G.7 Airway clearance techniques

Review question: What is the effectiveness of chest physiotherapy in people with cystic fibrosis?

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Braggion, C., Cappelletti, L. M., Cornacchia, M., Zanolla, L., Mastella, G., Short-term effects of three chest	Sample size See Cochrane SR Warnock 2013 Characteristics See Cochrane SR Warnock 2013 Inclusion criteria See Cochrane SR Warnock 2013	Interventions See Cochrane SR Warnock 2013	Details See Cochrane SR Warnock 2013	Results See Cochrane SR Warnock 2013	Limitations See Cochrane SR Warnock 2013 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
physiotherapy regimens in patients hospitalized for pulmonary exacerbations of cystic fibrosis: a cross-over randomized study, Pediatric Pulmonology, 19, 16-22, 1995 Ref Id 333496 Country/ies where the study was carried out Italy Study type RCT Aim of the study To compare short term efficacy of 3 different chest physiotherapy regimens: postural drainage (PD), PEP and high frequency chest compression.	Exclusion criteria See Cochrane SR Warnock 2013				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported. Source of funding Not reported.					
Full citation Darbee, J. C., Kanga, J. F., Ohtake, P. J., Physiologic evidence for high-frequency chest wall oscillation and positive expiratory pressure breathing in hospitalized subjects with cystic fibrosis, Physical Therapy, 85, 1278-89, 2005 Ref Id 333537 Country/ies where the study was carried out USA Study type RCT Aim of the study	Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria See Cochrane SR Morrison 2014 Exclusion criteria See Cochrane SR Morrison 2014	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
To compare the effectiveness of HFCWO versus PEP mask in people with CF. Study dates Not reported Source of funding A grant from the Medical Centre Research Fund at the Kentucky University.					
Full citation Grzincich, G. L., Longo, F., Faverzani, S., Chetta, A., Spaggiari, C., Pisi, G., Short term effects of high frequency chest compression (HFCC) and positive expiratory pressure (PEP) in adults with cystic fibrosis [Abstract], European	Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria See Cochrane SR Morrison 2014 Exclusion criteria See Cochrane SR Morrison 2014	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Respiratory Society Annual Congress, Berlin, Germany, October, 2008 Ref Id 364197 Country/ies where the study was carried out Study type Aim of the study Study dates Source of funding					
Full citation Homnick, D. N., Anderson, K., Marks, J. H., Comparison of the flutter device to standard chest physiotherapy in hospitalized patients with cystic fibrosis: a pilot study, Chest, 114, 993-7, 1998 Ref Id	Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria See Cochrane SR Morrison 2014 Exclusion criteria See Cochrane SR Morrison 2014	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
333644 Country/ies where the study was carried out USA Study type RCT Aim of the study To compare the efficacy and safety of the flutter compared to manual chest physiotherapy. Study dates Not reported Source of funding Not reported					
Full citation McIlwaine, M. P., Alarie, N., Davidson, G. F., Lands, L. C., Ratjen, F., Milner, R., Owen, B., Agnew, J. L., Long-term multicentre randomised controlled	Sample size See Cochrane SR McIlwaine 2015 Characteristics See Cochrane SR McIlwaine 2015 Inclusion criteria See Cochrane SR McIlwaine 2015 Exclusion criteria See Cochrane SR McIlwaine 2015	Interventions See Cochrane SR McIlwaine 2015	Details See Cochrane SR McIlwaine 2015	Results See Cochrane SR McIlwaine 2015	Limitations See Cochrane SR McIlwaine 2015 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
study of high frequency chest wall oscillation versus positive expiratory pressure mask in cystic fibrosis, Thorax, 68, 746-51, 2013 Ref Id 333735 Country/ies where the study was carried out Canada Study type RCT Aim of the study To compare the efficacy of HFCWO and PEP mask in people with CF. Study dates October 2008 and April 2012 Source of funding A grant from the Canadian CF Foundation.					

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation McIlwaine, P. M., Wong, L. T., Peacock, D., Davidson, A. G., Long-term comparative trial of positive expiratory pressure versus oscillating positive expiratory pressure (flutter) physiotherapy in the treatment of cystic fibrosis, Journal of Pediatrics, 138, 845-50, 2001 Ref Id 333738 Country/ies where the study was carried out Canada Study type RCT Aim of the study	Sample size See Cochrane SR McIlwaine 2015 Characteristics See Cochrane SR McIlwaine 2015 Inclusion criteria See Cochrane SR McIlwaine 2015 Exclusion criteria See Cochrane SR McIlwaine 2015	Interventions See Cochrane SR McIlwaine 2015	Details See Cochrane SR McIlwaine 2015	Results See Cochrane SR McIlwaine 2015	Limitations See Cochrane SR McIlwaine 2015 Other information Notes

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
To assess the long term effects of chest physiotherapy with an oscillating device compared with PEP. Study dates Not reported Source of funding Supported by Telecon Funds.					
Full citation Moran,Fidelma , Bradley,Judy M., Piper,Amanda J., Non-invasive ventilation for cystic fibrosis, Cochrane Database of Systematic Reviews, -, 2013 Ref Id 319449 Study type Cochrane systematic review	Sample size and number of studies included in the Cochrane SR 7 trials, N=106 participants Characteristics of relevant studies Placidi 2006 Population: 17 participants with CF and severe lung disease. Acute participants. Young 2008 Population: 8 participants with CF and moderate lung disease. Mean age (SD) 37 (8) years; mean FEV1% predicted (SD) 35 (8) Inclusion criteria Placidi 2006* age > 15 yrs,	Interventions Placidi 2006 Interventions: direct cough, PEP mask, CPAP mask, NIV with IPAP. Order of intervention randomized: treatment twice daily for 70 minutes for 2 days per intervention. Young 2008 Intervention: 6 weeks of NIV Placebo (room air) 2-week washout period	Details Placidi 2006 Design: RCT, cross-over trial Outcomes. sputum weight, FEV1, SpO2, participants subjective impression of effectiveness Young 2008 Design: RCT, cross-over Outcomes: lung function, awake and sleep gas exchange, QoL (CF-QoL) Post treatment assessments carried out during a period of clinical stability i.e no need for hospitalisation or intravenous antibiotics*	Results Comparison: PEP vs control Sputum dry weight (follow-up mean 2 days (Placidi 2006) MD 0.03 lower (0.48 lower to 0.42 higher) Sputum wet weight (follow-up mean 2 days (Placidi 2006) MD 1.8 higher (1.72 lower to 5.32 higher) Lung function - FEV1 (follow-up mean 2 days (Placidi 2006) MD 0.01 higher (0.18 lower to 0.2 higher)	Limitations Quality of the Cochrane SR: Systematic review assessed using AMSTAR checklist. Total score: 11/11. Quality of the individual studies: Risk of bias assessment taken from the Cochrane systematic review Placidi 2006 Random sequence generation: low risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Aim of the study To evaluate the effectiveness of NIV in people with CF. Study dates Last search: 01/03/2013 Source of funding Not reported	'best' value of the FEV1 in last 6 months < 40% of predicted, ability to expectorate sputum and reliably perform pulmonary function tests, ability to produce > 30 ml sputum volume expectorated per day, proficiency in PEP mask. Young 2008* FEV1 equal to or below 70% predicted, clinical stability, positive screening overnight oximetry SpO2 < 90% for >= 5% of night, impaired gas exchange on polysomnography, awake hypercapnia. Exclusion criteria Placidi 2006* severe respiratory failure with need of fraction of inspired oxygen > 31% and/or symptoms or signs of right heart failure, airway infection with B.cepacia complex and/or oxacillin-resistant S.aureus, need for > 2 physiotherapy sessions a day, gastroesophageal reflux, pneumothorax or massive hemoptysis,			Lung function - FVC (follow-up mean 2 days (Placidi 2006) MD 0.05 higher (0.35 lower to 0.45 higher) Oxygen saturation - Spo2 % (Placidi 2006) MD 0.3 higher (0.58 lower to 1.18 higher) Comparison: NIV vs control QoL - CF- QoL chest symptom score (Young 2008, n=8) MD (fixed, 95% CI): 7.00 (-11.73 to 25.73) QoL - CF- QoL traditional dyspnoea index score (Young 2008, n=8) MD (fixed, 95% CI): 2.90 (0.71 to 5.09) Lung function (while awake) - FEV1 (Young 2008, n=8) MD (fixed, 95% CI): 1.00 (-8.62 to 10.62) Lung function (while awake) - FVC (Young 2008, n=8) MD (fixed, 95% CI): 4.00 (-10.30 to 18.30)	Allocation concealment: unclear risk Blinding(all outcomes): unclear risk Incomplete outcome data (all outcomes): unclear risk Selective reporting: low risk Other bias: unclear risk Young 2008 Random sequence generation: low risk Allocation concealment: low risk Blinding: unclear risk Incomplete outcome data: low risk Selective reporting: low risk Other bias: low risk Other information The data presented in this section has been adapted from the

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	need for surgical or endoscopic procedures during study period, symptons of asthma in the last year or FEV1 increase > 12% of predicted after inhalation of albuterol, known or suspected tympanic rupture or other middle-ear pathology, headache, earache or recurrent epistaxis associated with administration of positive airway pressure, inability to tolerate CPAP and NPPV via nasal mask. Young 2008* previous domiciliary oxygen or NIV, current sedative use, cardiac or neurological disease, obstructive sleep apnoea.			Oxygen saturation (nocturnal) (Young 2008, n=8) MD (fixed, 95% CI): 3.00 (-1.04 to 7.04)	Cochrane systematic review. We present the data that is relevant to the aims of this review. Individual studies where retrieved for accuracy and to check if other outcomes of interest where reported. Data extracted by the review team from the original study has been marked with an *.
Full citation Morrison, L., Agnew, J., Oscillating devices for airway clearance in people with cystic fibrosis, Cochrane Database of	Sample size and number of studies included in the Cochrane SR 35 trials, N=1050 participants Characteristics of relevant studies Darbee 2005 15 participants, 8 male, 7 female.	Interventions Darbee 2005 PEP versus HFCWO. Both treatments were alternated within 48 hours of hospital admission and then reversed prior to discharge.	Details Darbee 2005 Design: RCT, cross-over All participants performed HFCWO 1 - 3 times daily as outpatients before admission, but none had performed PEP Grzincich 2008 Design: RCT	Results Comparison: PEP mask vs oscillation Lung function - FEV1 (follow-up 2-4 weeks) % change from baseline Padman 1999: MD 4.08 higher (4.66 lower to 12.82 higher)	Limitations Quality of the Cochrane SR: Systematic review assessed using AMSTAR checklist. Total score: 11/11. Quality of the individual studies:

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Systematic Reviews, 7, CD006842, 2014 Ref Id 361498 Study type Cochrane SR Aim of the study To determine if oscillatory devices are effective for airway clearance, and compare them to other airway clearance techniques. Study dates Last search 13/01/2014 Source of funding Not reported	Aged at least 7 years, mean (SD) age 17.5 (4.2) years. Participants were admitted to hospital for acute exacerbation. Grzincich 2008 23 participants. 12 female, mean age 25 years. Homnick 1998 22 participants enrolled into study, the data for 33 hospitalisations 20 male, 13 female. Mean (range) age: 12 (7- to 44) years. CF confirmed by sweat test and/or genetic testing. Oermann 2001 29 participants enrolled 14 male Aged 6 years or greater. Mean age 23 (9 to 39 range). Diagnosis of CF confirme d by sweat test. Required ability to reliably perform spirometry and lung volume measurements, to have baseline FVC of 50 - 80 %predicated and be clinically stable for 1 month prior toenrolment. Excluded if in concurrent study or history of massive haemoptysis within 1 month	Treatment lasted 30 minutes. Grzincich 2008 Use of HFCWO at setting of 20 Hz f or 30 minutes compared with 30 minutes of PEP; this occurred during the first 3 days of treatment Homnick 1998 Flutter or manual physiotherapy. Treatment was 4 times daily. CPT was carried out for 30 min and Flutter for 15 min. Oermann 2001 HFCWO and Oscillating PEP (Flutter) As prescribed previous to study - no mention whether this was 2 x daily etc. 4 weeks in each arm, 2-week lead-in/ wash out periods during which time they resumed their normal routine therapies which were not outlined Padman 1999 Flutter, PEP and manual physiotherapy.	Patients randomised to receive either HFCWO or PEP during the first 3 days of hospitalisation for an exacerbation Homnick 1998 Design: open label comparative trial, cross-over Oermann 2001 Design: RCT, cross-over 5 participants withdrew (4 exited due to illness and 1 due to non-compliance with clinic visits) Padman 1999 Design: RCT, cross-over 5 participants excluded due to hospital admission for acute exacerbation, 4 withdrew (no reason given). 6 participants completed the study van Winden 1998 Design: RCT, cross-over Outcomes were measured before and after each treatment intervention Warwick 2004 Design: RCT, cross-over 12 participants (all male) with CF. Mean (range) age 29.2 (19 - 50) years. Consistent sputum producers; all volunteers	Lung function - FEV1 (follow-up 2-4 weeks) % predicted van Winden: MD - 2 (4.36 lower to 0.36 higher) Lung function - FVC (follow-up 2-4 weeks) % predicted MD - 2 (4.09 lower to 0.09 higher) Comparison: PEP mask vs HFCWO Sputum volume (follow-up mean 1 weeks) ml Grzincich 2008: 1.8 (3 lower to 6.6 higher) Lung Function - FEV1 (follow-up 1-2 weeks) % predicted Darbee 2005: MD -3 (20.54 lower to 14.54 higher) FVC (follow-up 1-2 weeks) % predicted Darbee 2005: MD - 3 lower (16.6 lower to 10.6 higher) Comparison: oscillating device vs high frequency oscillation Lung function - FEV1 % predicted 2 to 4 weeks (1 study, =24) Oerman 2001: MD (fixed, 95% CI): -1.60 (-3.44 to 0.24)	Risk of bias assessment taken from the Cochrane systematic review Darbee 2005 Random sequence generation: low risk Allocation concealment: high Blinding(all outcomes): unclear risk Incomplete outcome data (all outcomes): unclear risk Selective reporting: unclear risk Other bias: unclear risk Grzincich 2008 Random sequence generation: unclear risk Allocation concealment: uncl ear risk Blinding(all outcomes): unclear risk Incomplete outcome data (all

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	or pneumothorax within 6 months of entrance. Padman 1999 15 participants aged 5 to 17 years with CF. Gender split was not stated. Participants were clinically stable and able to perform RFT's, no hospitalisations in the month prior to study. van Winden 22 participants 12 males Mean age 12 years; range 7 - 17 years. CF confirmed by sweat test or DNA mutation analysis, clinically stable for 2 weeks before study. Warwick 2004 12 participants (all male) with CF. Mean (range) age 29.2 (19 - 50) years. Consistent sputum producers; all volunteers with no illness within 6 weeks of study Inclusion criteria See characteristics of included studies Exclusion criteria See characteristics of included studies	Participants served as own controls, each therapy was performed for 15 min 3x daily for 1 month van Winden 1998 Flutter, PEP mask. Twice daily, 2 weeks in each arm, 1 week wash-in and wash-out period Warwick 2004 HFCC 5 minutes at 6 freque ncies, followed by 3 huffs and directed coughs at the end of each cycle. Manual physiotherapy10 hand positions. 3 huffs and directed cough afte r each position treatment lasting about 40 - 50 min. All treatments preceded by nebulisers and given daily for 4 weeks. Treatment times took approximately 36 - 50 min (standard CPT 45 - 50 min and HFCWO 36 - 40 min)	with no illness within 6 weeks of study	Lung function - FVC (% predicted) 2 to 4 weeks (1 study, =24) Oerman 2001: MD (fixed, 95% CI): -1.40 (-3.07 to 0.27) Comparison: manual chest physio vs oscillating device Lung function - FEV1 (% change from baseline) 2 to 4 weeks Padman 1999 (n=6) - Mean (SD): 3.66 (9.6) vs. 6.25 (5.6) Lung function - FEV1 (follow-up mean 8.8 days; % change from baseline Homnick 1998: MD 7.9 lower (31.04 lower to 15.24 higher) Lung Function - FVC (follow-up mean 2 weeks; % change from baseline) Homnick 1998: MD 2.9 higher (14.21 lower to 20.01 higher) Comparison: manual chest physio vs HFCWO Sputum weight, dry (g.) 1 to 2 weeks Warwick 2004 (n=12): MD 0.13 lower (0.42 lower to 0.16 higher)	outcomes): unclear risk Selective reporting: unclear risk Other bias: unclear risk Homnick 1998 Random sequence generation: unclear risk Allocation concealment: unclear risk Blinding(all outcomes): unclear risk Incomplete outcome data (all outcomes): high risk Selective reporting: unclear risk Other bias: low risk Oermann 2001 Random sequence generation: unclea r risk Allocation concealment: uncl ear risk Blinding(all outcomes): unclear risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
				Sputum weight, wet(g.) 1 to 2 weeks Warwick 2004 (n=12): MD 4.04 lower (10.77 lower to 2.69 higher)	Incomplete outcome data (all outcomes): low risk Selective reporting: high risk Other bias: unclear risk Padman 1999 Random sequence generation: unclear risk Allocation concealment: unclear risk Blinding(all outcomes): unclear risk Incomplete outcome data (all outcomes): high risk Selective reporting: high risk Other bias: unclear risk van Winden 1998 Random sequence generation: unclear risk Allocation concealment: unclear risk Blinding(all outcomes): low risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
					Incomplete outcome data (all outcomes): low risk Selective reporting: unclear risk Other bias: unclear risk Warwick 2004 Random sequence generation: unclear risk Allocation concealment: unclear risk Blinding(all outcomes): high risk Incomplete outcome data (all outcomes): unclear risk Selective reporting: unclear risk Other bias: high risk - paper also reports that a natural competition between two different therapists was created. In addition the hand positions used by

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
					the therapist were not defined. Other information The data presented in this section has been adapted from the Cochrane systematic review. We present the data that is relevant to the aims of this review. Individual studies where retrieved for accuracy and to check if other outcomes of interest where reported. Data extracted by the review team from the original study has been marked with an *.
Full citation Newbold, M. E., Tullis, E., Corey, M., Ross, B., Brooks, D., The Flutter Device versus the PEP Mask in the	Sample size See McIlwaine 2015 Characteristics See McIlwaine 2015 Inclusion criteria See McIlwaine 2015 Exclusion criteria See McIlwaine 2015	Interventions See McIlwaine 2015	Details See McIlwaine 2015	Results See McIlwaine 2015	Limitations See McIlwaine 2015 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
treatment of adults with cystic fibrosis, Physiotherapy Canada, 57, 199-207, 2005 Ref Id 361522 Country/ies where the study was carried out Canada Study type RCT Aim of the study To evaluate the effectiveness of the flutter versus the PEP mask. Study dates Not reported Source of funding Not reported					
Full citation Oermann, C. M., Sockrider, M. M., Giles, D., Sontag, M. K., Accurso, F. J., Castile, R. G., Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None	

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Comparison of high-frequency chest wall oscillation and oscillating positive expiratory pressure in the home management of cystic fibrosis: a pilot study, Pediatric Pulmonology, 32, 372-7, 2001 Ref Id 333781 Country/ies where the study was carried out USA Study type RCT Aim of the study To compare the effectiveness of high-frequency chest wall oscillation and oscillating positive expiratory	Exclusion criteria				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
pressure in the home management of cystic fibrosis. Study dates Not reported Source of funding Not reported					
Full citation Padman, R., Geouque, D. M., Engelhardt, M. T., Effects of the flutter device on pulmonary function studies among pediatric cystic fibrosis patients, Delaware Medical Journal, 71, 13-8, 1999 Ref Id 333786 Country/ies where the study was carried out Study type	Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria See Cochrane SR Morrison 2014 Exclusion criteria See Cochrane SR Morrison 2014	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Aim of the study Study dates Source of funding					
Full citation Placidi, G., Cornacchia, M., Polese, G., Zanolla, L., Assael, B. M., Braggion, C., Chest physiotherapy with positive airway pressure: a pilot study of short-term effects on sputum clearance in patients with cystic fibrosis and severe airway obstruction, Respiratory Care, 51, 1145-53, 2006 Ref Id 333804 Country/ies where the study was carried out	Sample size See Cochrane SR Moran 2013 Characteristics See Cochrane SR Moran 2013 Inclusion criteria See Cochrane SR Moran 2013 Exclusion criteria See Cochrane SR Moran 2013	Interventions See Cochrane SR Moran 2013	Details See Cochrane SR Moran 2013	Results Comparison: PEP versus control* Pulmonary function - FEV1 Before (mean±SD): 0.99±0.27 vs 0.96±0.26 After (mean±SD): 1.00±0.27 vs 0.99±0.25; p=0.19 Pulmonary function - FVC Before (mean±SD): 1.94±0.63 vs 1.87±0.57 After (mean±SD): 2.00±0.62 vs 1.95±0.58; p=0.99 Pulmonary function - FEF25-75 Before (mean±SD): 0.28±0.12 vs 0.28±0.11 After (mean±SD): 0.27±0.11 vs 0.28±0.12; p=0.20 Sputum dry weight (g) Mean±SD: 0.94±0.57 vs 0.97±0.76; p=0.29	Limitations See Cochrane SR Moran 2013 Other information The comparison PEP vs control was not included in the Cochrane review.

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Not reported (author correspondence in Italy). Study type RCT Aim of the study To evaluate short-term effects of directed cough combined with PEP, CPAP and NPPV on wet and dry sputum weight. Study dates Not reported Source of funding Not reported.				Sputum wet weight (g) Mean±SD: 15.78±5.49 vs 13.98±4.96; p<0.05 Oxygen saturation - Spo2 Before (mean±SD): 95.1±1.5 vs 94.8±1.7 After (mean±SD): 94.9±1.2 vs 94.6±1.4; p=0.007 Comparison: NIV (NPPV) vs control See Cochrane SR Moran 2013	
Full citation van Winden, C. M., Visser, A., Hop, W., Sterk, P. J., Beckers, S., de Jongste, J. C., Effects of flutter and PEP mask physiotherapy on symptoms and lung function in	Sample size See Cochrane SR Morrison 2014 Characteristics See Cochrane SR Morrison 2014 Inclusion criteria See Cochrane SR Morrison 2014 Exclusion criteria	Interventions See Cochrane SR Morrison 2014	Details See Cochrane SR Morrison 2014	Results See Cochrane SR Morrison 2014	Limitations See Cochrane SR Morrison 2014 Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
children with cystic fibrosis, European Respiratory Journal, 12, 143-7, 1998 Ref Id 333902 Country/ies where the study was carried out Switzerland Study type RCT Aim of the study To compare the effectiveness of flutter and PEP mask in people with CF. Study dates Not reported Source of funding Not reported. Flutters were provided by VarioRaw.	See Cochrane SR Morrison 2014				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Warnock, L., Gates, A., van der Schans, C. P., Chest physiotherapy compared to no chest physiotherapy for cystic fibrosis, Cochrane Database of Systematic Reviews, 9, CD001401, 2013 Ref Id 333912 Study type Cochrane SR Aim of the study To assess the effectiveness and acceptability of chest physiotherapy compared to no treatment in people with CF. Study dates Last search 05/09/2013	Sample size and number of studies included in the Cochrane SR 8 trials, N=96 participants Characteristics of relevant studies Braggion 1995 Population: 16 patients with CF 8 males, 8 females; mean age (SD): 20.3 (4) years; mean FEV1% 61.7% (17%) Interventions: breathing exercises, vibrations, manual percussion, PEP and control Inclusion criteria Age 14 yrs ability to expectorate sputum and reliably perform lung function tests more than 30 mL/day sputum volume expectorated mild/moderate airway obstruction profeciency in postural drainage and PEP CPT (manual technique). Exclusion criteria Need for > 2 physiotherapy sessions per day gastrooesophageal reflux, pneumothorax, massive haemoptysis	Interventions Braggion 1995 Interventions: breathing exercises, vibrations, manual percussion, PEP and control	Details Braggion 1995 Design: Cross-over study Outcomes: weight expectorated mucus; pulmonary function; subjective assessment	Results Comparison: PEP vs. control Lung function - FEV1 (Braggion 1995) mean (SD) before: 62.3±21.6 vs 60.8±19.9 mean (SD) after: 62.4±20.5 vs 60.3±19.4, ns Lung function - FVC (Braggion 1995) mean (SD) before: 82.8±21.1 vs 81.6±19.5 mean (SD) after: 83.6±19.8 vs 82.1±19.6, ns Lung function - FEF25-75 (Braggion 1995) mean (SD) before: 30.81±20.8 vs 27.8±17.2 mean (SD) after: 29.4±19.7 vs. 26.7±16.0, ns Expectorated secretions - wet weight of sputum (g) (Braggion 1995) mean (SD): 26.13±12.28 vs 5.98±6.21	Limitations Quality of the Cochrane SR: Systematic review assessed using AMSTAR checklist. Total score: 11/11. Quality of the individual studies: Risk of bias assessment taken from the Cochrane systematic review Braggion 1995 Random sequence generation: low risk Allocation concealment: unclear risk Blinding (all outcomes): unclear risk Incomplete outcome data (all outcomes): unclear risk Selective reporting: low risk Other bias: low risk Other information The data presented in this

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Source of funding Not reported	need for surgical or endoscopic procedures during the study period symptoms of asthma in the year before the study need for corticosteroid or bronchodilator therapy during study period.				section has been adapted from the Cochrane systematic review. We present the data that is relevant to the aims of this review. Individual studies where retrieved for accuracy and to check if other outcomes of interest where reported. Data extracted by the review team from the original study has been marked with an *.
Full citation Warwick, W. J., Wielinski, C. L., Hansen, L. G., Comparison of expectorated sputum after manual chest physical therapy and high-frequency chest compression, Biomedical Instrumentation & Technology,	Sample size See Cochrane SR Morrison 2014. Characteristics See Cochrane SR Morrison 2014. Inclusion criteria See Cochrane SR Morrison 2014. Exclusion criteria See Cochrane SR Morrison 2014.	Interventions See Cochrane SR Morrison 2014.	Details See Cochrane SR Morrison 2014.	Results See Cochrane SR Morrison 2014.	Limitations See Cochrane SR Morrison 2014. Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
38, 470-5, 2004 Ref Id 333916 Country/ies where the study was carried out USA Study type RCT Aim of the study To compare high frequency chest compression and manual chest physiotherapy in people with CF. Study dates Not reported Source of funding Not reported					
Full citation Young, A. C., Wilson, J. W., Kotsimbos, T. C., Naughton, M. T., Randomised placebo	Sample size See Cochrane SR Moran 2013. Characteristics See Cochrane SR Moran 2013. Inclusion criteria	Interventions See Cochrane SR Moran 2013.	Details See Cochrane SR Moran 2013.	Results See Cochrane SR Moran 2013.	Limitations See Cochrane SR Moran 2013. Other information None

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
controlled trial of non-invasive ventilation for hypercapnia in cystic fibrosis, Thorax, 63, 72-7, 2008 Ref Id 361764 Country/ies where the study was carried out Australia Study type RCT Aim of the study To study the effects of nocturnal NIV on quality of life, functional and physiological outcomes in CF subjects with awake hypercapnia. Study dates Not reported Source of funding National Health and Medical Research Council of	See Cochrane SR Moran 2013. Exclusion criteria See Cochrane SR Moran 2013.				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Australia, Monash University and The Australian Cystic Fibrosis Research Trust.					
Full citation McIlwaine, M, Button, B, Dwan, K, Positive expiratory pressure physiotherapy for airway clearance in people with cystic fibrosis, Cochrane Database of Systematic Reviews, CD003147, 2015 Ref Id 372830 Study type Cochrane SR Aim of the study To determine the effectiveness and the acceptability of	Sample size and number of studies included in the Cochrane SR 26 trials, N=733 participants Characteristics of relevant studies McIlwaine 2013 Participants: CF confirmed by sweat test or genotyping. 107 participants from 12 CF centres (57 males); age range 6 - 47 years; FEV1 over 40% predicted. Participants were excluded if they had been hospitalised within the past month for a pulmonary exacerbation, or if they were not stable on clinical evaluation, chest radiograph or pulmonary function. McIlwaine 2001 Participants CF confirmed by sweat test. 40 participants (24 male); age range 7 - 17 years;	Interventions McIlwaine 2013 Interventions: 2 interventions: 51 participants were randomised to PEP and 56 to HFCWO PEP - using a mask with pressures 10 - 20 cms H20, participants breathed through the device for 15 breaths followed by 2 -3 huffs and a cough; this was repeated for 6 cycles; HFCWO - using the InCourageTM system; 6 sets of 5-minute cycles were performed with frequencies between 6 - 15 Hz, this was interspersed with huffing and coughing. McIlwaine 2001 Interventions 2 interventions: 20 participants were	Details McIlwaine 2013 Design: Multi-centre RCT. Parallel design. Treatment for 1 year. On entering the study, participants performed a 2-month washout period before being allocated to an intervention Outcomes: Number of pulmonary exacerbations and time to first exacerbation. PFTs measuring FVC, FEV1 and FEF 25−75% in absolute change. Quality of life using the Cystic Fibrosis Questionnaire and patient satisfaction visual analogue scale Notes: There were 16 drop-outs during the washout period before participants commenced one of the two interventions being studied. These were not included in the results. A further 3 dropped out during the	Results COMPARISON: PEP VS OSCILLATING PEP (flutter and cornet) Lung function (FEV1) >6 to 12 months (1 study, n=30) MD (fixed, 95% CI): 9.71 (-2.12 to 21.54) Lung function (FEV1) >1 to 2 years (2 studies, n=72) MD (fixed, 95% CI): -2.34 (-6.86 to 2.18) Lung function (FVC) >6 to 12 months (1 study, n=30) MD (fixed, 95% CI): 8.68 (-0.54 to 17.90) Lung function (FVC) >1 to 2 years (1 study, n=42)	Limitations Quality of the Cochrane SR: Systematic review assessed using AMSTAR checklist. Total score: 11/11. Quality of the individual studies: Risk of bias assessment taken from the Cochrane systematic review McIlwaine 2013 Random sequence generation (selection bias): Low risk (Randomised was by an independent statistician using a computer-generated randomisation table. Participants were matched for age, sex and pseudomonas

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
positive pressure devices in people with CF. Study dates Last search 02/12/2014 Source of funding This SR is supported by the NIH.	FEV1 range 47 - 107% predicted; Schwachman score range 54 - 98 points. Participants were excluded if they had been hospitalised within the past month for a pulmonary exacerbation, or if they were not stable on clinical evaluation, chest radiograph or pulmonary function Newbold 2005 Participants CF diagnosed by St Michael's Hospital CF Clinic, Toronto. 42 participants (24 male). PEP Group: 21 participants (15 male); mean age 28, SD 8.1 years; mean FEV1 2.5, SD 1.2 litres; mean FEV1 66, SD 19.9% predicted. Flutter Group: 21 participants (9male); mean (SD) age 31 (8.7) years;mean (SD) FEV1 2.2 (0.7) litres; mean (SD) FEV1 69(18.5) % predicted. Participants were excluded if they had been hospitalised within the past month for a pulmonary exacerbation, had changed their medication within the past month, or did not have a daily cough or daily sputum	randomised to each group. The daily regimen for use of the devices is not described. 1. PEP treatment - participants inhaled and exhaled through the Astra Meditec PEP mask in sitting; the resistor which produced 10 to 20 cm H2O pressure during midexpiration was used. Over approximately 2 minutes, 15 tidal breaths with slightly active expiration were performed. Participants then removed themask, performed 2 or 3 forced expirations, and coughed, followed by 1 - 2 minutes of relaxed breathing. This sequence was repeated 6 times and these 20-minute sessions were repeated twice daily; 2. Oscillating PEP - participants exhaled through the flutter device which was angled to maximise the sensation of vibration in the chest. In sitting,	intervention period. These were included in analysis with intention to treat analysis. Published paper. McIlwaine 2001 Design: RCT. Parallel design. Treatment for 1 year. Outcomes: FEV1, FVC, and FEF25−75 and clinical assessment using Shwachman and Huang scores were measured at the beginning and at 3-monthly intervals throughout the study. Number of hospitalizations for pulmonary exacerbations were recorded throughout the study. Compliance with the interventions was recorded daily by the participants. A monthly questionnaire recorded physical activity, general well-being, cough, sputum production, subjective impression of the therapy, and adverse events. Chest radiographs were evaluated by a blinded radiologist at the beginning and end of the study	MD (fixed, 95% CI): -1.70 (-6.27 to 2.87) Lung function (FEF25-75%) >6 to 12 months (1 study, n=30) MD (fixed, 95% CI): 5.29 (-7.84 to 18.42) Lung function (FEF25-75%) >1 to 2 years (1 study, n=42) MD (fixed, 95% CI): -1.1 (-6.50 to 4.30) Hospitalizations for respiratory exacerbation (number per participant) >1 to 2 years (1 study, n=42) MD (fixed, 95% CI): -0.40 (-0.92 to 0.12) Patient preference: self-withdrawal due to lack of perceived effectiveness (6 to 12 months) (1 study, n=40) RR (M-H, fixed, 95% CI): 0.09 (0.01 to 1.54) COMPARISON: PEP VS. HFCWO	status. The statistician also attempted to block patients within each centre to control for any treatment differences between centres) Allocation concealment (selection bias): Low risk (The randomisation was performed by an independent statistician who provided the randomisation to the centre after the participant had enrolled in the study Blinding (performance bias and detection bias) - All outcomes: Low risk (Participants and person providing the therapy were not blinded - unclear risk; Outcome assessors were blinded - low risk) Incomplete outcome data

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	Interventions 2 interventions: 21 participants were randomised to each group. Tannenbaum 2005 (abstract only) Participants 30 children with CF, age range 6 - 15 years, 20 females. Inclusion criteria See characteristics of included studies. Exclusion criteria See characteristics of included studies.	participants inhaled deeply through the nose, followed by a breath hold for 2 - 3 seconds, and exhaled through the device slightly into the expiratory reserve volume. After 10 - 15 breaths, participants huffed through the device, increasing the TV and speed of exhalation to precipitate coughing and expectoration. This sequence was repeated “until clear” and not for less than 15 minutes per session, twice daily Newbold 2005 Interventions 2 interventions: 21 participants were randomised to each group. PEP treatment - pressure 10 - 20 cm H2O using an Astra Meditec PEP mask; seated participants breathed 10 - 15 times through the mask, followed by huffing, coughing and relaxed breathing, this was repeated 5 - 6 times,	Notes: 3 participants were withdrawn due to non-compliance (< 85% of twice-daily sessions performed over 1 month) in the PEP group. 5 participants dropped out from the flutter group stating that subjectively the flutter did not appear to clear their secretions. Published paper. Newbold 2005 Design: RCT. Parallel design. Treatment for 13 months. Interventions 2 interventions: 21 participants were randomised to each group. Outcomes: Slope of change in FEV1, FVC, and FEF25−75 (absolute and % predicted), number of hospitalisations. Notes: 1 participant was withdrawn when he stopped attending the CF clinic. Published paper. Tannenbaum 2005 (abstract only) Design: RCT. Parallel design. Treatment period of 12 months.	Lung function (FEV1) 1 year (1 study, n=88) MD (fixed, 95% CI): -3.59 (-9.29 to 2.11) Lung function (FVC) 1 year (1 study, n=88) MD (fixed, 95% CI): -5.00 (-10.30 to 0.30) Lung function (FEF25-75) 1 year (1 study, n=88) MD (fixed, 95% CI): -0.34 (-12.54 to 11.86 Number of participants experiencing a respiratory exacerbation (1 study, n=91) RR (M-H, fixed, 95% CI): 0.73 (0.55 to 0.95) Patient preferences (1 study, n=36, single treatment) 18 participants preferred PEP 3 participants preferred HFCWO 13 participants had no preferences	(attrition bias) - All outcomes: Low risk (All outcomes in study design are reported. Dropouts prior to commencement of interventions being studies were not included in analysis. 3 dropouts during the intervention period were included in analysis with intention to treat approach) Selective reporting (reporting bias): Low risk (All outcomes in study design are reported). PFTs results were provided by the author Other bias: Low risk (Author of the study is one of this review’s authors, thus to eliminate bias, the study was assessed by the other two independent authors of this paper)

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		over a 20-minute session, twice daily; Oscillating PEP - participants exhaled through the flutter device (Axcan Scandipharm) which was angled to maximise the sensation of vibration in the chest. In sitting, participants inhaled deeply through the nose, followed by a breath hold for 2 - 3 seconds, and exhalation through the device. After 5 - 10 breaths, participants increased the TV and speed of exhalation through the device, to precipitate coughing and expectoration. This sequence was repeated “until clear” or for approximately 20 minutes, twice daily Tannenbaum 2005 (abstract only) PEP (no further data provided); Oscillating PEP provided by the RC cornet (no further data provided)	Outcomes QWBS, FEV1, pulmonary exacerbations, LCI. Notes Information was provided from 3 abstracts, no further information obtained	(1 study, n=16, up to 7 days) No significant differences between interventions	McIlwaine 2001 Random sequence generation (selection bias): Low risk (Described as randomised. Randomised using a computer-generated block of numbers) Allocation concealment (selection bias): Unclear risk (Not described) Blinding (performance bias and detection bias) - All outcomes: Low risk (Participants and person providing the therapy were not blinded - unclear risk; Outcome assessors were blinded - low risk) Incomplete outcome data (attrition bias) - All outcomes: Low risk 3 participants were withdrawn due to noncompliance (<

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					85% of twice-daily sessions performed over 1month) in the PEP group. 5 participants dropped out from the flutter group stating that subjectively the flutter did not appear to clear their secretions, they also had a clinically significant deterioration in pulmonary function. intention to treat approach used) Selective reporting (reporting bias): Low risk (All outcome measures are reported in full) Other bias: Low risk (Both groups were reported to be similar at baseline regarding the most important prognostic indicators. Author of the study is one of the authors on this review, thus to eliminate bias, the

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					study was assessed by the other two independent authors of this paper and by the previous authors) Newbold 2005 Random sequence generation (selection bias): Low risk (A random numbers table and block randomisation were used to ensure that groups would be of equal size) Allocation concealment (selection bias): Low risk (Allocation was sealed in opaque envelopes by an independent assistant. The envelopes were open in sequence after a participant was enrolled) Blinding (performance bias and detection bias) - All outcomes: Unclear risk

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					(Participants and person providing the therapy were not blinded - unclear risk; Outcome assessors were blinded - low risk) Incomplete outcome data (attrition bias) - All outcomes: Low risk (1 participant was withdrawn when he stopped attending the CF clinic) Selective reporting (reporting bias): Low risk (Results are reported for all outcome measures) Other bias: Low risk (Groups similar at baseline regarding the most important prognostic indicators) Tannenbaum 2005 (abstract only) Random sequence generation (selection bias): Unclear risk (Randomisation

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					was stratified by age, sex and FEV1. How randomisation was generated was not recorded) Allocation concealment (selection bias): Unclear risk (Not discussed) Blinding (performance bias and detection bias) - All outcomes: Unclear risk (Not discussed) Incomplete outcome data (attrition bias) - All outcomes: Low risk (2 dropouts are reported, one from each group. One found the cornet ineffective and difficult to clean. The other preferred a previously used device. Used Intention to treat approach) Selective reporting (reporting bias): Unclear risk (Not all outcome measures results

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					were provided in full. QWBS was reported as no significant changes over the year) Other bias: Low risk (Groups were similar at baseline regarding the most important prognostic indicators) Other information The data presented in this section has been adapted from the Cochrane systematic review. We present the data that is relevant to the aims of this review. Individual studies where retrieved for accuracy and to check if other outcomes of interest where reported. Data extracted by the review team from the original study has been marked with an *.

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Full citation Tannenbaum, E, Prasad,SA, Main, E, Scrase, E, 374 Long term effects of positive expiratory pressure (PEP) or oscillatory positive pressure (RC cornet®) on FEV1 and perceived health in children with CF, Journal of Cystic Fibrosis, 4, S100, 2005 Ref Id 398314 Country/ies where the study was carried out Study type Aim of the study Study dates Source of funding	Sample size See Cochrane SR McIlwaine 2015 Characteristics See Cochrane SR McIlwaine 2015 Inclusion criteria See Cochrane SR McIlwaine 2015 Exclusion criteria See Cochrane SR McIlwaine 2015	Interventions See Cochrane SR McIlwaine 2015	Details See Cochrane SR McIlwaine 2015	Results See Cochrane SR McIlwaine 2015	Limitations See Cochrane SR McIlwaine 2015 Other information None