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Chest physiotherapy compared to no chest physiotherapy for cystic fibrosis

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A B S T R A C T

Background
Chest physiotherapy is widely used in people with cystic fibrosis in order to clear mucus from the airways.

Objectives
To determine the effectiveness and acceptability of chest physiotherapy compared to no treatment or spontaneous cough alone to improve mucus clearance in cystic fibrosis.

Search strategy
We searched the Cochrane Cystic Fibrosis and Genetic Disorders Group Trials Register which comprises references identified from comprehensive electronic database searches and handsearches of relevant journals and abstract books of conference proceedings.

Date of the most recent search of the Group's Cystic Fibrosis Trials Register: 09 February 2009.

Selection criteria
Randomised or quasi-randomised clinical trials in which a form of chest physiotherapy (airway clearance technique) were taken for consideration in people with cystic fibrosis compared with either no physiotherapy treatment or spontaneous cough alone.

Data collection and analysis
Both authors independently assessed trial eligibility, extracted data and assessed trial quality.

Main results
One hundred and twenty-six trials were identified by the search, of which six cross-over trials with 66 participants were found eligible for inclusion in the review. Five studies were single treatment studies; in one study each treatment regimen was used twice daily for two consecutive days. Three studies, involving 36 participants, found a higher amount of expectorated secretions during chest physiotherapy as compared to a control period. Two studies, involving 24 participants found no significant effect on pulmonary function variables following intervention. In four studies radioactive tracer clearance was used as an outcome variable. In three of these, involving 28 participants, it was found that chest physiotherapy, including coughing, increased radioactive tracer clearance as compared to the control
period. One study of eight participants, reported no significant difference between chest physiotherapy, without coughing, compared to the control period.

Authors’ conclusions

The results of this review show that airway clearance techniques have short-term effects in the terms of increasing mucus transport. No evidence was found on which to draw conclusions concerning the long-term effects.

PLAIN LANGUAGE SUMMARY

Chest physiotherapy compared to no chest physiotherapy for cystic fibrosis

The lungs of people with cystic fibrosis produce excess mucus. This leads to repeated infection and tissue damage in the lungs. It is important to clear the mucus using drugs and chest physiotherapy (CPT). Physiotherapy clears mucus by various techniques or by using mechanical devices or both. Daily physiotherapy takes a lot of time and trouble. We found that techniques for clearing the airways have short-term benefits for mucus transport. Four studies measured radioactive tracer clearance and found increased clearance with CPT; three studies measured sputum which had been coughed up, found a higher amount with CPT. At present there is no clear evidence of long-term effects in chest clearance, quality of life or survival with CPT.

BACKGROUND

Description of the condition

Cystic fibrosis (CF) is a common inherited life-limiting disorder. Persistent infection and inflammation within the lungs are the major contributory factors to severe airway damage and loss of respiratory function over the years (Cantin 1995; Konstan 1997). Excessive production of thick mucus may overwhelm the normal mucus transport mechanisms and thereby lead to airway obstruction and mucus plugging (Zach 1990). Removal of airway secretions is therefore an integral part of the management of CF. A variety of methods are used to help remove secretions from the lungs, some physical, i.e. chest physiotherapy, and some chemical, i.e. medications and inhalation therapies. Treatment methods which improve mucus clearance are considered essential in optimising respiratory status and reducing the progression of lung disease.

Description of the intervention

Chest physiotherapy has, for a long time, played an important role in assisting the clearance of airway secretions and is usually commenced as soon as the diagnosis of CF is made. However, the performance of chest physiotherapy may be unpleasant, uncomfortable, and time-consuming. Early chest physiotherapy relied on techniques for which the assistance of another person, such as a physiotherapist or relative, was needed and which included postural drainage, percussion, vibration, and shaking performed by an assistant and huffing or coughing. More recently, several self-administered alternatives to these conventional techniques have been developed. These include the active cycle of breathing techniques (ACBT), forced expiration technique (FET), autogenic drainage (AD), positive expiratory pressure (PEP), flutter, high frequency chest compression (HFCC) and exercise. We have defined all of these methods under the interventions below. These methods of treatment help to give the individual with CF more independence in their management.

Why it is important to do this review

Despite the expansion of treatment modalities, there remains little evidence supporting their efficacy (Prasad 1998; van der Schans 1996). A previous meta-analysis (Thomas 1995a) concluded that standard chest physiotherapy resulted in more mucus (phlegm or sputum) expectoration than no treatment in people with CF, however a recent Cochrane review reported that there is not enough evidence to support or refute mucus clearance techniques for people with COPD or bronchiectasis (Jones 1998). This review compares the efficacy of any of these interventions as compared to no treatment or spontaneous coughing alone. Subsequent reviews will aim to determine whether a specific type of treatment offers any advantage over others.

OBJECTIVES

Chest physiotherapy compared to no chest physiotherapy for cystic fibrosis (Review)

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To determine the effectiveness of chest physiotherapy (airway clearance) compared to no treatment or cough alone in people with CF. This review does not address all possible comparisons between the multiple treatment techniques available for people with CF. This review is the first in a series of reviews which will compare the efficacy of different treatment modalities.

The following hypotheses will be tested: chest physiotherapy, whatever the type of intervention, is more:

1. effective than no chest physiotherapy;
2. effective than spontaneous coughing alone;
3. acceptable than no chest physiotherapy;
4. acceptable than spontaneous coughing alone.

**METHODS**

**Criteria for considering studies for this review**

**Types of studies**
Randomised or quasi-randomised clinical trials.
Short-term studies (less than seven days duration, including single treatment studies) will be analysed separately from studies of longer duration.

**Types of participants**
People with CF, of any age, diagnosed on the basis of clinical criteria and sweat testing or genotype analysis.

**Types of interventions**
Chest physiotherapy of any type (see below) compared to no chest physiotherapy or spontaneous coughing alone.
In existing literature and in practical terms, variation occurs in the application of specific techniques. For the purposes of this series of reviews, it is necessary to group these variations under their broader headings. Separate analysis of each variation would render the reviews unmanageable. The following interventions aim to improve mucus transport or facilitate expectoration:

- **Conventional chest physiotherapy**
  This will include any combination of the following: postural drainage; percussion; chest shaking; huffing; and directed coughing. It should not include the use of exercise, PEP or other mechanical devices.

- **Positive expiratory pressure (PEP) mask therapy**
  As described by the authors to be the primary intervention, with or without additional techniques. PEP is defined as breathing with a positive expiratory pressure of 10 to 25 cmH₂O.

- **High pressure PEP (hPEP) mask therapy**
  As described by the authors to be the primary intervention, with or without additional techniques. It is a modification of the above PEP technique but includes a full forced expiration against a fixed mechanical resistance.

- **Active cycle of breathing techniques (ACBT)**
  This includes relaxation or breathing control, forced expiration technique (FET), thoracic expansion exercises and may include postural drainage or chest clapping.

- **Autogenic Drainage (AD)**
  As described originally by Chevalier or modified versions thereof. The authors should have identified AD to be the primary intervention, with or without additional techniques.

- **Exercise**
  With the sole purpose of improving mucus clearance as the primary intervention, with or without additional techniques.

- **Oscillating devices**
  Oscillating devices including flutter or cornet, thoracic oscillation, and oral oscillation. Flutter or cornet as described by the authors to be the primary intervention, with or without additional techniques. These devices produce an oscillatory PEP effect. Thoracic oscillation as defined by the authors to be the primary intervention, with or without additional techniques, to provide oscillation to the chest wall. Oral oscillation as defined by the authors to be the primary intervention, with or without additional techniques, to provide oscillation to the airways via the mouth. Two authors independently categorised the physiotherapeutic interventions.

**Types of outcome measures**

**Primary outcomes**

1. Expectorated secretions (mucus, sputum, phlegm), dry or wet weight, or volume (an increase in the amount of expectorated secretions as a short-term effect of the intervention is considered as beneficial)
2. Mucus transport rate (assessed by radioactive tracer clearance)
3. Pulmonary function tests (post-intervention objective change from baseline compared to control)
i) forced expiratory volume in one second (FEV₁)
ii) forced vital capacity (FVC)
iii) forced expiratory flow between 25% and 75% expired FVC (FEF₂₅₋₇₅)

Secondary outcomes
1. Oxygen saturation measured by pulse or transcutaneous oximetry
2. Total lung capacity (TLC) and functional residual capacity (FRC) (objective change from baseline compared to control)
3. Radiological ventilation scanning
4. Subjective perception of well-being, ability to participate in activities of daily living
5. Therapy compliance
6. Objective change in exercise tolerance;
7. Nutritional status (assessed by growth, weight, body composition)
8. Number of respiratory exacerbations per year
9. Number of days in hospital per year
10. Number of days of intravenous antibiotics per year
11. Cost of intervention
   i) equipment
   ii) duration
   iii) deaths

Search methods for identification of studies

Electronic searches
Relevant studies were identified from the Group's Cystic Fibrosis Trials Register using the terms: physiotherapy AND conventional. The Cystic Fibrosis Trials Register is compiled from electronic searches of the Cochrane Central Register of Controlled Trials (CENTRAL) (updated each new issue of The Cochrane Library), quarterly searches of MEDLINE, a search of EMBASE to 1995 and the prospective handsearching of two journals - Pediatric Pulmonology and the Journal of Cystic Fibrosis. Unpublished work is identified by searching the abstract books of three major cystic fibrosis conferences: the International Cystic Fibrosis Conference; the European Cystic Fibrosis Conference and the North American Cystic Fibrosis Conference. For full details of all searching activities for the register, please see the relevant sections of the Cystic Fibrosis and Genetic Disorders Group Module.
Date of the most recent search of the Group's Trials Register: 09 February 2009.

Data collection and analysis

Selection of studies
Two authors from different centres independently assessed which trials should be included. In the event of disagreement about inclusion of a trial, we asked an independent author from a third centre to review the paper(s) in question.

Data extraction and management
Each author independently extracted data on the outcome measures listed above. Review authors used the Cochrane Review Manager software to compile and analyse the data (Review Manager 2008).
Outcome data from longer-term studies (more than seven days) will be grouped into those measured at one, three, six, twelve months and annually thereafter. If outcome data is recorded at other time periods, then consideration will be given to examining these as well. Short-term studies are defined as studies with a duration less than seven days.

Assessment of risk of bias in included studies
In order to assess the risk of bias of the included studies, two authors independently assessed the quality of the included studies using a system as described by Jadad (Jadad 1996). In the event of disagreement about the quality score, we asked an independent author from a third centre to review the paper(s) in question. We considered aspects such as generation of randomisation sequence, the concealment of this sequence, degree of blinding and whether data were reported completely. If we considered these to be adequate, then we judged the study to have a low risk of bias, if these were inadequate then we judged the study to have a high risk of bias and if these were unclear we deemed the study to have an unclear risk of bias.

Measures of treatment effect
For continuous outcomes, we recorded either the mean change from baseline for each group or mean post-treatment or intervention values and the standard deviation or standard error for each group. In the case of binary outcomes odds ratios and their 95% confidence intervals (CIs) were calculated.

Unit of analysis issues
If trials had a cross-over design, the analysis that we planned to carry out is one recommended by Elbourne; however this was not possible with the data currently available (Elbourne 2002).

Dealing with missing data
In order to allow an intention-to-treat analysis, we collected data on the number of participants with each outcome event by allocated treated group irrespective of compliance and whether or not the participant was later thought to be ineligible or otherwise excluded for treatment or follow up.
Assessment of heterogeneity

When sufficient studies are included in a meta-analysis, we plan to assess heterogeneity using the I^2 statistic (Higgins 2003). This measure describes the percentage of total variation across studies that are due to heterogeneity rather than by chance (Higgins 2003). The values of I^2 lie between 0% and 100%, and a simplified categorization of heterogeneity that we plan to use is of low (I^2 value of 25%), moderate (I^2 value of 50%), and high (I^2 value of 75%) (Higgins 2003).

Assessment of reporting biases

We assessed all included studies for potential reporting bias including missing outcome values and relationships with sponsors.

Data synthesis

We were not able to present data in a meta-analysis for this version of the review. However, if in future we are able to perform a meta-analysis we will combine the data using a fixed-effect model if there is little or no heterogeneity. If there is a moderate or high degree of heterogeneity, we plan to use a random-effects model.

Subgroup analysis and investigation of heterogeneity

If we identify a high degree of heterogeneity, we plan to investigate this using subgroup analyses including long-term versus short-term interventions. Subgroup analysis looking at the effects of specific interventions has been carried out in a series of separate physiotherapy reviews published by the Cochrane Cystic Fibrosis and Generic Disorders Review Group (Elkins 2006; Main 2005; Morrison 2009).

Sensitivity analysis

We plan to test the robustness of our results by performing a sensitivity analysis of the data comparing results with and without quasi-randomised studies.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

Results of the search

Of the 126 studies of airway clearance techniques identified by the literature search, 114 were excluded and six studies were included.

Included studies

The six included studies were cross-over in design and included a control period (Braggion 1995; Falk 1993; Mortensen 1991; Pfleger 1992; Rossman 1982; van der Schans 1991).

Two studies compared two treatments, postural drainage combined with the FET; and PEP breathing combined with the FET with a control period (spontaneous coughing) in a three-day cross-over trial (Falk 1993; Mortensen 1991). One study was described in one abstract as having 10 participants and in another abstract as having 11 participants (Mortensen 1991). In this short-term study each treatment was given only once on one of three separate days.

Falk compared the same treatments and the same study design in 12 people with CF (Falk 1993).

Pfleger compared four forms of chest physiotherapy (PEP breathing, AD, PEP breathing followed by AD or AD followed by PEP breathing) with a control period (including some directed coughing) in 14 people with CF (Pfleger 1992). In this short-term study each treatment was undertaken once on separate days.

Rossman compared the immediate effect of four forms of chest physiotherapy (directed vigorous cough, postural drainage, postural drainage with mechanical percussion and conventional physiotherapy) with a control (including some requested cough periods) in six people with CF in a cross-over design (Rossman 1982). In this short-term study each treatment was given only once on separate days.

Van der Schans compared the immediate effect of two forms of chest physiotherapy (positive expiratory pressure breathing with 5 cm water pressure followed by directed vigorous coughing or PEP breathing with 15 cm water pressure followed by directed vigorous coughing) with a control period in eight CF participants in a cross-over design (van der Schans 1991). In this short-term study each treatment was given only once on separate days.

Braggion compared the immediate effect of three forms of chest physiotherapy (HFCC combined with FET and coughing, PEP combined with FET and coughing or postural drainage combined with vibrations, deep breathing, percussion or FET and coughing) with a control (spontaneous coughing) (Braggion 1995). Each regimen was used twice a day for two consecutive days.

Excluded studies

A total of 120 studies were excluded; 107 were excluded as they lacked a 'no treatment' or 'spontaneous coughing' control group and 13 studies were excluded for other reasons as follows. Two studies were not clinical trials (Langenderfer 1998; Thomas 1995); four included diagnoses other than cystic fibrosis (Cochrane 1977; Parker 1984; Sutton 1985; van Hengstum 1988); four did not evaluate chest physiotherapy (Deli 1994; Fauroux 1999; Gayer 1988; Wordsworth 1996); one because none of the outcome measures which we had defined for this review were used (Murphy 1988); one because the intervention was not thought to improve mucus clearance (Stites 2006); and one was in participants during an intra-operative period under anaesthesia (Tannenbaum 2001).
Risk of bias in included studies
The methodological quality scored using the Jadad score is as follows: Mortensen: 1 (Mortensen 1991); Falk: 1 (Falk 1993); Pfleger: 2 (Pfleger 1992); Rossman: 1 (Rossman 1982); van der Schans: 1 (van der Schans 1991); Braggion: 2 (Braggion 1995). The maximal score according to Jadad is five, however, two items are related to blinding of the investigator. Since blinding of the investigator is impossible in case of chest physiotherapy the maximal possible score for these studies is only three.

Allocation
All six studies were described as randomised; however, only one study gave any details on the method of randomisation (Latin square design) (Braggion 1995). We therefore judged the studies to have an unclear risk of bias for the generation of the randomisation sequence, except for the Braggion study which had a low risk of bias. None of the six studies discussed the concealment of the allocation and so were deemed to have an unclear risk of bias.

Blinding
It is impossible to blind participants and care-givers or clinicians to physiotherapy interventions, but it is possible to blind the outcome assessors to the intervention. Only one study was described as single-blind, which we assume refers to the outcome assessors being blinded (Mortensen 1991). Since, except for the outcomes well-being and therapy compliance, all other outcome measurements are physiological data, we do not consider the fact that participants, care-givers or clinicians were not blinded as an important source of bias.

Follow up and exclusions
Five of the included studies do not mention any drop outs, but one study states that one participant was excluded from the study due to respiratory infection (Pfleger 1992). Since all included studies are short term and the effect is measured immediately after the intervention we do not consider drop-outs an important risk of bias.

Selective reporting
We did not identify any selective reporting in any of the included studies.

Other potential sources of bias
We identified the potential for assessor bias in all six included studies (Braggion 1995; Falk 1993; Mortensen 1991; Pfleger 1992; Rossman 1982; van der Schans 1991); although the assessors may have been blinded in one study, but this was not explicitly stated (Mortensen 1991). Assessor bias is when assessors of outcome may be influenced in their judgement when they are aware whether the data reflect the control or an intervention outcome.

Effects of interventions
Six trials were included. All are cross-over trials and no meta-analysis was possible. All were short-term studies (less than seven days). Five studies were single treatment studies (Falk 1993; Mortensen 1991; Pfleger 1992; Rossman 1982; van der Schans 1991) and in one study each physiotherapy treatment was given four times (Braggion 1995).

Primary outcomes

1. Expectorated secretions
Three studies, involving 36 participants, found a higher amount of expectorated secretions during chest physiotherapy compared to the control period (Braggion 1995; Pfleger 1992; Rossman 1982). In the study by Pfleger, the mean weight of expectorated mucus during spontaneous coughing was approximately 17 g and during the three forms of chest physiotherapy between 34 to 45 g (Pfleger 1992). Braggion found a mean wet weight of expectorated secretions during the control day of 6 g and during the chest physiotherapy sessions 23 to 30 g (Braggion 1995). Rossman found a statistically significant higher volume of expectorated secretions during the different forms of chest physiotherapy compared to the control session (Rossman 1982).

2. Mucus transport rate as assessed by radioactive tracer clearance
In four studies radioactive tracer clearance was used as an outcome variable (Falk 1993; Mortensen 1991; Rossman 1982; van der Schans 1991). In three of these, involving 28 participants, it was found that chest physiotherapy, including coughing, increased radioactive tracer clearance as compared to the control period (Falk 1993; Mortensen 1991; Rossman 1982). In the study by Mortensen, median clearance after 30 minutes during control was 7% and during two different chest physiotherapy sessions was 33% and 34% (Mortensen 1991). Falk found approximately 6% clearance during the control measurement and 9% during chest physiotherapy (Falk 1993). Rossman found 32% radioactive tracer clearance during the control measurement and 40 to 46% during the different forms of chest physiotherapy (Rossman 1982). One study, of eight participants, reported no significant difference between two different chest physiotherapy sessions of PEP-breathing (clearance 10% and 6%), without coughing, compared to a control period (clearance 8%) (van der Schans 1991). Different outcomes between the study by van der Schans and the other studies can be explained by the fact that in the van der Schans study participants were requested not to cough, but coughing was
encouraged in the other studies as a part of the treatment (van der Schans 1991).

3. Pulmonary function tests
No data were available in any of the studies regarding this outcome.

Secondary outcomes

1. Oxygen saturation measured by pulse or transcutaneous oximetry
No data were available in any of the studies regarding this outcome.

2. Total lung capacity (TLC) and functional residual capacity (FRC)
Two studies, involving 24 participants, measured TLC and FRC after chest physiotherapy and found no significant effect on pulmonary function variables following intervention (Braggion 1995; van der Schans 1991).

3. Radiological ventilation scanning
No data were available in any of the studies regarding this outcome.

4. Subjective perception of well-being, ability to participate in activities of daily living
No data were available in any of the studies regarding this outcome.

5. Therapy compliance
No data were available in any of the studies regarding this outcome.

6. Objective change in exercise tolerance
No data were available in any of the studies regarding this outcome.

7. Nutritional status as assessed by growth, weight, body composition
No data were available in any of the studies regarding this outcome.

8. Number of respiratory exacerbations per year
No data were available in any of the studies regarding this outcome.

9. Number of days in hospital per year
No data were available in any of the studies regarding this outcome.

10. Number of days of intravenous antibiotics per year
No data were available in any of the studies regarding this outcome.

11. Cost of intervention (equipment and duration)
No data were available in any of the studies regarding this outcome.

12. Deaths
No data were available in any of the studies regarding this outcome.

Discussion
Chest physiotherapy has been a mainstay of the respiratory management of people with CF for so long that it may now be difficult for these people, their parents, physiotherapists and medical staff to consider a trial design that incorporated a no treatment control group for any length of time. Despite there being a reasonable degree of equipoise with regard to whether physiotherapy is better than no treatment, many would argue that to recruit participants into a no treatment group would be unethical. This explains in part why there are currently no long-term trials which use this design.

Evidence from short-term or single treatment studies, which incorporate a ‘no treatment’ group, should be interpreted with caution because of the long-term nature of the disease. The clinical consequences of missing one or two treatments is unlikely to be significant. Despite this limitation, the majority of physiotherapy studies involve single treatment or short-term study designs. In addition, the small participant numbers and enormous heterogeneity of treatments and outcome measures reported in the literature make it impossible to pool results from different studies. The short-term studies that were included in this review suggest that chest physiotherapy increases mucus transport in people with CF. This finding supports the conclusion of an earlier review (Thomas 1995a).

Finally a sham or placebo treatment clearly cannot be substituted for a clearly physical intervention such as percussion, PEP or postural drainage. Similarly, participants and therapists cannot be ‘blinded’ from the treatment being received. This partly explains the low quality scores of the included studies, as the Jadad scoring system places significant emphasis on blinding. Methodological variations between systematic reviews/meta-analyses may account for the differences in conclusions regarding treatment efficacy. The included cross-over trials may have provided potentially useful information about the efficacy of physiotherapy treatments.

Authors’ Conclusions
Implications for practice
Short-term cross-over trials suggest that airway clearance regimens have beneficial effects in people with CF in regard to improving mucus transport. However, based on this review, we have not been able to find any robust scientific evidence to support the hypothesis that chest physiotherapy for the purpose of clearing airway
secretions has a long-term beneficial effect in people with CF, nor to support the claim by some authors that it is harmful.

Implications for research

The gold standard for establishing efficacy of therapy is the randomised controlled trial with a 'no treatment' group. The application of this study design to the question in this review would be very effective. However, several ethical considerations could be raised in the discussion with regard to the withdrawal of an established and trusted treatment like chest physiotherapy in people with CF; even in the absence of firm evidence. On the other hand, it could be argued that in view of scant evidence to support the use of chest physiotherapy for people with CF and the fact that this intervention can be unpleasant, uncomfortable, and time-consuming, we believe that a study with a control group with no treatment in some circumstances is justified. Therefore, we propose that in future research, control groups or control periods should be included with sufficient numbers of included participants. This would be best studied as a parallel study over a time period of months rather than days or weeks.

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Homnick D, Spillers C, White F. The intrapulmonary percussive ventilator compared to standard aerosol therapy and chest physiotherapy in the treatment of patients with cystic fibrosis \{abstract\}. *Pediatric Pulmonology* 1994; Suppl 10:312.

Homnick 1998 \{published data only\}

Jacobs 1981 \{published data only\}

Keller 2001 \{published data only\}

Kerrebijn 1982 \{published data only\}


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Murphy 1983 *(published data only)*

Murphy 1988 *(published data only)*
Murphy K, Hagmann V, Morris-Gayer D. Effects of chest physiotherapy on sleep onset in hospitalized cystic fibrosis patients [abstract]. Proceedings of the 10th International Cystic Fibrosis Congress; 1988 March 4-10; Sydney. 1988;R(d)7.

Natale 1994 *(published data only)*

Newhouse 1998 *(published data only)*

Oberwalder 1986 *(published data only)*

Oberwalder 1991 *(published data only)*

Orlik 2000 *(published data only)*

Orlik 2001 *(published data only)*

Padman 1999 *(published data only)*

Parker 1984 *(published data only)*

Parsons 1995 *(published data only)*

Phillips 1998a *(published data only)*

Phillips 1998b *(published data only)*

Pike 1999 *(published data only)*

Pollard 2000 *(published data only)*
Pryor 1979a [published data only]

Pryor 1979b [published data only]

Pryor 1979c

Pryor 1981 [published data only]

Pryor 1990 [published data only]

Pryor 1994 [published data only]

Pryor 1995 [published data only]

Reisman 1988 [published data only]

Roos 1987 [published data only]

Salh 1989 [published data only]

Samuelson 1994 [published data only]

Sanchez 1999 [published data only]

Scherer 1998 [published data only]

Steen 1991 [published data only]

Steen 1994 [published data only]

Stiller 1996 [published data only]

Stites 2006 [published data only]

Sutton 1995 [published data only]

Tannenbaum 2001 [published data only]


Tecklin 1976 [published data only]


Thomas 1995 [published data only]

Tonnesen 1982 [published data only]
Tonnesen P, Kelstrup M. Self-administered positive end expiratory pressure (PEEP) using a face mask as an alternative to conventional lung [Selvadministeret positiv sluteksspiratorisk tryk (PEEP)
van Hengstum 1987 [published data only]


van Hengstum 1988 [published data only]


van Winden 1998 [published data only]


VanGinderdeuren 2000 [published data only]


Verboon 1986 [published data only]


Warwick 1999 [published data only]


Warwick 1991 [published data only]


Warwick 2004 [published data only]


Webber 1985 [published data only]


White 1997 [published data only]


Wilson 1995 [published data only]


Wong 1999 [published data only]


Wordworth 1996 [published data only]


Zapletal 1983 [published data only]

Znotina 2000  [published data only]

Additional references
Cantin 1995
Elbourne 2002
Elkins 2006
Higgins 2003
Jadad 1996
Jones 1998
Konstan 1997
Main 2005
Main E, Prasad A, van der Schans CP. Conventional chest physiotherapy compared to other airway clearance techniques for cystic fibrosis. Cochrane Database of Systematic Reviews 2005, Issue 1. [DOI: 10.1002/14651858.CD002011.pub2]
Morrison 2009
Prasad 1998
Review Manager 2008
Thomas 1995a
van der Schans 1996
Williams 1949
Zach 1990
* Indicates the major publication for the study
## Characteristics of included studies  [ordered by study ID]

### Braggion 1995

<table>
<thead>
<tr>
<th><strong>Methods</strong></th>
<th>Cross-over trial with random order of the interventions</th>
</tr>
</thead>
</table>
| **Participants** | Cystic fibrosis  
 n = 16  
 mean (SD) age 20.3 (4) years |
| **Interventions** | - high-frequency chest compression  
 - postural drainage, breathing exercises, vibrations, manual percussion  
 - PEP breathing  
 - control |
| **Outcomes** | - wet and dry weight expectorated mucus  
 - FVC, FEV1, FEF25-75%  
 - subjective assessment |
| **Notes** | Measurement 30 minutes after intervention |

### Risk of bias

<table>
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<tr>
<th>Item</th>
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<th>Description</th>
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<td>Yes</td>
<td>Random order of the interventions performed according to Latin square design described by Williams (<a href="#">Williams 1949</a>). In order to balance distribution between sexes, two 4x4 Latin squares were used for male participants and two for female participants.</td>
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| Blinding?  
 All outcomes | Unclear | Interventions did not allow participants or clinicians to be blinded, not discussed whether outcome assessors were blinded. |
| Incomplete outcome data addressed?  
 All outcomes | Unclear | No mention of any drop outs. |
| Free of selective reporting? | Yes | Immediate measurement after intervention. |
| Free of other bias? | Unclear | Potential assessor bias. |
### Falk 1993

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### Mortensen 1991

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Mortensen 1991  (Continued)

Notes
Measurements 30 minutes, 1 hour and 24 hours after intervention

Risk of bias

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Pfleger 1992

Methods
Cross-over trial with random order of the interventions

Participants
Cystic fibrosis
n = 14
mean (range) age 14 (9.8 - 22.4) years

Interventions
- PEP breathing
- AD
- PEP followed by AD
- AD followed by PEP
- control, spontaneous coughing

Outcomes
- FVC, FEV1, RV/TLC, Raw
- weight expectorated mucus

Notes
Measurements during an immediately after intervention

Risk of bias

<table>
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<th>Description</th>
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### Rossman 1982

<table>
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<th>Cross-over trial with random order of the interventions</th>
</tr>
</thead>
</table>
| Participants | Cystic fibrosis  
  n = 6  
  mean (SD) age: 22.8 (5.6) years |
| Interventions | - postural drainage  
- postural drainage, mechanical percussion  
- regimented coughing  
- chest physiotherapy, breathing exercises, vibrations, manual percussion, postural drainage  
- control, spontaneous coughing |
| Outcomes | - radioactive tracer clearance |
| Notes | Measurements during and up to 2 hours after intervention |

### Risk of bias

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<th>Description</th>
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<td>Paper states random order of the interventions, but no details of randomisation method given</td>
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<td>Interventions did not allow participants or clinicians to be blinded, not discussed whether outcome assessors were blinded</td>
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<tr>
<td>Incomplete outcome data addressed? All outcomes</td>
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<td>Abstract and paper state that 15 participants were randomly selected from local clinic, but data from 14 only as 1 developed symptoms of acute respiratory viral infection during study and was excluded</td>
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Rossman 1982  (Continued)

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<td>No mention of any drop outs</td>
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van der Schans 1991

<table>
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<tr>
<th>Methods</th>
<th>Cross-over trial with random order of the interventions</th>
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</table>
| Participants | Cystic fibrosis  
 n = 8  
 mean (SD) age: 16 (3) years |
| Interventions | - PEP breathing with a resistance of 5 cmH₂O followed by 5 minutes of coughing  
- PEP breathing with a resistance of 15 cmH₂O followed by 5 minutes of coughing  
- control followed by 5 minutes of coughing |
| Outcomes | - radioactive tracer clearance  
- TLC, FRC |
| Notes | Measurements during intervention |

Risk of bias

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<th>Description</th>
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<td>Yes</td>
<td>Immediate measurement after intervention</td>
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Free of other bias? | Unclear | potential assessor bias
--- | --- | ---

AD: autogenic drainage;  
FEF25-75%: forced expiratory flow 25-75%  
FET: forced expiration technique  
FEV1: forced expiratory volume at one second  
FRC: functional residual capacity  
FVC: forced vital capacity  
PEP: positive expiratory pressure breathing  
RV: residual volume  
SD: standard deviation  
TLC: total lung capacity

Characteristics of excluded studies  [ordered by study ID]

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Button 1998 | No control group without chest physiotherapy  
---|---  
Castile 1998 | No control group without chest physiotherapy  
Castle 1994 | No control group without chest physiotherapy  
Cegla 1993 | No control group without chest physiotherapy  
Cerny 1989 | No control group without chest physiotherapy  
Chatham 1998 | No physiotherapy to improve mucus clearance  
Chatham 2004 | No control group without chest physiotherapy  
Cochrane 1977 | Mixed group of participants (cystic fibrosis, chronic bronchitis, and bronchiectasis)  
Costantini 1998 | No control group without chest physiotherapy  
Darbee 1990 | No control group without chest physiotherapy  
Davidson 1988 | No control group without chest physiotherapy  
Davidson 1992 | No control group without chest physiotherapy  
Davidson 1998 | No control group without chest physiotherapy  
de Boeck 1984 | No control group without chest physiotherapy  
Delk 1994 | No physiotherapy to improve mucus clearance  
Desmond 1983 | No control group without chest physiotherapy  
Elkins 2000 | No control group without chest physiotherapy  
Falk 1984 | No control group without chest physiotherapy  
Falk 1988 | No control group without chest physiotherapy  
Fauroux 1999 | No chest physiotherapy (airway clearance technique) studied  
Gaskin 1998 | No control group without chest physiotherapy  
Gayer 1988 | No chest physiotherapy (airway clearance technique) studied
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<td>Warwick 2004</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>Webber 1985</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>White 1997</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>Wilson 1995</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>Wong 1999</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>Wordsworth 1996</td>
<td>No chest physiotherapy</td>
</tr>
<tr>
<td>Zapletal 1983</td>
<td>No control group without chest physiotherapy</td>
</tr>
<tr>
<td>Znotina 2000</td>
<td>No control group without chest physiotherapy</td>
</tr>
</tbody>
</table>
**DATA AND ANALYSES**

This review has no analyses.

**WHAT'S NEW**

Last assessed as up-to-date: 17 February 2009.

<table>
<thead>
<tr>
<th>Date</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 February 2009</td>
<td>Amended</td>
<td>The Methods section has been updated in light of new guidance and functionality of RevMan 5.</td>
</tr>
<tr>
<td>18 February 2009</td>
<td>New search has been performed</td>
<td>A search of the Group's Cystic Fibrosis Trials Register identified one additional reference to an already included study (Braggion 1995) and one to an already excluded study (Tannenbaum 2001).</td>
</tr>
</tbody>
</table>

**HISTORY**

Protocol first published: Issue 1, 1999

Review first published: Issue 2, 2000

<table>
<thead>
<tr>
<th>Date</th>
<th>Action</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>12 November 2008</td>
<td>Amended</td>
<td>Converted to new review format.</td>
</tr>
<tr>
<td>20 February 2008</td>
<td>New search has been performed</td>
<td>The search of the Group's Cystic Fibrosis Trials Register identified one new reference which was the main paper to a previously excluded abstract (Lagerkvist 2006).</td>
</tr>
<tr>
<td>20 February 2008</td>
<td>Amended</td>
<td>The Plain Language Summary has been updated in line with guidance from The Cochrane Collaboration. Also, in a post hoc change and in line with Group guidelines, the outcome measures have been split into 'Primary outcomes' and 'Secondary outcomes'.</td>
</tr>
<tr>
<td>14 November 2006</td>
<td>New search has been performed</td>
<td>The search of the Group's Cystic Fibrosis Trials Register identified two new references. Both studies were excluded (Stites 2006; Warwick 2004).</td>
</tr>
<tr>
<td>14 November 2005</td>
<td>New search has been performed</td>
<td>The search of the Group's Cystic Fibrosis Trials Register identified four new references. One study identified was not eligible for inclusion in the review and has been added to the 'Excluded studies' section (Chatham 2004). The remaining three references were to three</td>
</tr>
<tr>
<td>Date</td>
<td>Event Description</td>
<td>Notes</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>18 May 2004</td>
<td>New search has been performed</td>
<td>Additional references (providing no additional information) have been added to the following already 'Included studies': Mortensen 1991; Falk 1993. Additional references have been added to the following already 'Excluded studies': Button 1997a; Costantini 1998; Orlik 2001. Three new studies have been added to 'Excluded studies': Hare 2002; Orlik 2000; Tannenbaum 2001.</td>
</tr>
<tr>
<td>14 August 2002</td>
<td>New search has been performed</td>
<td>Six crossover trials, previously cited in &quot;Excluded Studies&quot; have now been moved to the &quot;Included Studies&quot; section (Braggion 1995; Falk 1993; Mortensen 1991; Pfieger 1992; Rossman 1982; van der Schans 1991). Relevant changes to the text of the review have been made. Four new &quot;Excluded Studies&quot; have been incorporated into the review (Battistini 2001; Keller 2001; Pollard 2000; Orlick 2001). Additional references to studies already listed in “Excluded Studies” have been incorporated into the review within the following study ID’s: Button 1997a; Gondor 1999; Grasso 2000; Marks 1999; Newhouse 1998).</td>
</tr>
<tr>
<td>9 February 2000</td>
<td>New citation required and conclusions have changed</td>
<td>Substantive amendment</td>
</tr>
</tbody>
</table>

**Contributions of Authors**

Amman Prasad and Eleanor Main independently assessed studies for inclusion in this review and assisted in writing of text. Cess van der Schans acts as guarantor of the review.

**Declarations of Interest**

None known.
DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The Methods section has been updated in light of new guidance and functionality of RevMan 5.

INDEX TERMS

Medical Subject Headings (MeSH)

*Physical Therapy Modalities; Cystic Fibrosis [*therapy]

MeSH check words

Humans