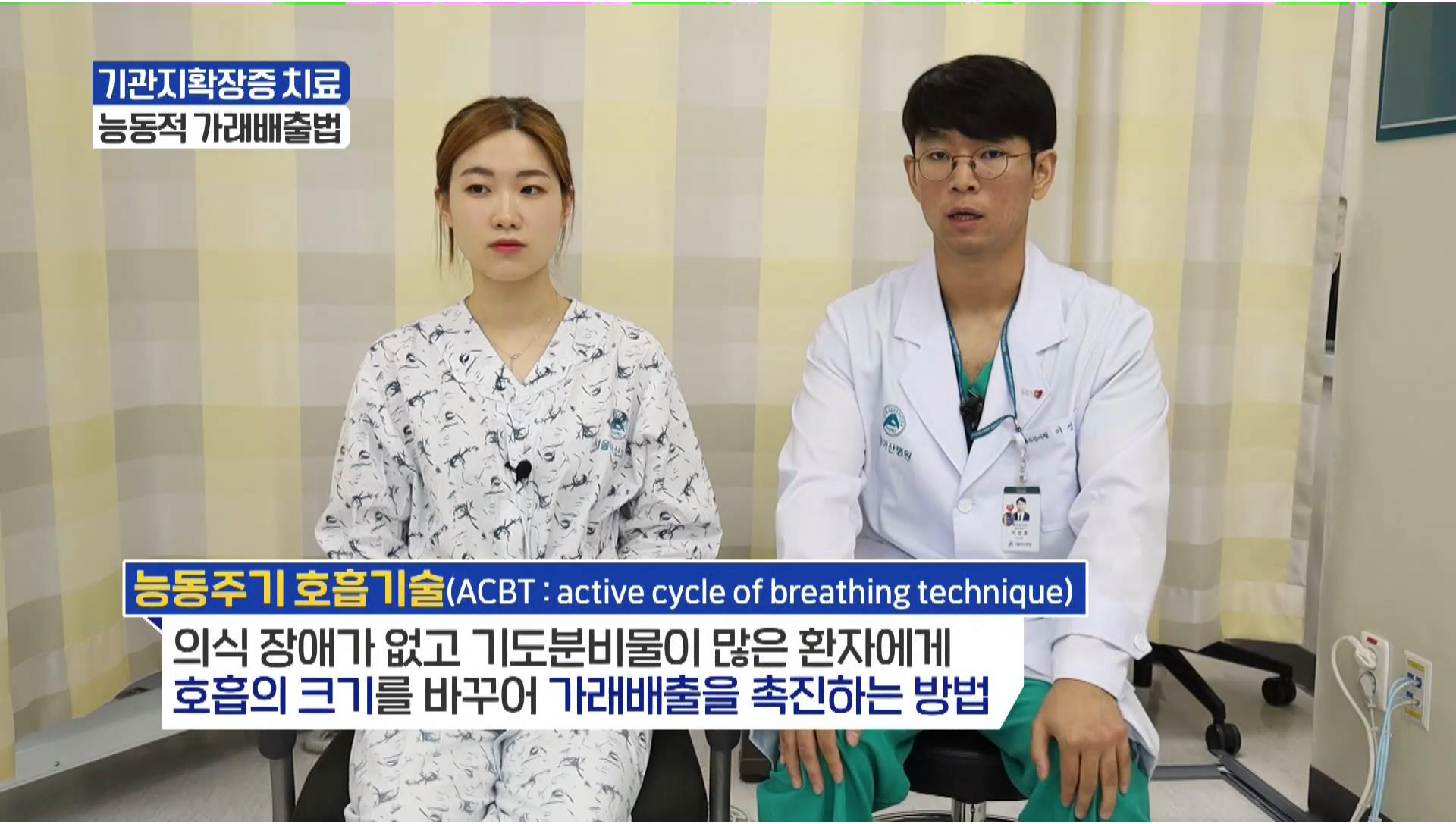
가래배출법	**능동적**	▫ 기침법 ▫ 허핑 ▫ 가슴팽창운동 ▫ 능동주기 호흡법 (ACBT) ▫ 자가 배출법 ▫ 보조기침법과 덧대기 기침법
	수동적	▫자세변경 배출법 ▫두드리기·진동법 및 흔들기 ▫가슴팽창운동과 자세변경 배출법의 활용
	도구	▫에어로비카 · 플루터 · 아카펠라 ▫BPEP ▫HFCO · IPPB

Active Cyclic Breathing



Small-long puff and Big-Short puff

Active Cyclic Breathing



ORIGINAL PAPER

Airway clearance in bronchiectasis: a randomized crossover trial of active cycle of breathing techniques (incorporating postural drainage and vibration) versus test of incremental respiratory endurance

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[2]Regional Adult CF Centre, Belfast City Hospital, Belfast, Northern Ireland BT9 7AB, UK; and
[3]Department of Respiratory Medicine, Queen's University Belfast, University Street, Belfast, Northern Ireland BT7 1SU, UK

Table 1 Weights of sputum expectorated with ACBT and TIRE

	ACBT	*TIRE*	*Mean difference (95% CI)*	P-*value*
Sputum weight (during treatment) (g)	6.34 (6.63)	4.04 (4.26)	2.30 (0.52 to 4.08)	0.01
Sputum weight (30 min post-treatment) (g)	2.66 (2.61)	2.50 (3.26)	0.16 (−1.02 to 1.34)	0.78
Total (g)	8.98 (7.82)	6.53 (6.83)	2.44 (0.43 to 4.45)	0.02

Table 2 Pre- and post-treatment lung function and SpO_2

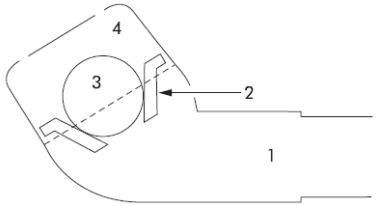
	ACBT *Mean difference (95% CI)*	P-*value*	*TIRE* *Mean difference (95% CI)*	P-*value*
FEV_1 (%pred)	2.25 (−2.48 to 6.98)	0.33	−0.03 (−2.56 to 1.96)	0.78
		0.66		0.22
FVC (%pred)	0.65 (−2.80 to 4.10)	0.70	1.45 (−1.07 to 3.97)	0.24
FVC (L)	0.006 (−0.12 to 0.14)	0.93	0.03 (−0.04 to 0.10)	0.34
PEF (%pred)	2.95 (−0.44 to 6.34)	0.08	3.65 (−0.95 to 8.25)	0.11
PEF (L/min)	10.30 (−3.69 to 24.29)	0.14	15.70 (−3.60 to 35.00)	0.11
SpO_2 (%)	1.20 (−1.07 to 3.47)	0.28	1.90 (−0.32 to 4.12)	0.89

Chronic Respiratory Disease 2004; 1: 127-130

SHORT PAPER

Randomised crossover study of the Flutter device and the active cycle of breathing technique in non-cystic fibrosis bronchiectasis

C S Thompson, S Harrison, J Ashley, K Day, D L Smith



Sputum weights: 26.6 g (15.0–45.2) for ACBT
23.4 g (16.8–36.2) for the Flutter ($p>0.05$).

There was a statistically significant improvement in FEV_1 with the Flutter, but this did not achieve a clinically meaningful change.

11/17: patients preferred the Flutter for routine daily use,
3/17: preferred ACBT,
3/17: three had no preference.

Thorax 2002;57:446–448

Airway Clearance in Bronchiectasis: A Randomized Crossover Trial of Active Cycle of Breathing Techniques versus Acapella®

Janet E. Patterson Judy M. Bradley Oonagh Hewitt Ian Bradbury
J. Stuart Elborn

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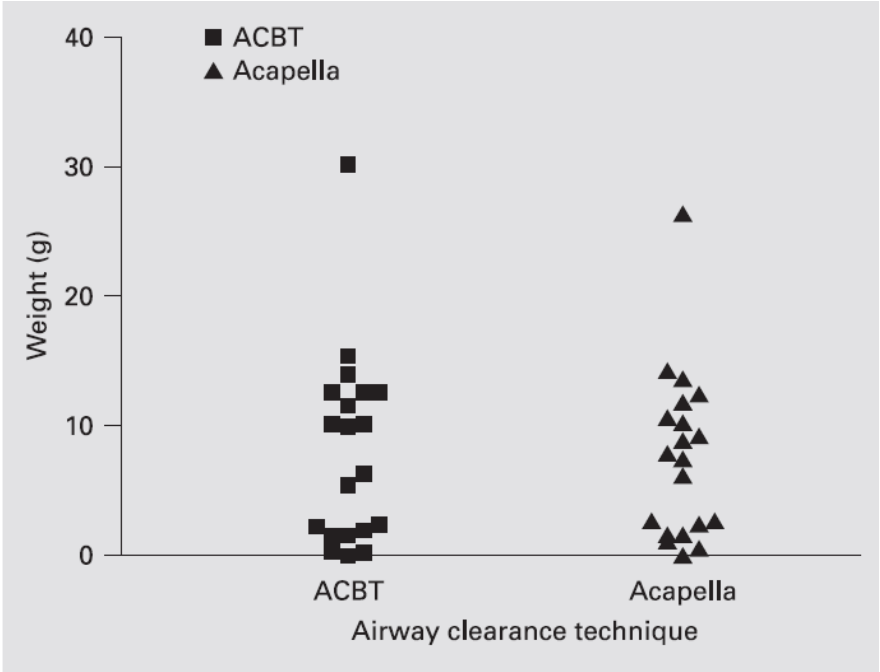


	ACBT before treatment mean ± SD	ACBT after treatment mean ± SD	p value (95% CI)	Acapella before treatment mean ± SD	Acapella after treatment mean ± SD	p value (95% CI)
FEV_1, % predicted	65±20	65±22	0.56 (–2.02 to 1.12)	65±22	65±22	0.88 (–2.42 to 2.82)
FVC, % predicted	81±20	81±20	0.40 (–2.23 to 0.93)	80±19	81±20	0.48 (–3.42 to 1.82)
PEF, % predicted	67±19	68±19	0.89 (–3.50 to 2.20)	69±20	70±18	0.34 (–5.48 to 1.98)
SpO_2, %	97±1	96±2	0.23 (–0.18 to 0.68)	97±1	97±1	0.06 (–0.81 to 1.31)

Respiration 2005;72:239–242

ORIGINAL PAPER

A randomized evaluation of the acute efficacy, acceptability and tolerability of Flutter and active cycle of breathing with and without postural drainage in non-cystic fibrosis bronchiectasis

Table 2 (a) Comparison of acute sputum clearance measures with Flutter and ACBT with and without PD

Results expressed as mean (SD)	*Flutter*	*ACBT*	*ACBT-PD*
Sputum wet wt (g) clearance	4.4 (6.1)	4.1 (5.7)	10.0 (12.4)
Sputum wet wt (g) post-30-min	1.2 (1.8)	1.5 (2.1)	
Total wet wt (g)	5.6 (7.5)	5.6 (6.7)	11.2 (13.3)
Sputum vol (mL) clearance	6.0 (8.5)	5.4 (8.0)	
Sputum vol (mL) clearance	1.9 (3.1)	1.9 (2.4)	11.1 (15.1)
Total vol (mL)	7.9 (11.4)	7.3 (9.6)	12.6 (15.9)
Duration (min)	15.0 (7.8)	15.8 (7.6)	
Total vol (mL)			12.6 (15.9)

(b) Comparison of mean differences in acute sputum clearance between Flutter and ACBT with and without PD

Results expressed as mean difference (SD)	*Flutter versus ACBT*	*Flutter versus ACBT-PD*	*ACBT versus ACBT-PD*
Sputum wet wt (g)	0.3 (3.4)	−5.6 (8.2)*	−5.9 (9.6)*
Sputum wet wt (g) post-30-min	−0.3 (2.0)	0.01 (1.6)	0.3 (1.6)
Total wet wt (g)	0.0 (3.7)	−5.6 (8.5)**	−5.6 (9.2)**
Sputum wet vol (mL)	0.6 (3.9)	−5.1 (8.8)*	−5.7 (10.5)*
Sputum wet vol (mL) post-30-min	0.1 (2.2)	0.5 (2.5)	0.4 (1.8)
Total vol (mL)	0.9 (4.7)	−4.9 (8.2)**	−5.3 (9.9)**
Duration	−0.7 (7.0)	−1.7 (7.3)	−1.4 (9.5)

P-value: *<0.01; **<0.001.

Chronic Respiratory Disease 2007; 4: 23–30

A randomized evaluation of the acute efficacy, acceptability and tolerability of Flutter and active cycle of breathing with and without postural drainage in non-cystic fibrosis bronchiectasis

Results expressed as mean (SD) Likert scale (1 = extremely to 7 = not at all)	*Flutter*	*ACBT*	*ACBT-PD*
Useful at clearing sputum			
Easy to perform	2.4 (1.2)	2.3 (1.1)	
Discomfort	4.7 (1.8)	5.4 (1.3)	5.0 (1.6)
Time-consuming			
Interferes with everyday life	6.3 (0.9)	6.0 (1.3)	
Embarrassing	5.9 (1.6)	6.0 (1.6)	5.4 (2.1)

(b) Comparison of mean differences in acceptability and tolerability of Flutter and ACBT with and without PD

Results expressed as mean difference (SD)	*Flutter versus ACBT*	*Flutter versus ACBT-PD*	*ACBT versus ACBT-PD*
Useful at clearing sputum	−0.3 (2.3)	0.6 (2.0)	1.0 (1.9)*
Easy to understand	0.2 (0.8)	0.2 (0.9)	−0.1 (0.7)
Easy to perform	0.1 (1.4)	−0.4 (1.8)	−0.5 (1.9)
Tiring	−0.7 (1.7)	−0.3 (2.0)	0.4 (1.8)
Discomfort (why* text)	−0.4 (1.6)	0.3 (1.6)	0.7 (1.4)*
Time-consuming	−0.2 (1.6)	1.1 (1.8)**	1.3 (1.4)**
Interferes with everyday life	0.4 (1.1)	1 (1.6)***	0.6 (1.3)
Embarrassing	−0.1 (1.3)	0.5 (2.0)	0.6 (2.2)

Chronic Respiratory Disease 2007; 4: 23–30

Eur Respir J 2009; 34: 1086–1092
DOI: 10.1183/09031936.00055509

A randomised crossover trial of chest physiotherapy in non-cystic fibrosis bronchiectasis

M.P. Murray*, J.L. Pentland# and A.T. Hill*

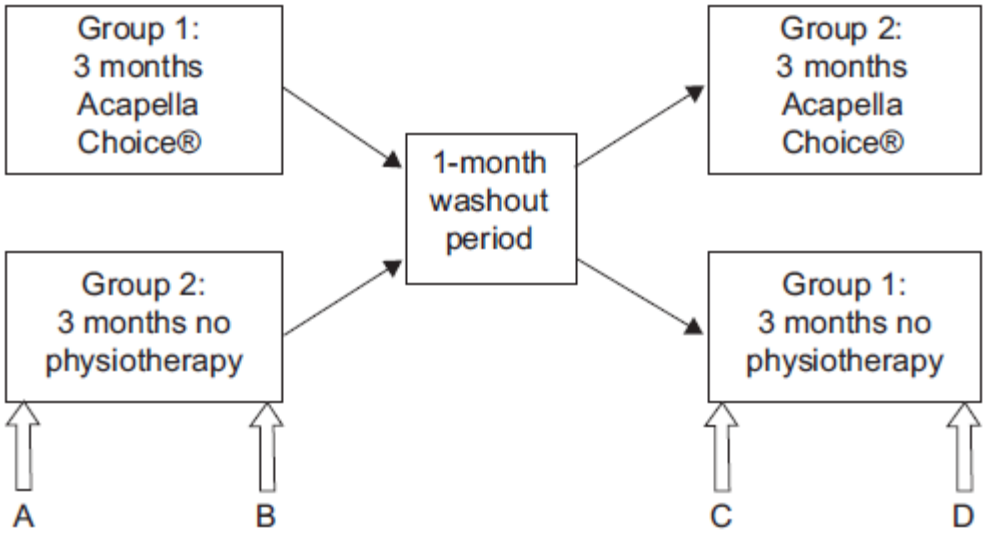
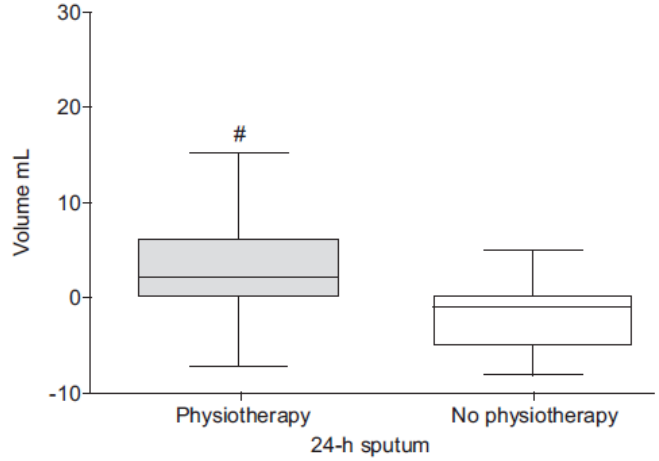


TABLE 1 Patient characteristics

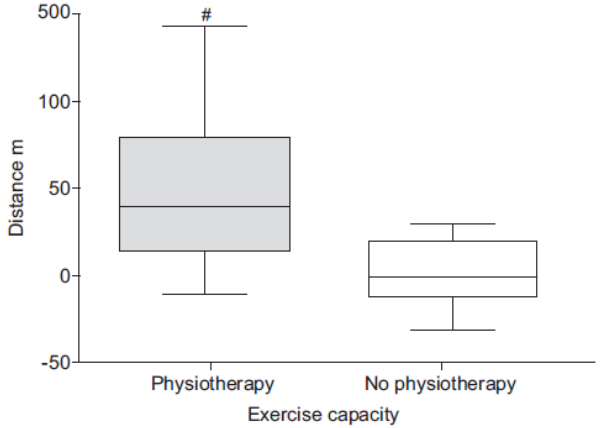
Study participants#	20
Male	12 (60)
Age yrs	73 (72–77)
Ex-smokers	8 (40)
Chronic cardiac disease	3 (15)
Neurological disease	1 (5)
Chronic renal impairment	1 (5)
Diabetes mellitus	0
Inhaled corticosteroid therapy	12 (60)
Systemic corticosteroid therapy	0
Long-term antibiotic therapy	2 (10)
Infective exacerbations requiring antibiotic treatment in preceding 12 months	2 (1.5–3)
Lobes affected with bronchiectasis on HRCT	4 (3–4.75)
Varicose or cystic dilatation affecting ⩾1 lobe	15 (75)
Chronically colonised with pathogenic organisms in sputum when stable	14 (70)
Pseudomonas aeruginosa	6 (42.9)
Haemophilus influenzae	5 (35.7)
Staphylococcus aureus	2 (14.3)
Moraxella catarrhalis	1 (7.1)
Aetiology of bronchiectasis	
Post-infective	10 (50)
Idiopathic	8 (40)
Inactive allergic bronchopulmonary aspergillosis	1 (5)
Inflammatory bowel disease	1 (5)

OPAP is effective in sputum expectoration and improving QOL and exercise capacity

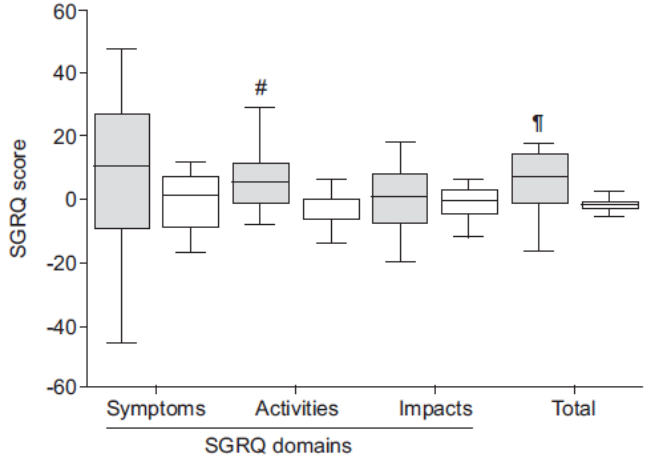
Sputum volume



Walking distance



SGRQ



Eur Respir J 2009; 34: 1086–1092

Egyptian Journal of Chest Diseases and Tuberculosis (2016) 65, 157–165

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ORIGINAL ARTICLE

Comparison between active cycles of breathing with postural drainage versus conventional chest physiotherapy in subjects with bronchiectasis

Hesham A. AbdelHalim [a,*], Heba H. AboElNaga [b], Karim A. Fathy [c]

[a] Pulmonar
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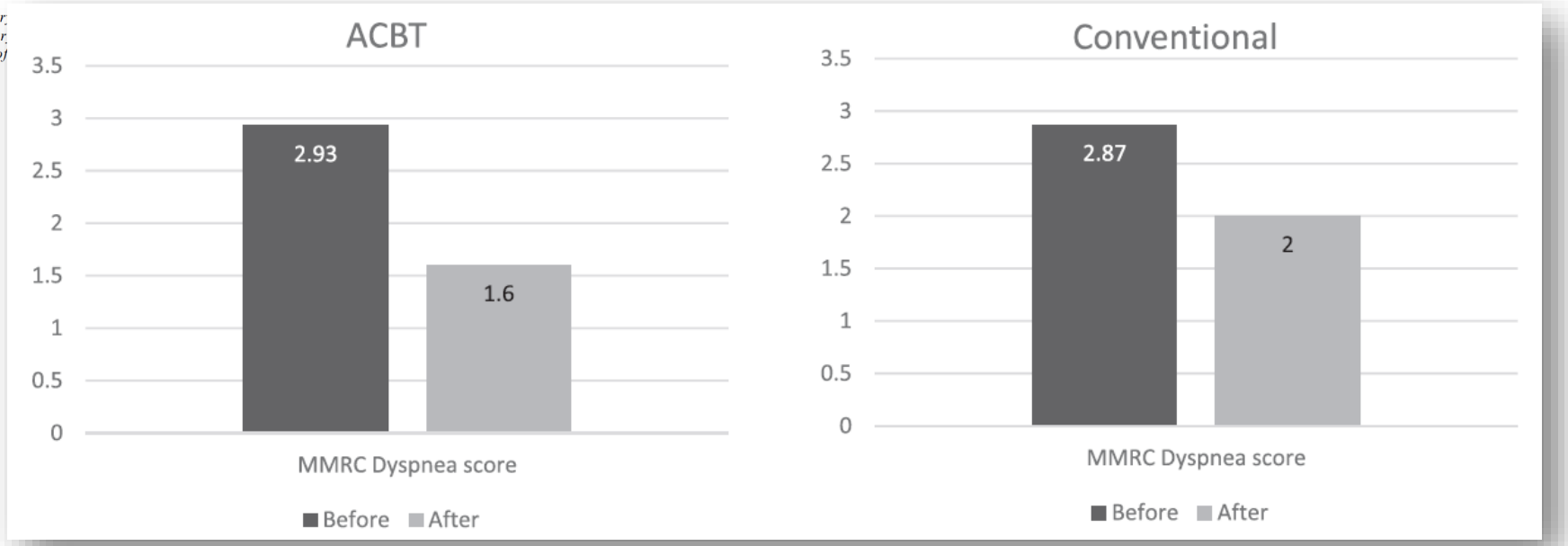
[c] Faculty of



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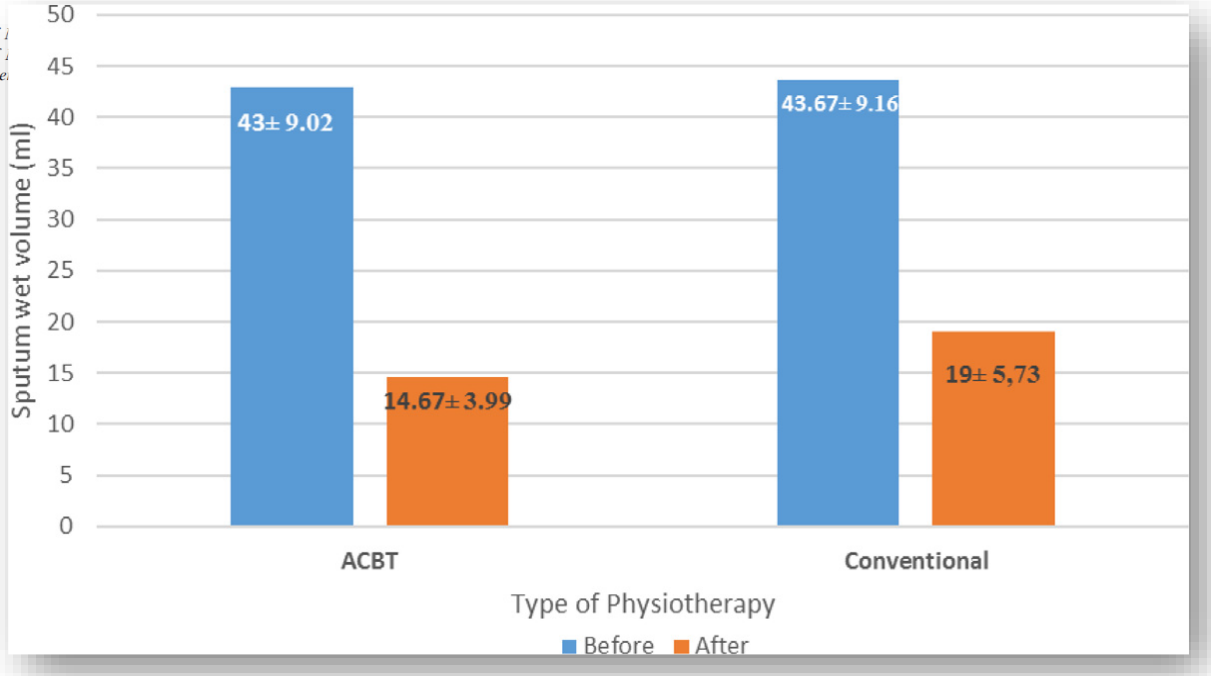
[a] Pulmonary Medicine Department, Faculty of
[b] Pulmonary Medicine Department, Faculty of
[c] Faculty of Physical Therapy, October 6 Unive



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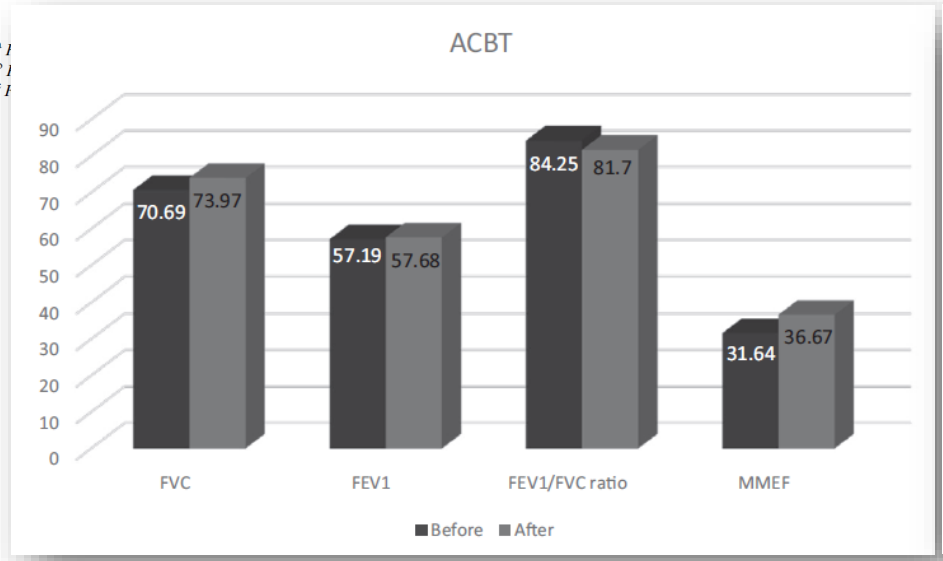
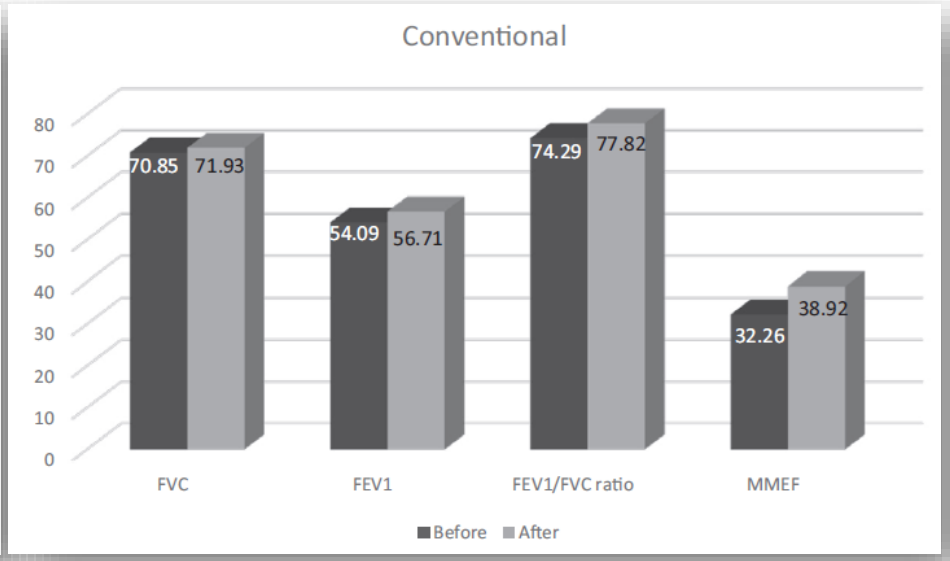
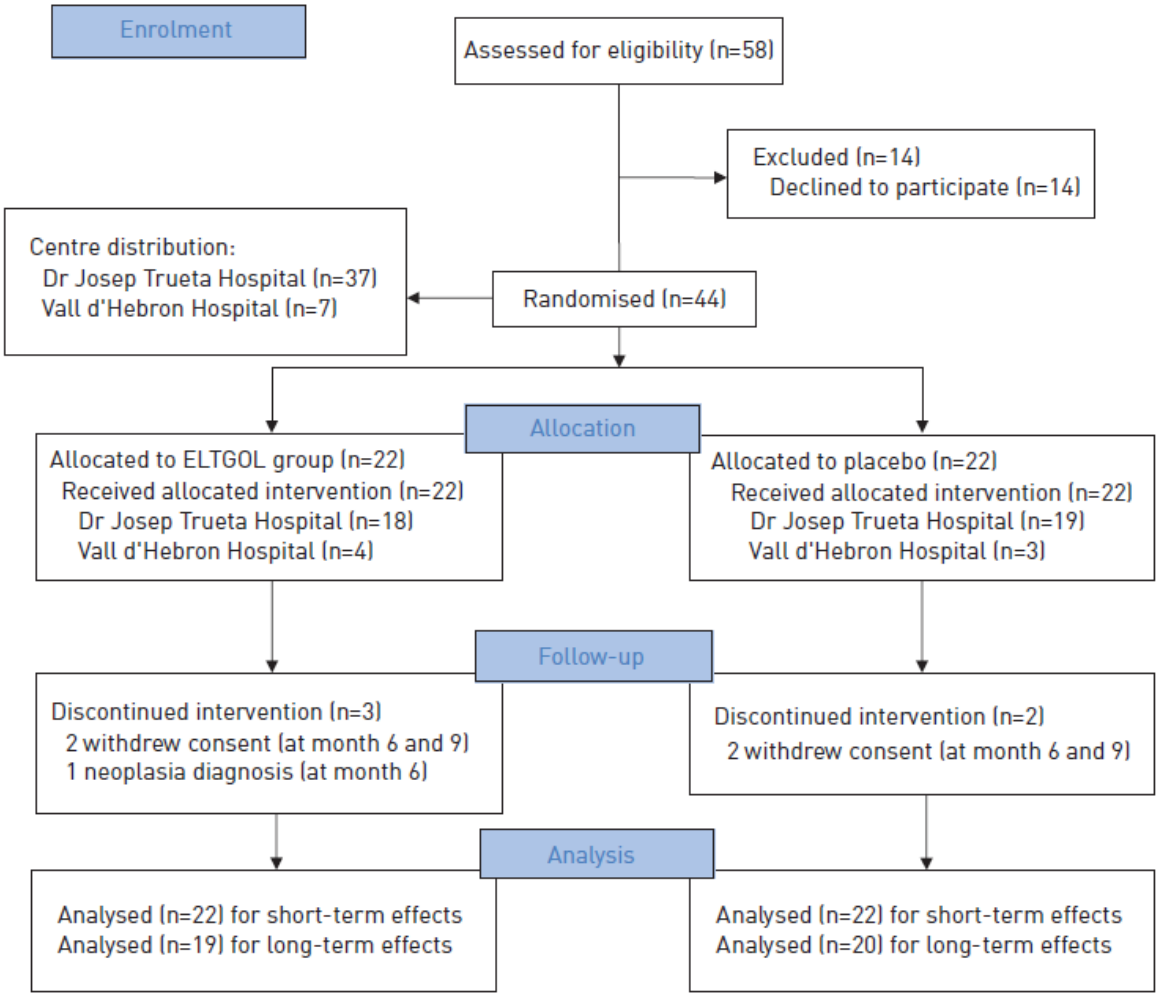




Long-term benefits of airway clearance in bronchiectasis: a randomised placebo-controlled trial

Gerard Muñoz[1,2], Javier de Gracia[3,4,5], Maria Buxó[6], Antonio Alvarez[3,4] and Montserrat Vendrell[1,3]

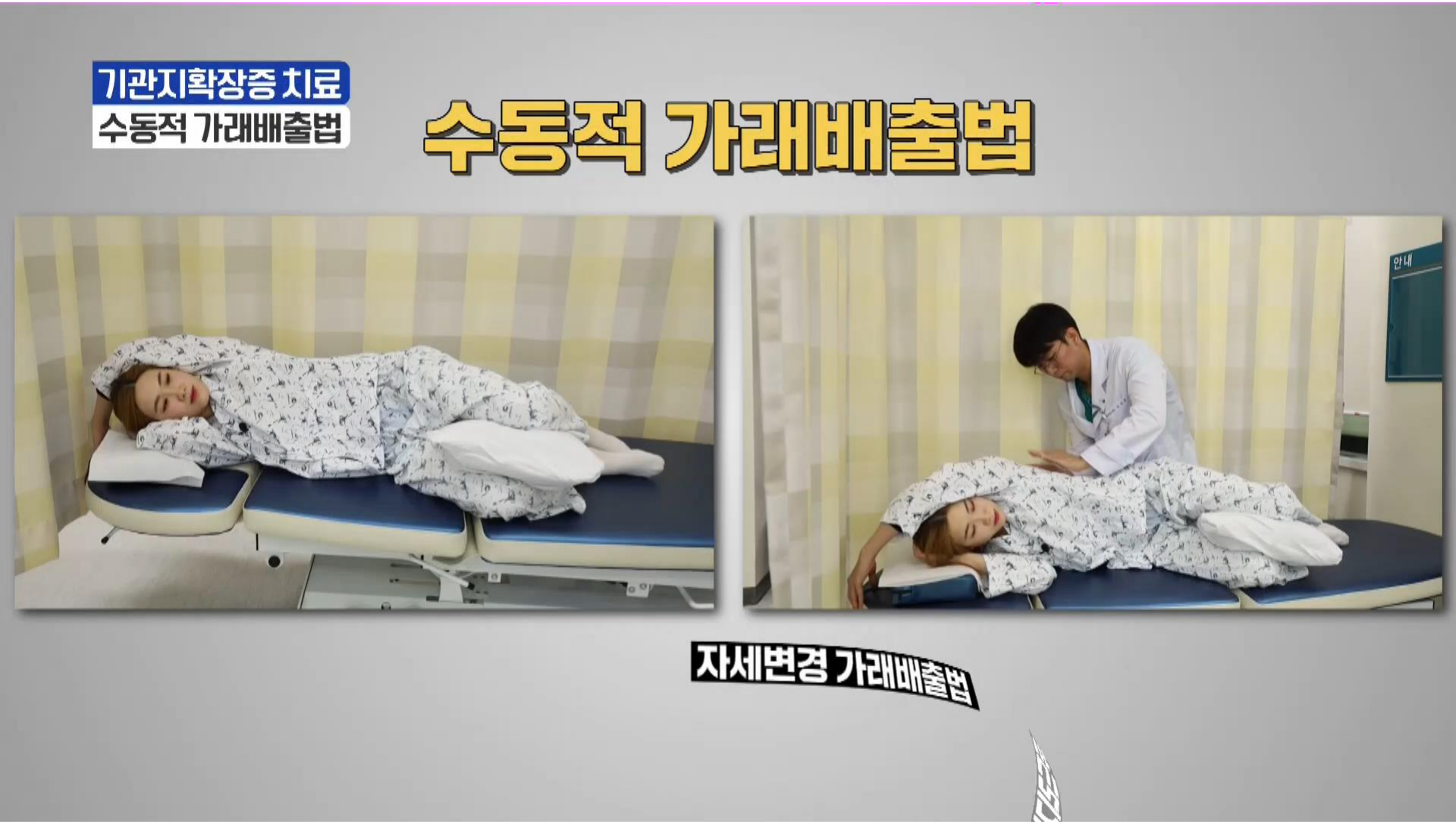


Intervention (ELTGOL)

Slow and prolonged expirations with the glottis opened, from the functional residual capacity to the residual volume, in the lateral decubitus position with the affected lung in the inferolateral position.

Eur Respir J 2018; 51: 1701926

자세 변경 가래 배출법



Long-term benefits of airway clearance in bronchiectasis: a randomised placebo-controlled trial

Gerard Muñoz[1,2], Javier de Gracia[3,4,5], Maria Buxó[6], Antonio Alvarez[3,4] and Montserrat Vendrell[1,3]

	Sputum volume mL		p-value
	ELTGOL group	Placebo group	
Baseline 24-h	20 (15–40)	15 (15–20)	0.061
Visit 2 overall 24-h	40 (23.75–60)	12.5 (0–20)	<0.001
During intervention	12.27±11.93	0	
24 h later	30 (20–45)	12.5 (0–20)	<0.001
Difference between visit 2 and baseline[+]	17.5 (10–26.25)	−5 (−11.25–0)	<0.001
Month 12 overall 24-h	35 (30–50)	15 (10–20)	<0.001
During intervention	10.83±5.21	0	
24 h later	25 (20–40)	15 (10–20)	0.001
Difference between month 12 and baseline[#]	10 (−5–25)	0 (−10–3.75)	0.015
Difference between month 12 and visit 2[¶]	−5 (−30–5)	5 (5–10)	0.019

Eur Respir J 2018; 51: 1701926

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	ELTGOL			Placebo			p-value#
	Baseline	Month 12	Between-group difference	Baseline	Month 12	Between-group difference	
SGRQ total score			−6.8 (−15.1–1.5)+			11.4 (6.9–15.9)+	
	40.2±13.7	33.7±15.7		35.0±9.9	47.6±12.8		<0.001
LCQ total score	14.5±3.4	16.2±3.2	1.96 (0.2–3.8)+	15.7±2	13.7±2.1	−2 (−2.8– −1.2)+	<0.001
Exacerbations	2 (1–3.25)	1 (0–2)	−0.8 (−1.5– −0.1)¶	1(0.75–2.25)	2 (1–3)	0.35 (−0.5–0.35)¶	0.042
FEV1% predicted	58.1±22.9	57.9±25	−0.4 (−3.5–2.8)+	64.6±21.1	61.3±21	−2.5 (−4.7– −0.2)+	0.262
FEV1 L	1.6±0.8	1.6±0.8	−0.004 (−0.1–0.03)+	1.5±0.4	1.5±0.4	−0.1 (−0.2–0.004)+	0.407
mMRC	1 (0–1.25)	1 (0–1)	0 (−0.5–0)¶	1 (1–1.25)	1 (1–2)	0.5 (0–0.5)¶	0.127
6MWT m	417.8±67	423.5±84.9	2.3 (−16.7–21.2)+	382.9±76.9	377.8±57.3	−2.6 (−29.3–24.1)+	0.746
ESR mm	22.3±26.5	17.1±17.5	9 (7–23)+	25.5±22.3	23.9±17.6	24 (7.3–34.5)+	0.863
Leukocytes $\times 10^3$ μL^{-1}	6.9±2	7.5±2	0.03 (−0.8–0.9)+	7.5±2.2	7.7±2.7	0.6 (−0.2–1.3)+	0.641
Neutrophils %	59.7±8.7	60±8.9	−1.6 (−6.6–3.3)+	58.5±8.4	57.9±12.1	−1.4 (−6–3.2)+	0.945
CRP mg·dL^{-1}	0.7±0.9	1.7±2.7	0.7 (−0.7–2.2)+	0.6±0.5	0.7±0.6	0.06 (−0.3–0.4)+	0.619
Fibrinogen mg·dL^{-1}	425.5±69	468.6±1000.5	43.9 (−31.3–119)+	449.6±930.5	492.6±125.2	59.3 (−13.8–132.3)+	0.756

Eur Respir J 2018; 51: 1701926

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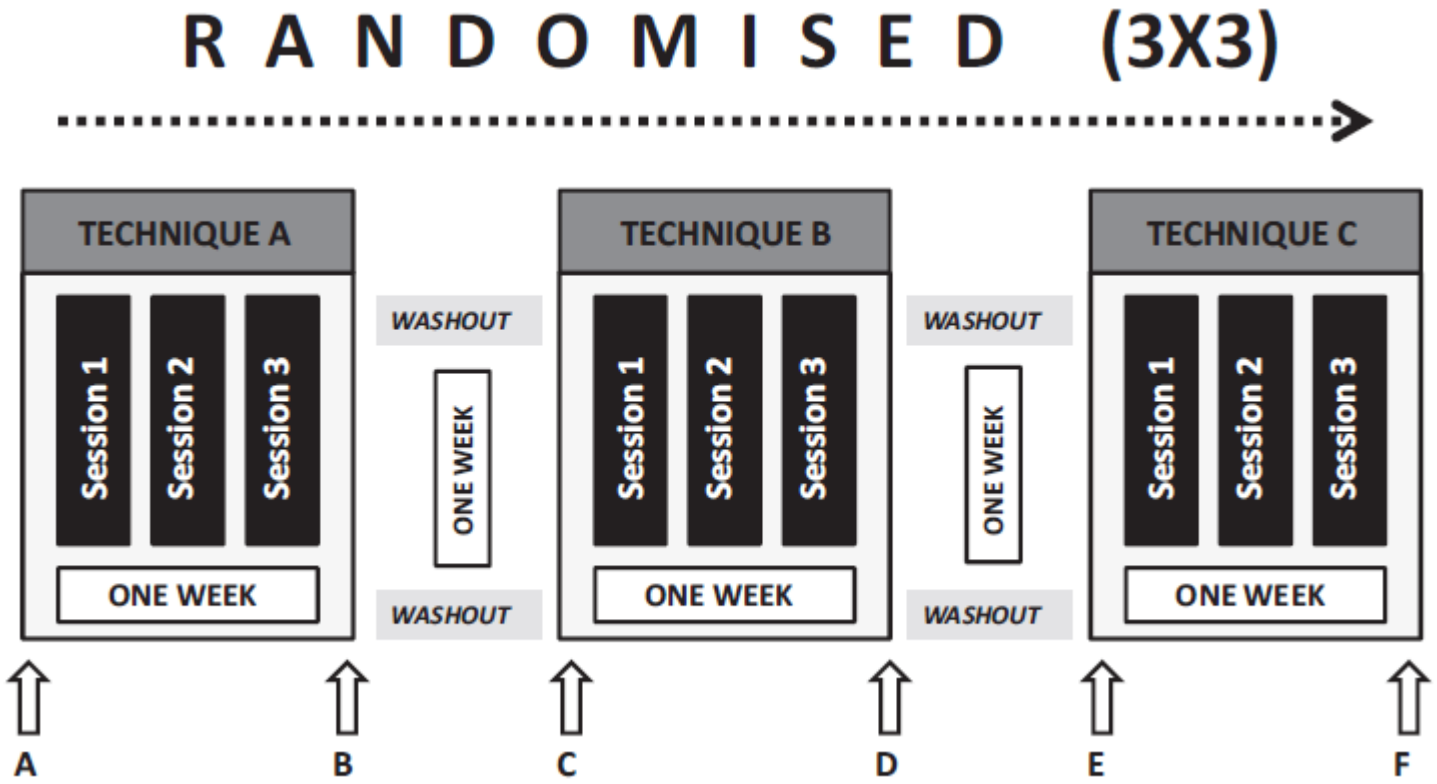
	Month 6 – visit 2				Month 12 – month 6			
	ELTGOL[#]	Placebo[#]	Mean difference (95% CI)[¶]	p-value[+]	ELTGOL[#]	Placebo[#]	Mean difference (95% CI)[¶]	p-value[+]
SGRQ total	−7.7±8.6	7.8±10.5	−15.51 (−22.10; −8.92)	<0.001	0.8±14	1.6±9.6	−0.78 (−9.07; 7.50)	0.848
SGRQ symptoms	−8.3±21.4	6.2±10.3	−14.50 (−26.11; −2.89)	0.017	−1±17.9	0.7±15.8	−1.65 (−9.04; 9.54)	0.775
SGRQ activity	−4.5±12	8.6±14.5	−13.06 (−22.17; −3.95)	0.006	0.4±14.4	2.5±15.8	−2.10 (−12.46; 8.26)	0.683
SGRQ impact	−9.3±10.5	7.9±13.2	−17.23 (−25.40; −9.06)	<0.001	1.6±16.4	1.4±9.5	0.25 (−9.04; 9.54)	0.957
LCQ total	1.9±4	−1.6±2.6	3.53 (1.20; 5.86)	0.004	0.002±3.5	−0.5±2.2	0.48 (−1.54; 2.50)	0.633

Eur Respir J 2018; 51: 1701926

Short-term effects of three slow expiratory airway clearance techniques in patients with bronchiectasis: a randomised crossover trial

B. Herrero-Cortina [a,b], J. Vilaró [c], D. Martí [a,*], A. Torres [a,d], M. San Miguel-Pagola [b], V. Alcaraz [a], E. Polverino [a]

[a] *Pneumology Department, Clinic Institute of Thorax, Hospital Clinic of Barcelona, Institut dÍnvestigacions Biomèdiques August Pi I Sunyer – Centro de Investigación Biomédica En Red-Enfermedades Respiratorias, Barcelona, Spain*
[b] *Health Sciences Faculty, San Jorge University, Zaragoza, Spain*
[c] *Health Sciences Faculty Blanquerna, Physiotherapy Research Group, Ramon Llull University, Barcelona, Spain*
[d] *University of Barcelona, Barcelona, Spain*



Physiotherapy 102 (2016) 357–364

Short-term effects of three slow expiratory airway clearance techniques in patients with bronchiectasis: a randomised crossover trial

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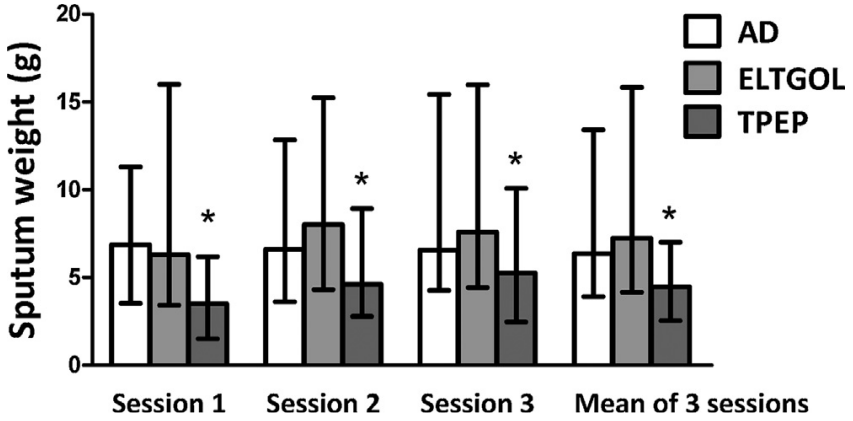

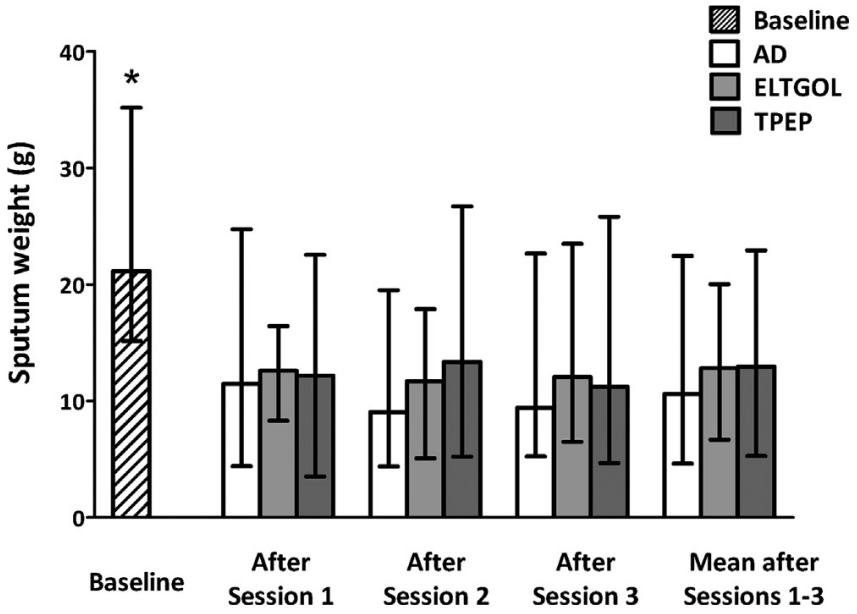

AD, auto-genic drainage

ELTGOL, slow expiration with glottis opened in lateralposture;

TPEP, temporary positive expiratory pressure.

Physiotherapy 102 (2016) 357–364

Short-term effects of three slow expiratory airway clearance techniques in patients with bronchiectasis: a randomised crossover trial

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[c] *Health Sciences Faculty Blanquerna, Physiotherapy Research Group, Ramon Llull University, Barcelona, Spain*
[d] *University of Barcelona, Barcelona, Spain*

Table 2
Change in Leicester Cough Questionnaire score after 1 week of treatment for each slow expiratory airway clearance technique.

	Total score			Physical score			Psychological score			Social score		
	Median difference	95% CI	*P*-value	Median difference	95% CI	*P*-value	Median difference	95%	*P*-value	Median difference	95% CI	*P*-value
AD	0.5	0.1 to 0.5	0.01	0.1	0.0 to 0.3	0.1	0.1	−0.1 to 0.4	0.1	0.0	−0.1 to 0.5	0.2
ELTGOL	0.9	0.5 to 2.1	0.001	0.4	−0.1 to 0.6	0.006	0.3	0.1 to 0.6	0.001	0.2	0.1 to 0.9	0.001
TPEP	0.4	0.1 to 1.2	0.04	0.1	−0.1 to 0.3	0.3	0.1	0.0 to 0.5	0.06	0.1	0.0 to 0.5	0.02

AD, autogenic drainage; ELTGOL, slow expiration with glottis opened in lateral posture; TPEP, temporary positive expiratory pressure; CI, confidence interval.
Wilcoxon's tests were performed. $P < 0.05$ was considered to indicate statistical significance.

AD, auto-genic drainage

ELTGOL, slow expiration with glottis opened in lateralposture;

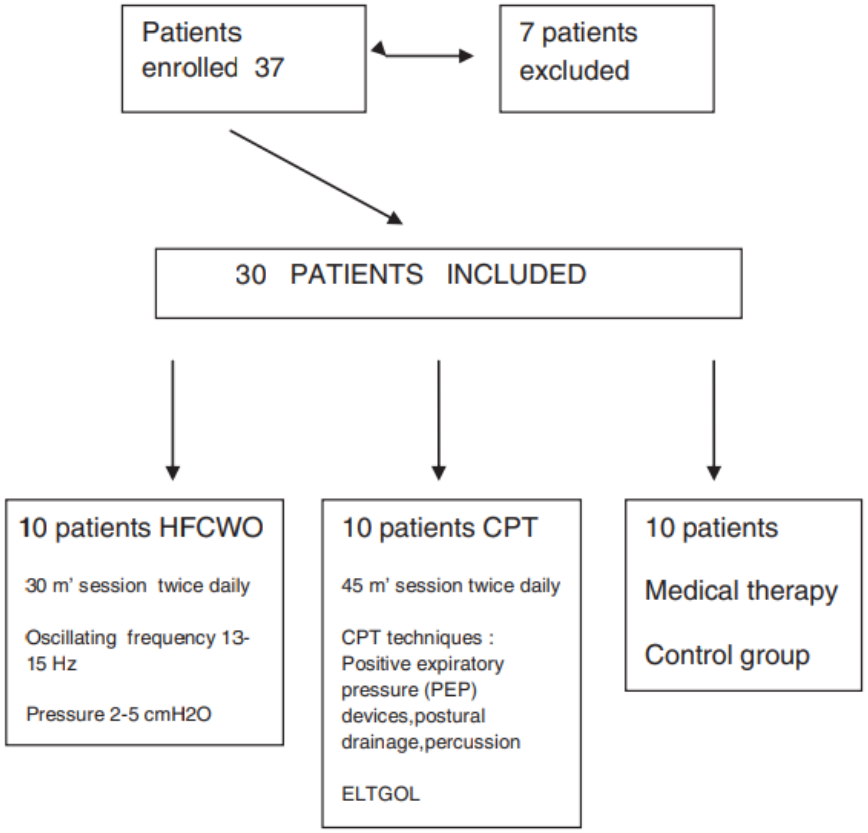
TPEP, temporary positive expiratory pressure.

Physiotherapy 102 (2016) 357–364

RESEARCH ARTICLE Open Access

Effectiveness of treatment with high-frequency chest wall oscillation in patients with bronchiectasis

Antonello Nicolini[1*], Federica Cardini[1], Norma Landucci[1], Sergio Lanata[2], Maura Ferrari-Bravo[3] and Cornelius Barlascini[4]



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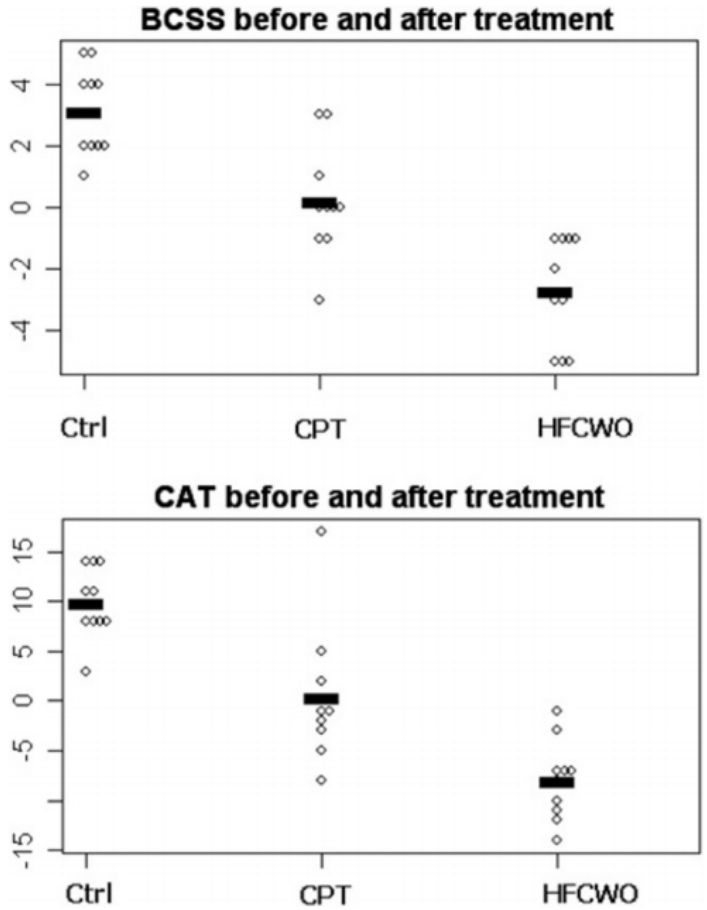

Figure 2 Dot-plot that shows BCSS score and CAT score change-values before and after treatment in HFCWO and CPT groups.

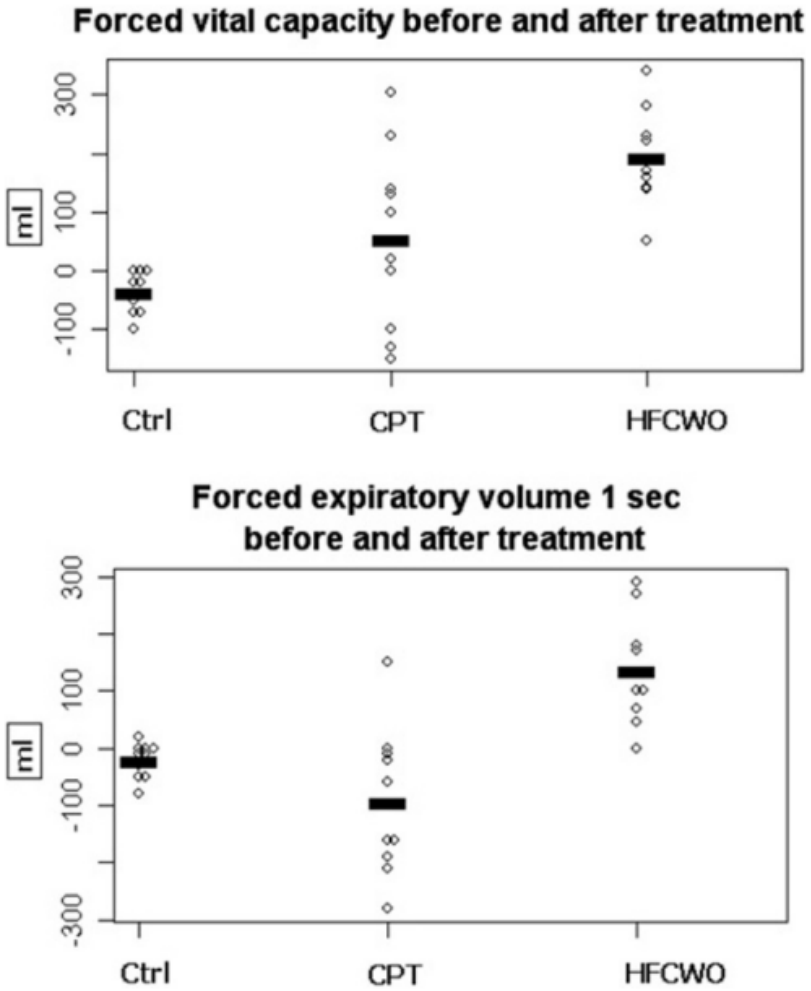

Figure 3 Dop-plot that shows FVC and FEV1 change values (ml) before and after treatment in HFCWO and CPT groups.

Physiotherapy

가래배출법	**능동적**	▫ 기침법 ▫ 허핑 ▫ 가슴팽창운동 ▫ 능동주기 호흡법 (ACBT) ▫ 자가 배출법 ▫ 보조기침법과 덧대기 기침법
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보조 기침법

Evidence A in BTS guideline 2019

- Teach individuals with bronchiectasis to perform airway clearance. **(D)**
- Offer active cycle of breathing techniques or oscillating positive expiratory pressure to individuals with bronchiectasis. (D)
- Consider gravity assisted positioning (where not contraindicated) to enhance the effectiveness of an airway clearance technique. (D)

- **Do not** routinely **use recombinant human DNase** in adults with bronchiectasis.

Non-pharmacologic Treatment of Bronchiectasis

- Active cyclic breathing
- Oscillating positive expiratory devices
- Postural drainage
- Forced expiration technique
- Pulmonary rehabilitation
- Inspiratory muscle training

Evidence B in BTS guideline 2010

- **Pulmonary rehabilitation** should be offered to individuals who have breathlessness affecting their activities of daily living.

- **Inspiratory muscle training** can be used in conjunction with conventional pulmonary rehabilitation to enhance the maintenance of the training effect.

Evidence B in BTS guideline 2019

- Offer **pulmonary rehabilitation** to individuals who are functionally limited by shortness of breath (MMRC ≥ 1).

- Consider the use of **inspiratory muscle training** in conjunction with conventional pulmonary rehabilitation to enhance the maintenance of the training effect.

Research Recommendations in BTS 2019

- The role of education, self management plans and who delivers the pulmonary rehabilitation needs to be explored.

- The role of pulmonary rehabilitation after exacerbations requiring hospital admission needs to be explored.

- The incidence of cross-infection of respiratory pathogens in the group exercise setting should be investigated in the bronchiectasis population.

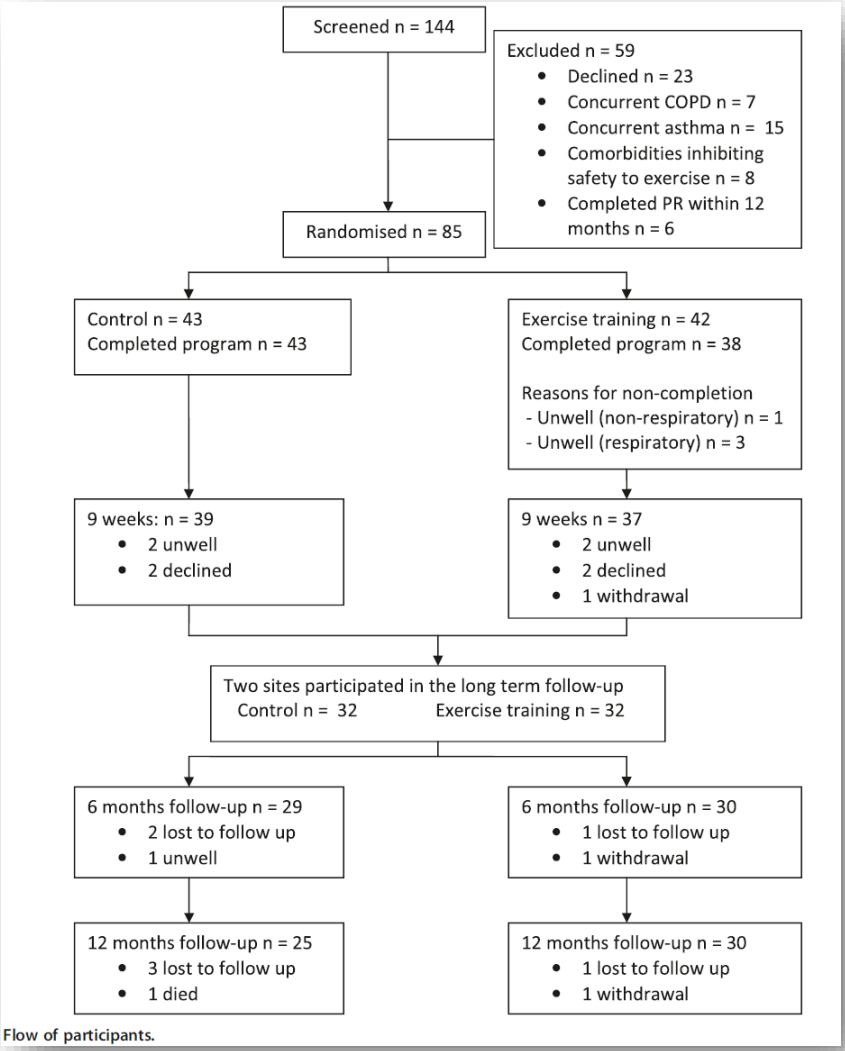
Lee et al. Respiratory Research 2014, 15:44
http://respiratory-research.com/content/15/1/44

RESPIRATORY RESEARCH

RESEARCH Open Access

The short and long term effects of exercise training in non-cystic fibrosis bronchiectasis – a randomised controlled trial

Annemarie L Lee[1,2,3*], Catherine J Hill[2,4], Nola Cecins[5,6], Sue Jenkins[5,6,7], Christine F McDonald[2,4], Angela T Burge[1], Linda Rautela[2,4], Robert G Stirling[1,8], Philip J Thompson[5,6,7] and Anne E Holland[1,2,9]



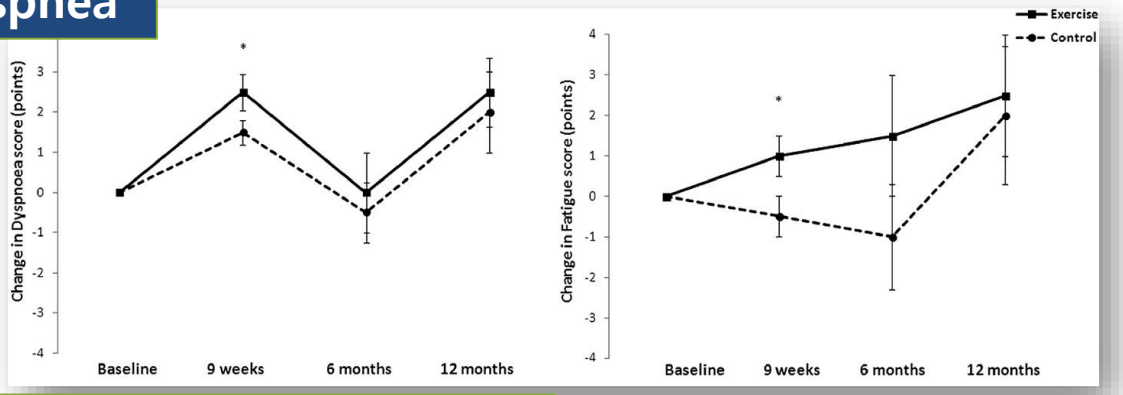
Flow of participants.

- 8 weeks of supervised exercise training
- Twice-weekly
- Treadmill or land-based walking
- Initial intensity set to 75% of the maximal speed

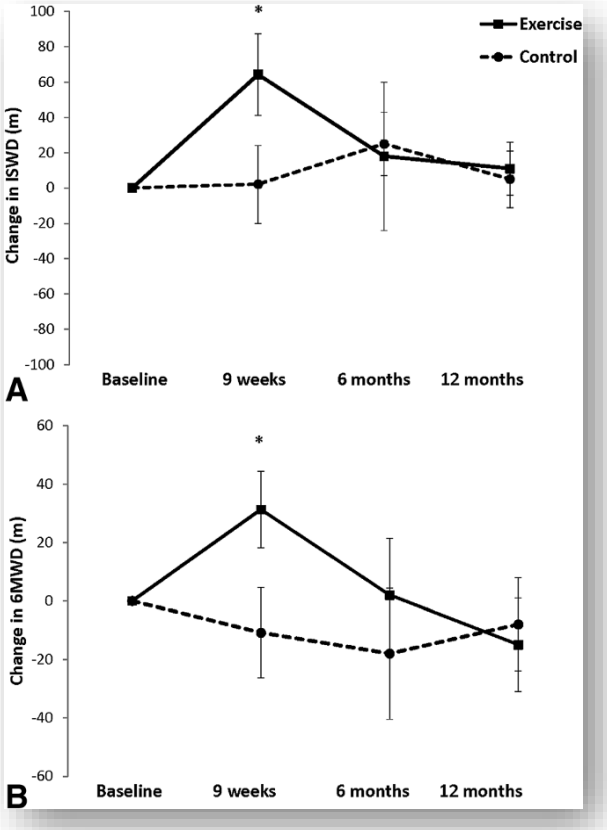
Respiratory Research 2014, 15:44

Pulmonary rehab improved exercise capacity and dyspnea in BE

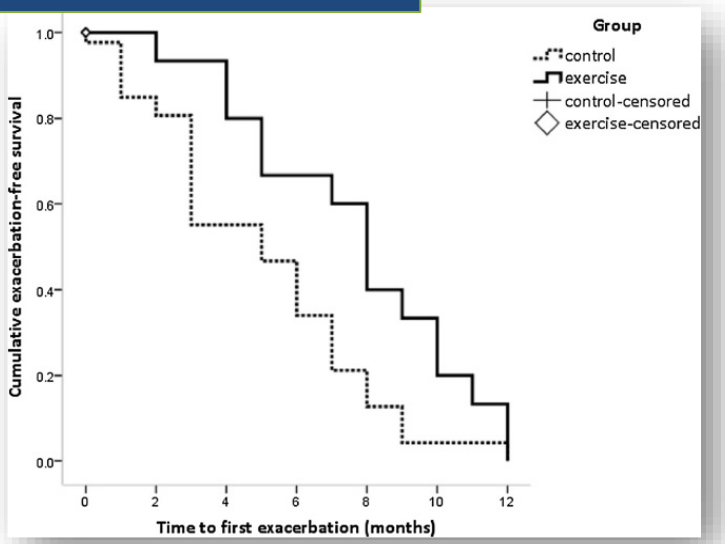
Dyspnea



ISWD



Exacerbation free



Respiratory Research 2014, 15:44

Exercise training and inspiratory muscle training in patients with bronchiectasis

C Newall, R A Stockley, S L Hill

Thorax 2005;**60**:943–948. doi: 10.1136/thx.2004.028928

Table 1 Mean (SD) baseline physiological characteristics of patients who completed the study (n = 32)

Parameter	PR-SHAM	PR-IMT	Control
M/F	4/7	2/10	0/9
Smoking status	4 EX/7 NS	2 EX/10 NS	2 EX/7 NS
Age (years)	63.1 (3.5)	57.3 (2.4)	62.9 (3.9)
FEV_1 (l)	1.44 (0.77)	1.23 (0.74)	1.49 (0.61)
FEV_1 (% predicted)	64	54	69
FEV_1/VC%	57.0 (0.20)	54.1 (0.20)	66.2 (0.09)
RV (l)	2.14 (0.97)	2.51 (0.95)	1.83 (0.87)
RV (% predicted)	111	133	99
TLC (l)	5.04 (1.68)	4.92 (1.10)	4.26 (1.37)
TLC (% predicted)	97	98	88
TLCO (mmol/min/kPa)	6.32 (2.07)	5.88 (1.61)	5.92 (2.13)
TLCO (% predicted)	79	76	76
KCO (mmol/min/kPa/l)	1.65 (0.44)	1.63 (0.29)	1.66 (0.35)
KCO (% predicted)	86	82	82
PImax (cm H_2O)	66.4 (22.0)	78.0 (17.7)	77.2 (24.7)
PImax (% predicted)	87	98	103
PEmax (cm H_2O)	97.3 (37.5)	75.8 (28.5)	87.4 (22.9)
PEmax (% predicted)	66	53	63
Peak $\dot{V}O_2$ (ml/min/kg)	15.6 (6.2)	19.8 (8.3)	19.0 (5.0)
Peak $\dot{V}O_2$ (% predicted)	77	88	92

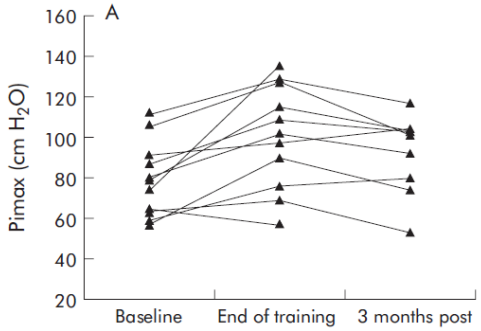
EX, ex-smoker; NS, never smoked; FEV_1, forced expiratory volume in 1 second; VC, vital capacity; TLC, total lung capacity; RV, residual volume; TLCO, lung carbon monoxide transfer factor; KCO, carbon monoxide transfer coefficient; PImax, PEmax, maximum inspiratory and expiratory pressures; $\dot{V}O_2$, oxygen consumption.

- 8 weeks of supervised exercise training
- Three times weekly
- IMT was performed at home for 15 minutes
- 80% of the peak heart rate

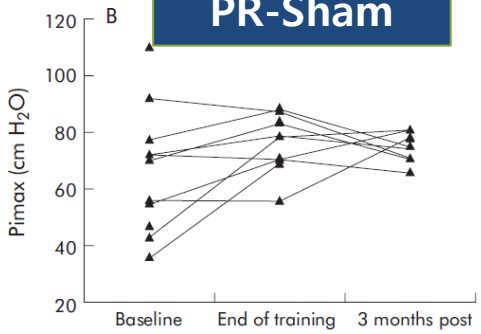
Thorax 2005; 60: 943–948

Exercise capacity maintained with pulmonary rehab

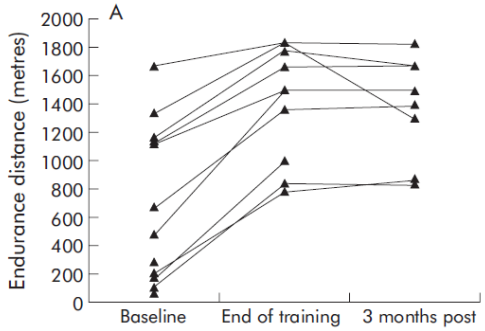
PR-IMT



PR-Sham



e 1 Individual changes in Pimax during training in (A) the PR-IMT
and (B) the PR-SHAM group. Individual values for Pimax during
ng are shown. The lines join data for individual patients.



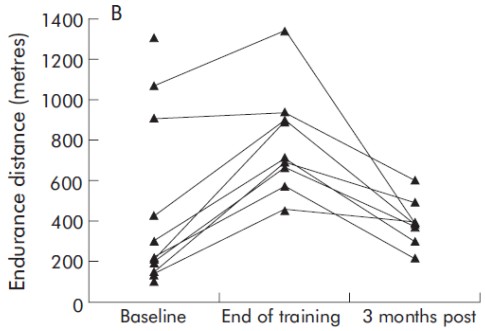
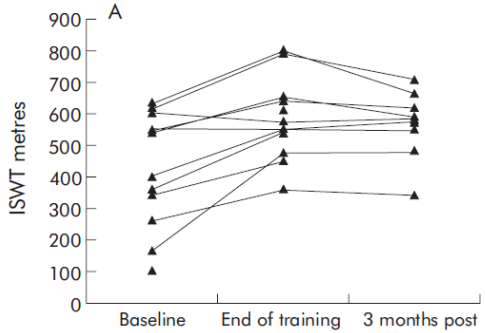
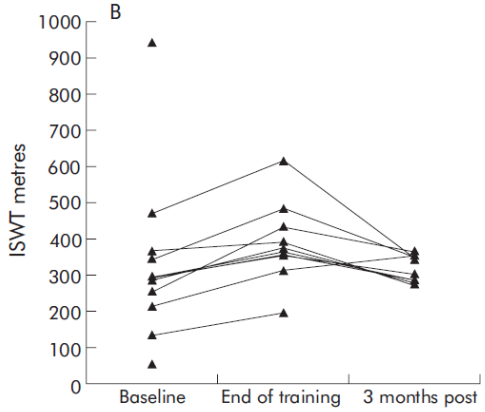


Figure 2 Individual changes in endurance capacity during training in (A) the PR-IMT group and (B) the PR-SHAM group. Individual data and changes in endurance capacity are shown before and after 8 weeks training.





Thorax 2005; 60: 943–948

Respiratory Medicine (2012) 106, 1647–1654

Available online at www.sciencedirect.com

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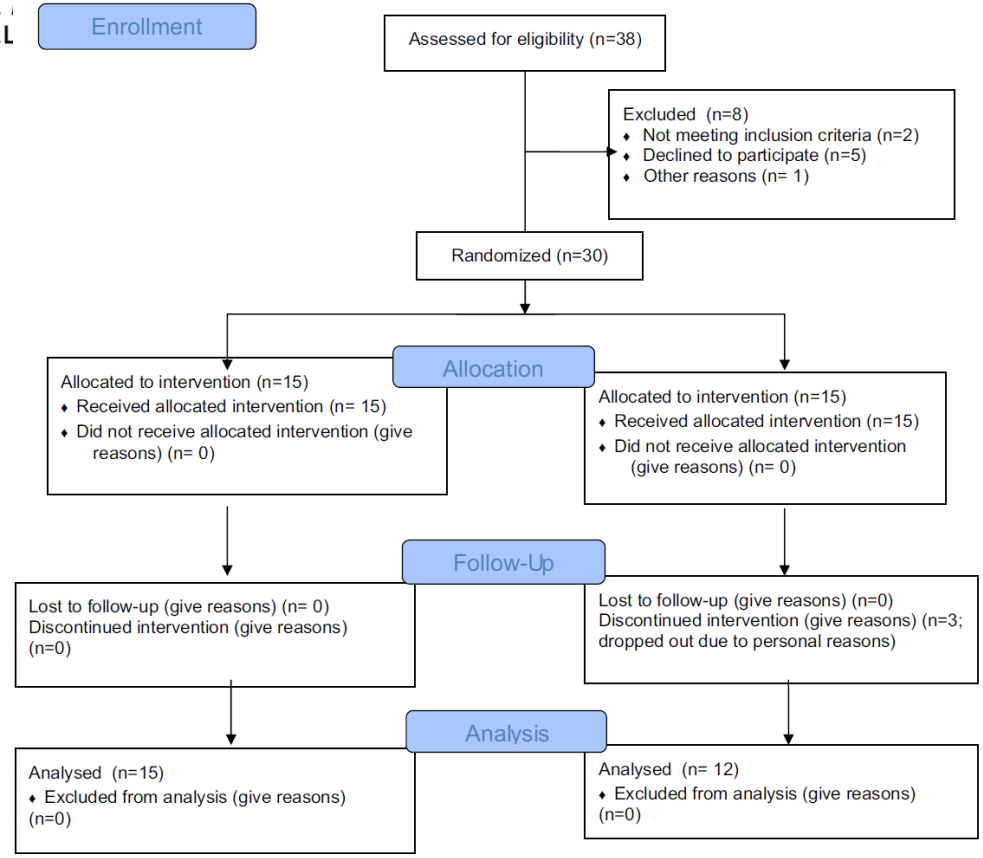
journal homepage: www.elsevier.com/locate/rmed

A pilot study of pulmonary rehabilitation and chest physiotherapy versus chest physiotherapy alone in bronchiectasis

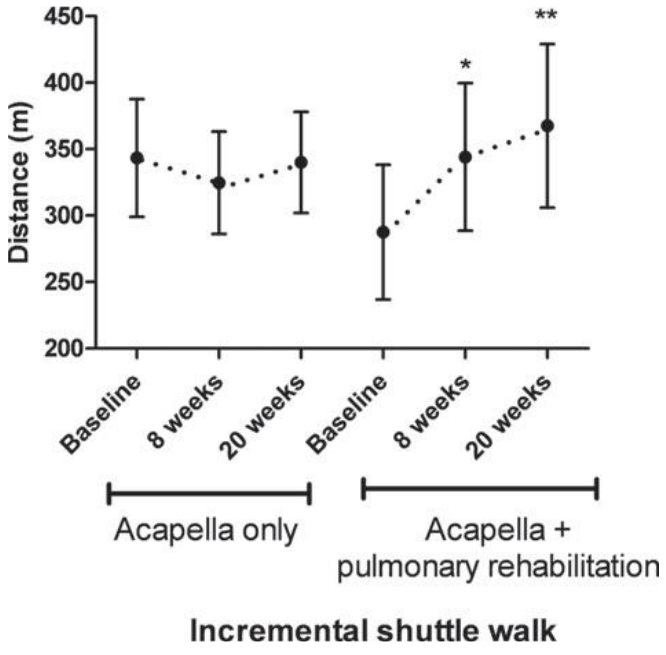
P.
J.L



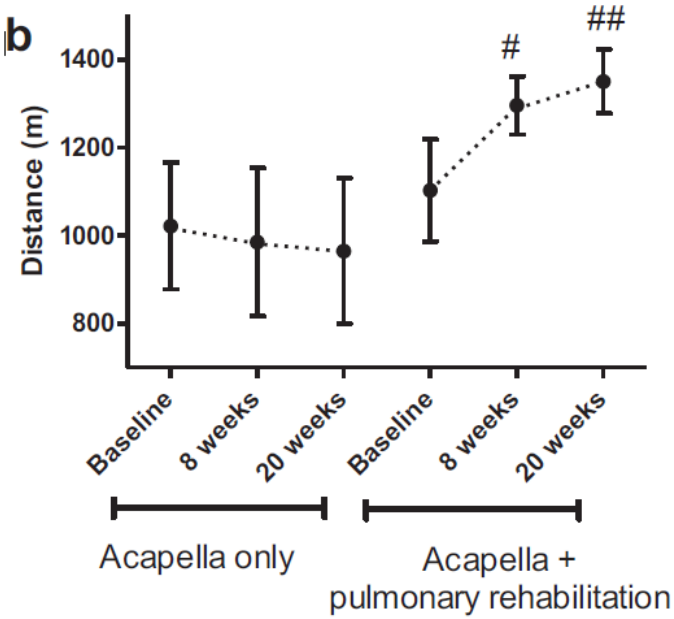
- 8 weeks
- 1:1 randomization
- Physiotherapy ± PR

Respiratory Medicine (2012) 106, 1647e1654

Exercise capacity improved with pulmonary rehab



Incremental shuttle walk



Endurance walk

Respiratory Medicine (2012) 106, 1647e1654

Exercise capacity and QOL improved with pulmonary rehab

Table 2 *p* values represent difference between groups at time points indicated.

	Group receiving acapella ($n = 15$)			Group receiving acapella + pulmonary rehabilitation ($n = 12$)		
	Baseline	8 weeks	20 weeks	Baseline	8 weeks	20 weeks
ISWT (m)	343.3 (44.4)	338.7 (42.2)	343.3 (39.8)	287.5 (50.6)	344.2 (115.5)*	367.5 (61.5)**
EWT (m)	1021.4(144.4)	985 (168.6)	964.3 (165.7)	1102.5 (116.2)	1295.8 (65.8) #	1350 (72.6) ##

*$p = 0.03$; **$p = 0.04$; #$p = 0.01$; ##$p = 0.003$.

Table 3 *p* values represent difference between groups at time points indicated.

	Group receiving acapella ($n = 15$)			Group receiving acapella + pulmonary rehabilitation ($n = 12$)		
	Baseline	8weeks	20weeks	Baseline	8weeks	20 weeks
SGRQ	40.6 (3.9)	39.2 (4.5)	45.2 (4.5)	38.6 (6.4)	30.6 (6.6)*	34.6 (7.7)*
LCQ	14.4 (1.5)	14.6 (1.4)	13.62 (1.4)	12.3 (2.3)	14.9 (2.3)*	16.7 (1.8)*

*$p < 0.001$.

Respiratory Medicine (2012) 106, 1647e1654

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation
journal homepage: www.archives-pmr.org
Archives of Physical Medicine and Rehabilitation 2017;98:774-82

REVIEW ARTICLE (META-ANALYSIS)

Pulmonary Rehabilitation in Individuals With Non—Cystic Fibrosis Bronchiectasis: A Systematic Review

Annemarie L. Lee, PhD,[a,b,c] Catherine J. Hill, PhD,[c,d] Christine F. McDonald, PhD,[c,e] Anne E. Holland, PhD[c,f,g]

From the [a]West Park Healthcare Centre, Toronto, Ontario, Can Canada; [c]Institute for Breathing and Sleep, and Departments Heidelberg, Victoria, Australia; [f]Department of Physiotherapy, of Rehabilitation, Nutrition and Sport, La Trobe University, M

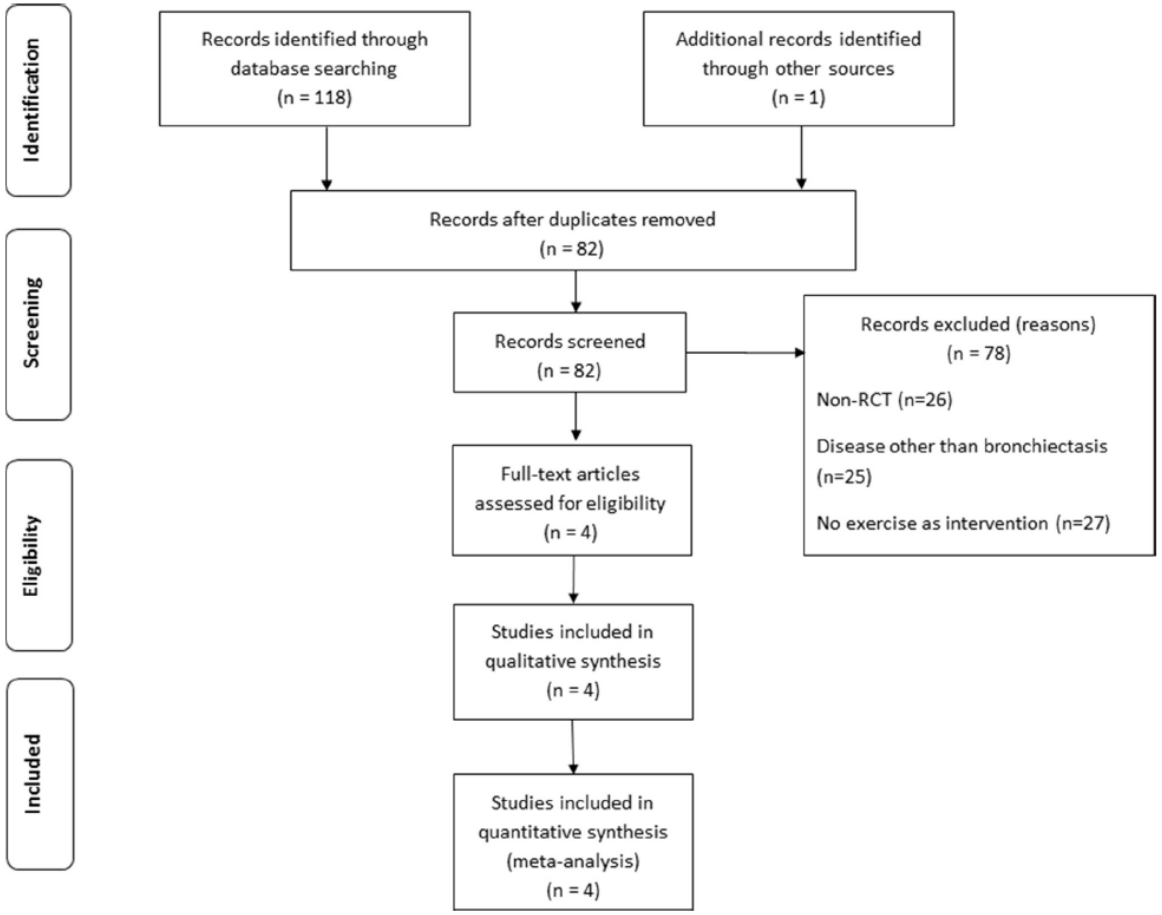


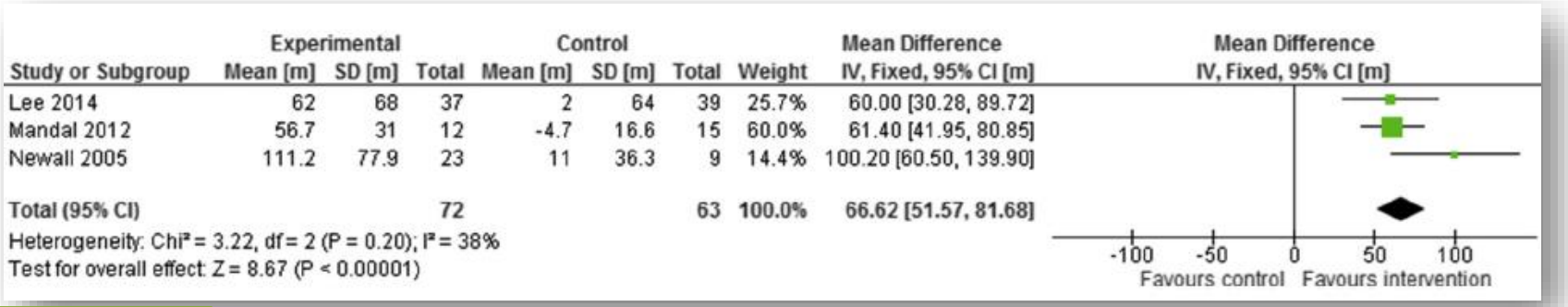
Fig 1 Study flow from identification to inclusion. Abbreviation: RCT, randomized controlled trial.

Exercise capacity and QOL improved with pulmonary rehab in meta-analysis

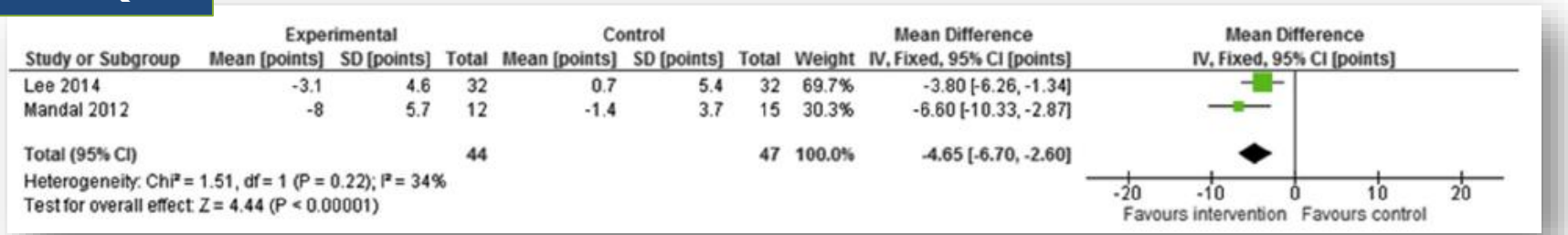
Table 3 Quality assessment (Cochrane risk-of-bias tool)

Study	Randomization Sequence	Allocation Concealment	Blinding: Participants	Blinding: Therapists	Blinding: Outcome Assessors	Incomplete Data	Selective Reporting	Other Biases
Newall,[16] 2005	Low	Unclear	Unclear	Unclear	Unclear	Low	Low	None
Mandal,[17] 2012	Low	Unclear	Unclear	Unclear	Unclear	Low	Low	None
Lee,[18] 2014	Low	Low	High	Unclear	Low	Low	Low	None
Greening,[26] 2014	Unclear	Unclear	High	Unclear	Low	Low	Low	None

ISWD



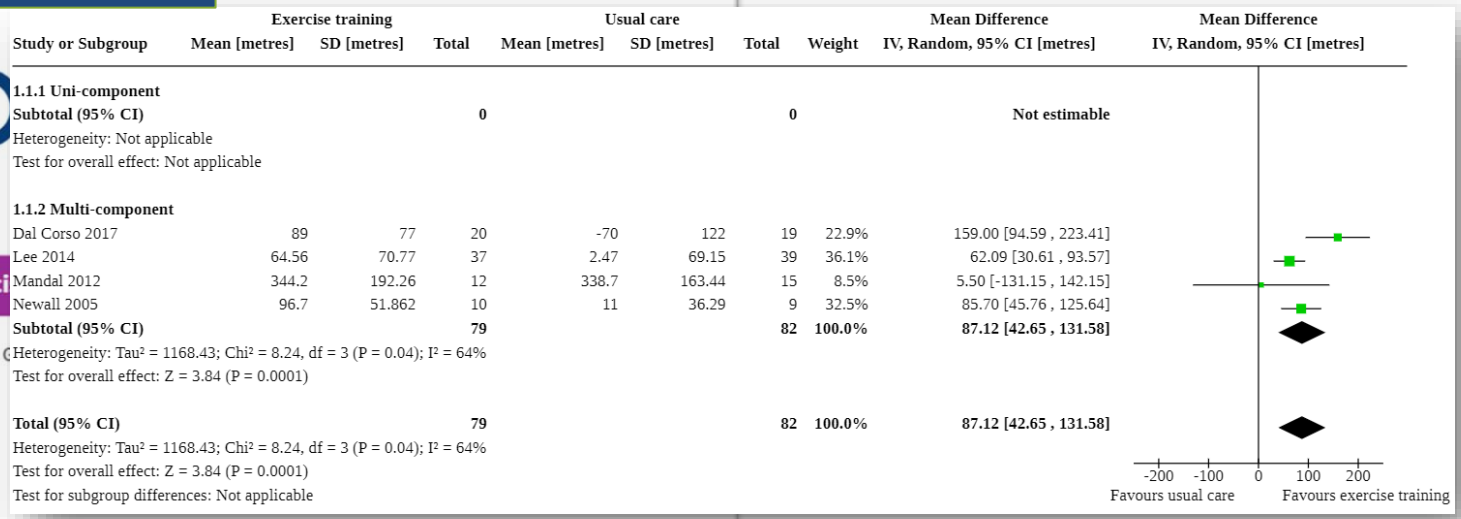
SGRQ



Archives of Physical Medicine and Rehabilitation 2017;98:774-82

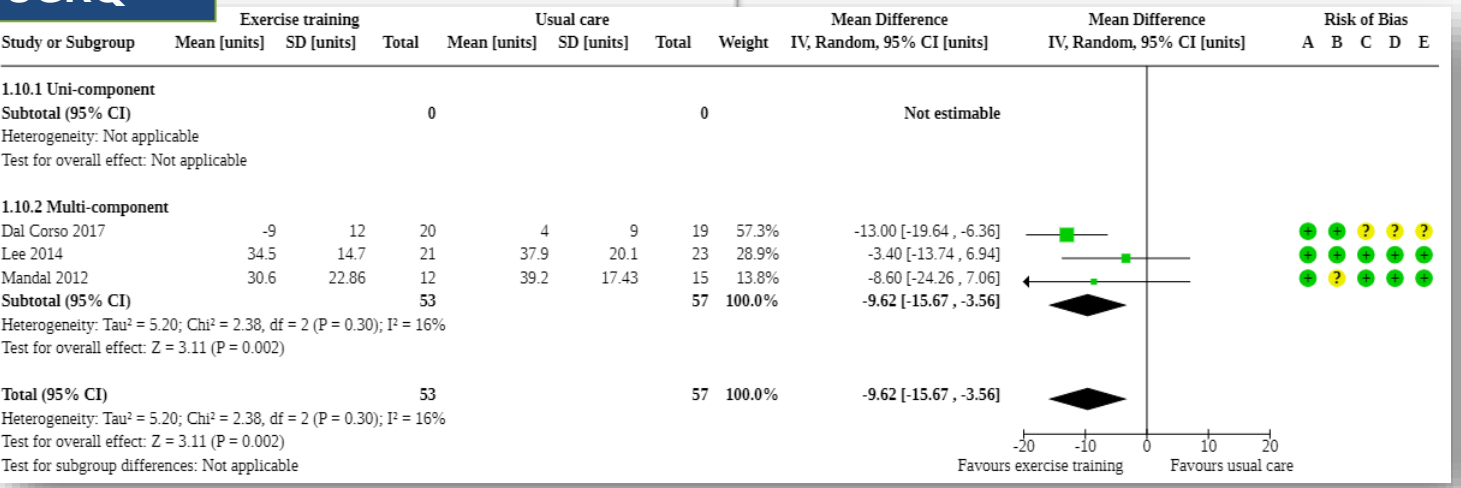
Exercise capacity and QOL improved with pulmonary rehab in meta-analysis

ISWD



Study or Subgroup	Exercise training Mean [metres]	SD [metres]	Total	Usual care Mean [metres]	SD [metres]	Total	Weight	Mean Difference IV, Random, 95% CI [metres]
1.1.1 Uni-component								
Subtotal (95% CI)			**0**			**0**		**Not estimable**
Heterogeneity: Not applicable								
Test for overall effect: Not applicable								
1.1.2 Multi-component								
Dal Corso 2017	89	77	20	-70	122	19	22.9%	159.00 [94.59 , 223.41]
Lee 2014	64.56	70.77	37	2.47	69.15	39	36.1%	62.09 [30.61 , 93.57]
Mandal 2012	344.2	192.26	12	338.7	163.44	15	8.5%	5.50 [-131.15 , 142.15]
Newall 2005	96.7	51.862	10	11	36.29	9	32.5%	85.70 [45.76 , 125.64]
Subtotal (95% CI)			**79**			**82**	**100.0%**	**87.12 [42.65 , 131.58]**
Heterogeneity: Tau² = 1168.43; Chi² = 8.24, df = 3 (P = 0.04); I² = 64%								
Test for overall effect: Z = 3.84 (P = 0.0001)								
Total (95% CI)			**79**			**82**	**100.0%**	**87.12 [42.65 , 131.58]**
Heterogeneity: Tau² = 1168.43; Chi² = 8.24, df = 3 (P = 0.04); I² = 64%								
Test for overall effect: Z = 3.84 (P = 0.0001)								
Test for subgroup differences: Not applicable								

SGRQ



Study or Subgroup	Exercise training Mean [units]	SD [units]	Total	Usual care Mean [units]	SD [units]	Total	Weight	Mean Difference IV, Random, 95% CI [units]	Risk of Bias A B C D E
1.10.1 Uni-component									
Subtotal (95% CI)			**0**			**0**		**Not estimable**	
Heterogeneity: Not applicable									
Test for overall effect: Not applicable									
1.10.2 Multi-component									
Dal Corso 2017	-9	12	20	4	9	19	57.3%	-13.00 [-19.64 , -6.36]	+ + ? ? ?
Lee 2014	34.5	14.7	21	37.9	20.1	23	28.9%	-3.40 [-13.74 , 6.94]	+ + + + +
Mandal 2012	30.6	22.86	12	39.2	17.43	15	13.8%	-8.60 [-24.26 , 7.06]	+ ? + + +
Subtotal (95% CI)			**53**			**57**	**100.0%**	**-9.62 [-15.67 , -3.56]**	
Heterogeneity: Tau² = 5.20; Chi² = 2.38, df = 2 (P = 0.30); I² = 16%									
Test for overall effect: Z = 3.11 (P = 0.002)									
Total (95% CI)			**53**			**57**	**100.0%**	**-9.62 [-15.67 , -3.56]**	
Heterogeneity: Tau² = 5.20; Chi² = 2.38, df = 2 (P = 0.30); I² = 16%									
Test for overall effect: Z = 3.11 (P = 0.002)									
Test for subgroup differences: Not applicable									

Cochrane Database of Systematic Reviews 2021, Issue 4. Art. No.: CD013110.

호흡재활 보험고시 (2016)

대상

만성폐쇄성폐질환

기관지확장증

천식

폐동맥고혈압

간질성폐질환

결핵성폐질환

폐암 및 폐암의 수술 전후

폐이식 폐용적감소수술

제한성폐질환

(전후척추측만증)

*호흡곤란, 일상생활 어려움

소요인력

의사 간호사 물리치료사

내용

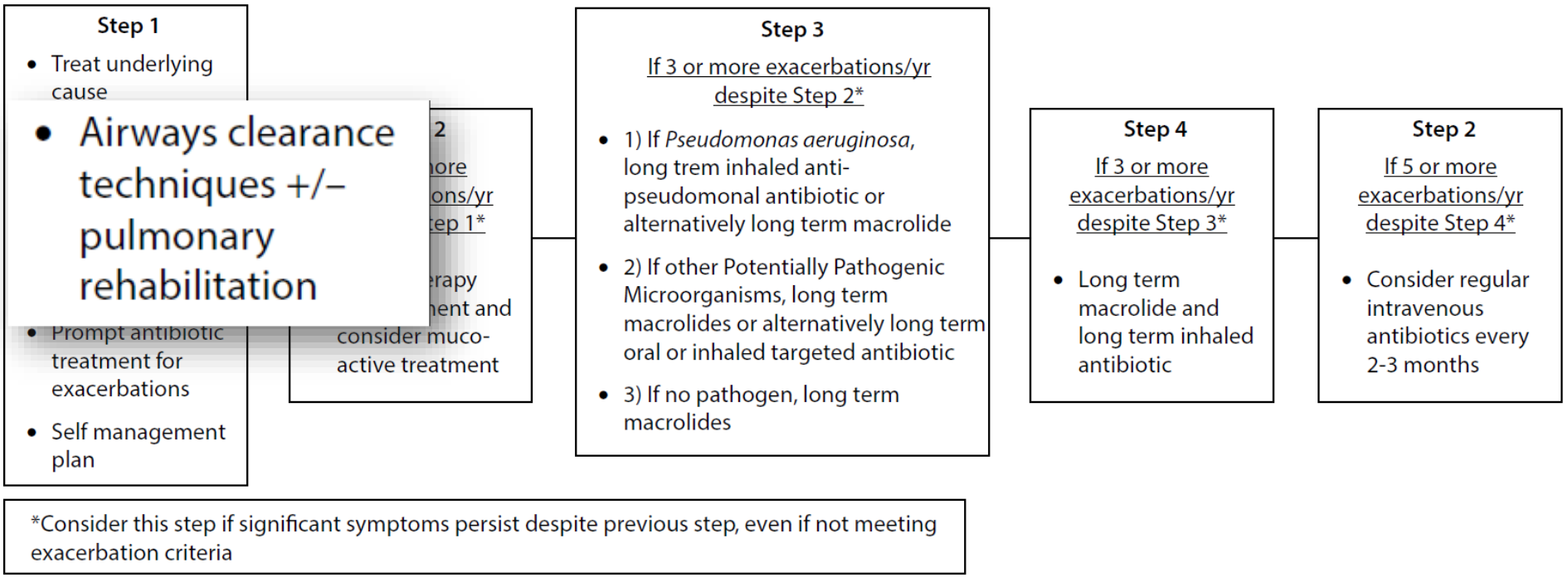
호흡재활 전문의사
환자의 운동능력과 호흡곤란 정도,
기저질환 및 동반질환을 고려
개인별 맞춤 운동프로그램
유산소 운동 :
- 최대운동능력의 60% 이상의 강도
- 20~60분의 운동
- 주 3~5회시행
- 고강도 운동이 불가능한 환자에서는 저강도 운동

근력 운동 :
- 최대 근력의 60~70%의 강도
- 1세트 10회 이상
- 세트 2~3회 시행

Non-pharmacologic Treatment of Bronchiectasis

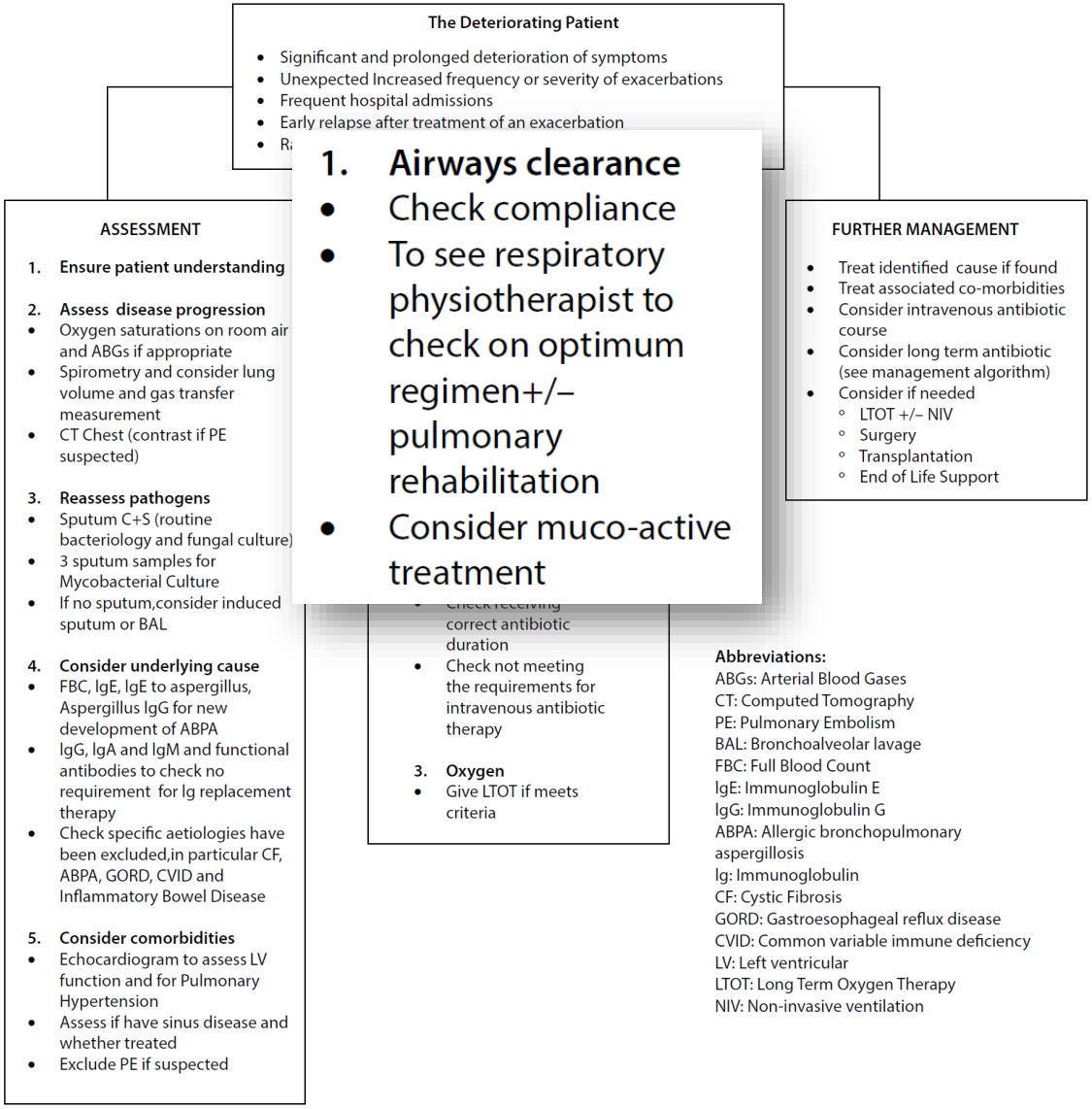
- Active cyclic breathing
- Oscillating positive expiratory devices
- Postural drainage
- Forced expiration technique
- Pulmonary rehabilitation
- Inspiratory muscle training

Stepwise management in BTS 2019



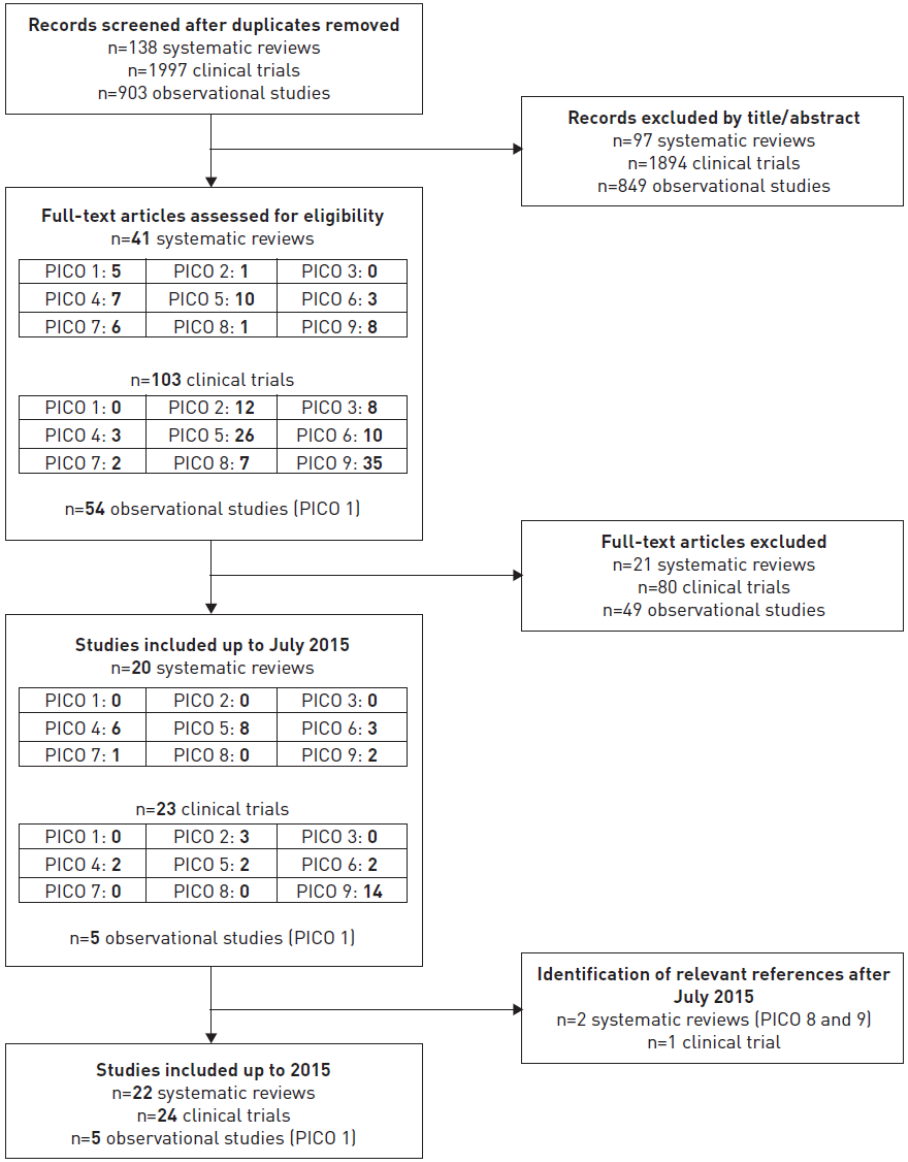
Thorax 2019;74(Suppl 1):1–69. doi:10.1136/thoraxjnl-2018-212463

Management of deteriorating patients



Thorax 2019;74(Suppl 1):1–69. doi:10.1136/thoraxjnl-2018-212463

ERS guidelines: Key Questions



Key Questions 9:

Question 9: Is regular physiotherapy (airway clearance and/or pulmonary rehabilitation) more beneficial than control (no physiotherapy treatment) in adult bronchiectasis patients?

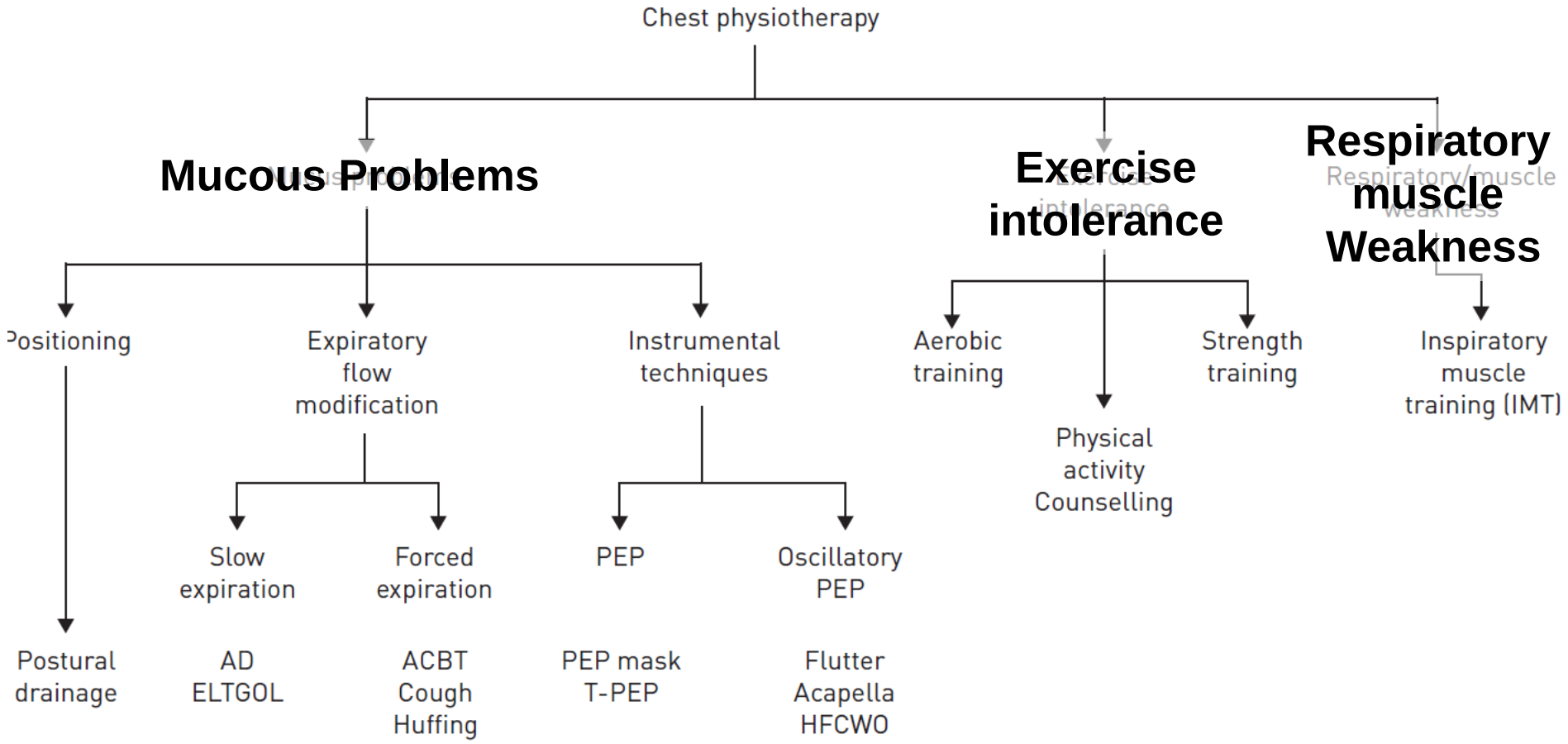
Eur Respir J 2017; 50: 1700629

Answers to Key Questions 9

Patients with chronic productive cough or difficulty to expectorate sputum should be taught an airway clearance technique (ACT) by a trained respiratory physiotherapist to perform once or twice daily.

Eur Respir J 2017; 50: 1700629

Chest physiotherapy interventions flow chart



Eur Respir J 2017; 50: 1700629

Summary

- Decreased mucociliary clearance and associated vicious cycle are the main pathogenesis of BE
- Physiotherapy to reduce sputum burden should be one of major treatment in BE.
- Pulmonary rehab can improve not only exercise capacity but also quality of life.