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Systematic review

Chest physiotherapy for patients admitted to hospital with an acute exacerbation of chronic obstructive pulmonary disease (COPD): a systematic review

Clarice Y. Tang [a,*], Nicholas F. Taylor [b], Felicity C. Blackstock [b]

[a] *Physiotherapy Department, Maroondah Hospital, Eastern Health, PO Box 135, Ringwood, East Victoria 3135, Australia*
[b] *School of Physiotherapy, La Trobe University, Bundoora, Victoria 3086, Australia*

Abstract

Objectives To examine the effectiveness of chest physiotherapy for patients admitted to hospital with an acute exacerbation of chronic obstructive pulmonary disease (COPD).
Data source CINAHL, MEDLINE, Embase, Cochrane, Expanded Academic Index, Clinical Evidence, PEDro, Pubmed, Web of Knowledge and Proquest were searched from the earliest available time to September 2007, using the key elements of COPD, acute exacerbation and chest physiotherapy interventions.
Review methods To be included, trials had to investigate patients during admission to hospital with an acute exacerbation of COPD, and to evaluate at least one physiotherapy intervention. Two reviewers independently applied the inclusion criteria, and assessed trial quality using the PEDro scale. Results were expressed as standardised mean differences and analysed qualitatively with a best-evidence synthesis.
Results Thirteen trials were identified. There was moderate evidence that intermittent positive pressure ventilation and positive expiratory pressure were effective in improving sputum expectoration. In addition, there was moderate evidence that walking programmes led to benefits in arterial blood gases, lung function, dyspnoea and quality of life. No evidence was found supporting the use of any other chest physiotherapy techniques to change lung function, arterial blood gases, perceived level of dyspnoea or quality of life.
Conclusions Chest physiotherapy techniques such as intermittent positive pressure ventilation and positive expiratory pressure may benefit patients with COPD requiring assistance with sputum clearance, while walking programmes may have wider benefits for patients admitted with an exacerbation of COPD. Chest physiotherapy techniques other than percussion are safe for administration to this patient population.

Keywords: Acute; COPD; Chest physiotherapy; Exacerbation

Introduction

Chronic obstructive pulmonary disease (COPD) is a significant chronic disease affecting about 1.5 million people in the UK [1]. On average, 25% of people with COPD are admitted to an acute hospital with an exacerbation each year [2].

It has been reported that 77% of physiotherapists in the UK routinely apply chest physiotherapy techniques to patients admitted to hospital with an acute exacerbation of COPD [3]. Chest physiotherapy is a broad term used for techniques or strategies aimed at improving lung volumes or facilitating the removal of airway secretions [4]. Common chest physiotherapy techniques include percussion, vibration, postural drainage, active cycle of breathing, continuous or oscillating positive expiratory pressure (PEP), intermittent positive pressure ventilation (IPPV), thoracic expansion exercises and walking programmes [5]. Despite the routine application of chest physiotherapy [3], recommendations for management of an acute exacerbation of COPD have not included the use of chest physiotherapy techniques [1].

The safety of chest physiotherapy has also been questioned. Vincenza *et al*. [6] claimed that chest physiotherapy techniques, particularly percussion, might harm the lung function of patients with an exacerbation of COPD.

* Corresponding author. Tel.: +61 3 98713502; fax: +61 3 98713501.
E-mail address: clarice.tang@easternhealth.org.au (C.Y. Tang).

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There is a need to clarify the effects of chest physiotherapy techniques for this group of patients. Therefore, the main aim of this review was to investigate the benefits of chest physiotherapy for patients admitted to hospital with an acute exacerbation of COPD. The secondary aim of this review was to investigate the safety of chest physiotherapy for patients admitted to hospital with an acute exacerbation of COPD.

Methods

Search strategy

The following relevant electronic databases were searched from the earliest available time to September 2007: CINAHL, MEDLINE, Embase, Cochrane, Expanded Academic Index, Clinical Evidence, PEDro, Pubmed, Web of Knowledge and Proquest.

The search strategy consisted of three main elements: acute exacerbation, chronic obstructive pulmonary disease and chest physiotherapy interventions. Acute exacerbation was linked with synonymous terms such as inpatient, hospital admission and infective exacerbation with the 'OR' operator. Chronic obstructive pulmonary disease was linked using synonyms such as chronic obstructive airway disease and COPD. For chest physiotherapy interventions, sputum clearance techniques, airway clearance techniques and physical therapy were some of the synonyms that were combined with the 'OR' operator. Finally, all three elements were grouped together using the 'AND' operator so that trials included all three elements. Table 1 shows the search terms.

Table 1
Search strategy for CINAHL.

#	Searches
1	(Acute exacerbation OR acute management OR inpatient OR hospital admission OR infective exacerbation).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
2	(Chronic obstructive pulmonary disease OR chronic bronchitis OR emphysema OR chronic obstructive airway disease OR chronic obstructive lung disease OR bronchiectasis OR copd).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
3	(Chest physiotherapy OR sputum clearance technique OR airway clearance technique OR sputum mobilisation OR physical therapy OR force expiratory technique OR respiratory physiotherapy OR sputum mobilisation).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
4	(Active cycle of breathing OR autogenic drainage OR postural drainage OR bubble pep OR positive expiratory pressure OR oscillating PEP OR flutter OR acapella OR vibration OR humidification OR saline nebuliser OR mobilisation OR physical therapy OR force expiratory techniques OR secretion clearance technique OR intrapulmonary percussive ventilation OR ambulation OR physical therapy OR walking programme OR exercise OR expiration with glottis open in lateral position OR ETGOL).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
5	(Respiratory therapy OR sputum clearance technique OR sputum mobilisation OR airway clearance technique OR intermittent positive pressure ventilation OR thoracic expansion exercise OR percussion OR cough OR incentive spirometry).mp. [mp = title, original title, abstract, name of substance word, subject heading word]
6	('Physical therapy OR chest physiotherapy' OR 'physiotherapy' OR 'respiratory therapy' OR 'sputum clearance technique').mp. [mp = title, original title, abstract, name of substance word, subject heading word]
7	3 AND 4 AND 5 AND 6
8	1 AND 2 AND 7

Inclusion and exclusion criteria

Inclusion and exclusion criteria were applied to all titles and abstracts identified by the search. Patients involved in the trials had to have been admitted to an acute care hospital as an inpatient with an acute exacerbation of COPD, and received at least one physiotherapy technique during their inpatient stay.

Potential trials were excluded if patients were intubated and mechanically ventilated, as the respiratory mechanics, outcomes and demands for physiotherapy on mechanically ventilated patients are different from self-ventilated patients [7]. Trials were also excluded if they included patients who were unable to actively participate in physiotherapy interventions, such as patients who were sedated. Table 2 details all inclusion and exclusion criteria.

Trial selection

Two reviewers (CT and either NT or FB) independently applied the inclusion and exclusion criteria to the titles and abstracts of all sourced trials. The full papers of the trials still considered for possible inclusion after this initial step were then obtained, and each reviewer (CT and either NT or FB) determined in further depth whether the inclusion criteria were met. A third reviewer was consulted if consensus could not be achieved between the two reviewers. References of included trials were checked to ensure that all possible trials were considered for the review.

Quality assessment

To assess the methodological quality of all included trials, the Physiotherapy Evidence Database (PEDro) scale was applied [8]. PEDro yields a score of 10 points if all criteria are satisfied. Two assessors (CT and NT or FB) independently applied the PEDro scale criteria. No trials were omitted on the basis of the quality assessment, but quality scores were taken into account when interpreting results. Trials with a PEDro score of less than 4 out of 10 were considered to be of a lower quality [9].

Table 2
Inclusion and exclusion criteria.

Categories	Inclusion	Exclusion
Population	Participants admitted into an acute hospital	Other respiratory conditions that can cause increased production of sputum, e.g. cystic fibrosis
	Primary admitting diagnosis was an acute exacerbation of COPD	Home therapy, community care or pulmonary rehabilitation on discharge from the acute hospital
		Participants who were intubated and unable to actively take part in the study
		Participants who were admitted with other complex medical issue(s), e.g. cardiac failure
Intervention	Interventions must be considered physiotherapy interventions	Interventions not considered to be physiotherapy treatment, e.g. drug therapy, invasive or non-invasive ventilation, oxygen therapy
	Interventions could be carried out by any professionals	Invasive physiotherapy interventions typically requiring intubations
	Pulmonary rehabilitation that is provided as a part of recovery from the acute episode during admission	Manual hyperinflation
	CPAP, BiPAP and IPPV if they are part of the physiotherapy treatment	Suction
		Ventilator hyperinflation
Outcome	Studies must have at least one outcome measure relevant to potential impairments or activity limitations in COPD	NA
Type of studies	Published clinical trials in peer-reviewed journals	Single case studies
	Empirical trials	Qualitative studies
	Full text	Non-English papers
	All papers must be in English	Papers with abstracts only
		Reviews (narrative and systematic)
		Individual opinions and editorials
		Thesis

COPD, chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure; BiPAP, bi-level positive airway pressure; IPPV, intermittent positive pressure ventilation; NA, not applicable.

Data analysis

Data were extracted from included trials using a standard form. Data extracted included details of the sample sizes, study design, severity of COPD, interventions, adverse effects and outcome measures. The severity of COPD was classified according to the Global Initiative for COPD as mild, moderate or severe [10].

Where possible, standardised mean differences (also known as effect sizes) with 95% confidence intervals were calculated using web-based software [11]. For dichotomous outcomes, odds ratios were calculated.

The results of the included trials were combined qualitatively using a best-evidence synthesis [12]:

- Strong: consistent findings among high-quality randomised controlled trials (RCTs).
- Moderate: consistent findings among multiple low-quality RCTs and/or non-randomised clinical controlled trials (CCTs) and/or one high-quality RCT.
- Limited: one low-quality RCT or CCT or consistent findings from pre- to post-trials.
- Insufficient: insufficient evidence to support or refute the effectiveness of the intervention with no RCT and/or CCT, or a single pre–post-trial.
- Conflicting: inconsistent findings among multiple trials.

Results

Yield

Four hundred and seventy-eight articles were identified from searching, of which 430 were excluded after applying the inclusion criteria to the title and abstract. Full papers were obtained for the remaining 48 articles and a detailed assessment was performed, resulting in the further exclusion of 37 articles. Of the 37 full-text articles excluded, 22 articles were based in an outpatient setting, one article was based in the intensive care environment with the majority of patients intubated, two articles had no physiotherapy interventions, nine articles were editorials and three articles were systematic reviews. Two more articles were identified and included from searching the reference lists of included articles. In total, 13 trials were included in this review. Fig. 1 illustrates the process of study selection.

Study quality and design

Five RCTs [13–17], one randomised parallel groups trial [18], two non-randomised CCTs [19,20] and five single group pre–post-trials [21–25] were included in this review (Table 3). A median score of 3 (range 1–6) on the PEDro

Table 3
Detailed information regarding participants.

Reference	Study design	Intervention	Sample size		Mean age		Gender		Dosage	Outcome measures
			Int	Con	Int	Con	M	F		
Anthonisen 1964 [19]	Non-randomised controlled trial	Postural drainage + vibration compared with standard care	35	33	59.5	59	44	24	Not reported	Daily temperature Daily amount of sputum expectorate (grams) Electrocardiogram Chest X-ray Arterial blood gases
Basoglu 2005 [13]	Randomised controlled trial	Incentive spirometry compared with standard care	15	12	65.5	72.0	26	1	5 to 10 breaths with incentive spirometry, every hour	Arterial blood gases Perceived level of dyspnoea via visual analogue scale FEV_1 St George's Respiratory Questionnaire
Bellone 2000 [21]	Single group pre–post	Postural drainage compared with oscillating PEP compared with ETGOL	10	NA	55.5	NA	10	0	30 minutes, once a day	Sputum wet weight (grams) Arterial oxygen saturation FEV_1
Bellone 2002 [14]	Randomised controlled trial	PEP compared with standard care	13	14	65.0	64.0	17	10	2 minutes of breathing with mask, assisted coughing followed by 2 minutes of breathing without mask, five to seven times a day	Total sputum expectoration (grams) Dropout rate within mask group Weaning time off non-invasive ventilation
Buscaglia 1983 [22]	Single group pre–post	Percussion + postural drainage	10	NA	70.0	NA	7	3	12° supine Trendelenburg position for 20 minutes including 10 minutes of clapping + 1 to 2 minutes of vibration	Arterial oxygen saturation
Campbell 1975 [20]	Non-randomised controlled trial	Percussion + postural drainage compared with postural drainage	7	10	65.5	65.5	NA	NA	12° Trendelenburg position for 20 minutes with 20 minutes of percussion on lateral and posterior chest	FEV_1

Kristen 1998 [15]	Randomised controlled trial	Walking compared with standard care	15	14	62.3	65.6	26	3	Five walking sessions per day at 75% of maximal walking distance achieved in walking test	Lung function test including FEV_1 Arterial blood gases 6-minute walk test Transition dyspnoea index Borg score Minute ventilation, oxygen uptake and carbon dioxide output
Newton 1978 [16]	Randomised controlled trial	Intermittent positive pressure ventilation compared with standard care	40	39	69	69.5	63	16	Three times daily for 10 to 15 minutes	Daily temperature Daily weight measurement Daily eating and sleep score Daily walking distance in 1 minute Length of stay Arterial blood gases Lung function test including FEV_1 Mean sputum volume (ml)
Newton 1978 [23]	Single group pre–post	Combination therapy at different intervals	23	NA	NA	NA	NA	NA	15 minutes consisting of breathing exercise, chest vibration, percussion and postural drainage	Thoracic gas volume using a body plethysmograph Airway resistance calculated using thoracic gas volume multiplied by derivative specific conductance FEV_1 Vital capacity
Petersen 1967 [17]	Randomised controlled trial	Combination therapy compared with standard care	10	28	64.0	63.7	23	15	Not reported	Vital capacity Expiratory reserve volume Functional residual capacity Peak expiratory flow Tidal volume Minute ventilation Respiratory rate Nitrogen distribution Ventilation–perfusion ratio Sputum expectoration (ml)

Table 3 (*Continued*)

Reference	Study design	Intervention	Sample size		Mean age		Gender		Dosage	Outcome measures
			Int	Con	Int	Con	M	F		
Wollmer 1985 [24]	Single group pre–post	Percussion + postural drainage compared with postural drainage	10	NA	71.6	NA	6	4	5 minutes in each of three positions (supine, right and left side) with 15 minutes of percussion	FEV_1 Vital capacity Arterial oxygen saturation Penetration index to measure deposition and clearance of inhaled radioparticles
Vitacca 1998 [25]	Single group pre–post	Deep breathing	25	NA	64.0	NA	23	2	Twice daily for 30 minutes	Arterial oxygen saturation Transcutaneous partial pressure of carbon dioxide Transcutaneous partial pressure of oxygen Heart rate Respiratory rate Tidal volume Perceived level of dyspnoea via visual analogue scale
Yohannes 2003 [18]	Randomised parallel groups trial	Walking programme using gutter frame with oxygen or air and rollator with oxygen or air	Four groups 1st: 26 2nd: 28 3rd: 28 4th: 28		Four groups 1st: 76 2nd: 75 3rd: 74 4th: 74		59	51	Three times daily, 15 minutes per session	Borg score Barthel index Compliance of patients using nurse's assessment Re-admission within 1 month Length of stay

PEP, positive expiratory pressure; ETGOL, expiration with glottis open in lateral position; FEV_1, forced expiratory volume in 1 second; NA, not applicable; Int, intervention; Con, control.

Table 4
Quality assessment of studies using a PEDro scale.

Study	Eligibility criteria	Random allocation	Allocation concealment	Groups similar at baseline	Blinding of subjects	Blinding of therapists	Blinding of assesors	More than one measure on 85% of subjects	All subjects included or intention to treat	Statistical comparison of groups	Point and variability measures	Final score (10)
Anthonisen 1964 [19]	Y	N	N	N	N	N	N	Y	N	N	N	1
Basoglu 2005 [13]	Y	Y	N	N	N	N	N	N	N	N	Y	2
Bellone 2000 [21]	N	N	N	N	N	N	N	Y	Y	N	Y	3
Bellone 2002 [14]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
Buscaglia 1983 [22]	Y	N	N	N	N	N	N	Y	Y	N	N	2
Campbell 1975 [20]	Y	N	N	N	N	N	N	Y	Y	N	Y	3
Kirsten 1998 [15]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	5
Newton 1978 [16]	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	6
Newton 1978 [23]	Y	N	N	N	N	N	Y	N	N	N	Y	2
Petersen 1967 [17]	Y	Y	N	N	N	N	N	Y	N	N	N	2
Wollmer 1985 [24]	N	N	N	N	N	N	N	Y	Y	N	Y	3
Vitacca 1998 [25]	Y	N	N	N	N	N	N	Y	Y	N	Y	3
Yohannes 2003 [18]	Y	Y	N	Y	N	N	N	Y	N	Y	Y	5

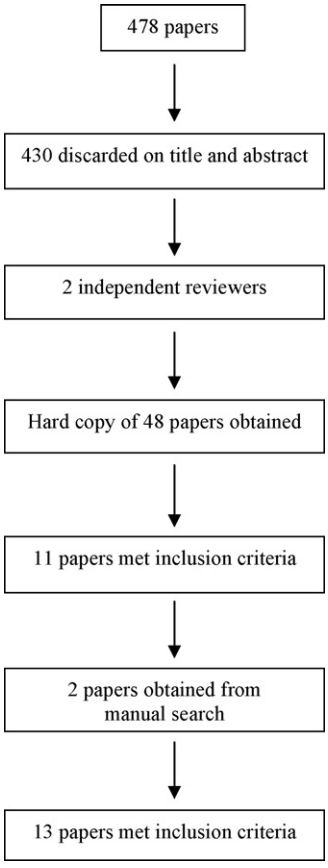

Fig. 1. Flow chart of the trial selection.

scale (1999) was obtained, with nine of 13 trials considered to be of lower quality [13,17,19,20–25]. Only one trial reported concealment of allocation [16], and one other trial fulfilled the criterion of blinding of the assessors for at least one outcome measure [23] (Table 4).

Trial characteristics

In total, 473 participants were involved in the included trials. The mean sample size of included trials was 36.2 [standard deviation (SD) 30.4]. The mean age of patients with COPD was 65.5 years (SD 4.72). The six trials that provided sufficient information investigated patients with severe COPD with a forced expiratory volume in 1 second percentage predicted (FEV_1%) varying from 34% (SD 8) to 44% (SD 13) (Table 3).

Chest physiotherapy techniques

Chest physiotherapy techniques examined by the trials included vibrations [19], deep diaphragmatic breathing [25], percussions [20,22,24], postural drainage in different positions [19–22,24], incentive spirometry [13], oscillating PEP via flutter [21], expiration with glottis open in lateral position (ETGOL) [21], IPPV [16], PEP using a PEP mask [14] and walking programmes [15,18]. Two trials [17,23] looked at combination therapy of various chest physiotherapy techniques such as breathing exercises, postural education, postural drainage, percussion, respiratory and abdominal muscle training; however, the exact intervention for each patient was not reported in one of the trials [17]. Table 3 shows the full details on dosing techniques and outcome measures for each trial.

Physiological outcome measures

Sputum expectoration

Of the 11 different chest physiotherapy techniques included in this review, only four techniques were found to increase sputum expectoration [14,16,21]. PEP [14] resulted in a significant increase in sputum expectoration compared with standard care, while the increment in sputum expectoration with the use of IPPV [16] seemed to be limited to male patients with a partial pressure of oxygen in arterial blood (PaO_2) >60 mmHg (Fig. 2). Both oscillating PEP and ETGOL produced a significant increase in sputum expectoration both immediately and 1 hour after treatment [21]. Vibrations [19] and combination therapy [17] did not produce any significant increase in sputum expectoration compared with standard care.

Arterial blood gases

Implementing a walking programme was the only chest physiotherapy intervention that had a favourable effect on arterial blood gases compared with standard care (Figs. 3 and 4). Kristen *et al.* [15] reported a significant increase in mean differences of PaO_2 and a significant decrease in mean differences of partial pressure of carbon dioxide in arterial blood during exercise, favouring the walking group over standard care. None of the other chest physiotherapy techniques produced a significant improvement in arterial blood gases compared with standard care and other techniques. However, deep diaphragmatic breathing [25] and incentive spirometry [13] resulted in a significant increase in PaO_2 pre–post intervention.

Lung function

A walking programme was the only intervention that demonstrated a beneficial effect on lung function [15]. Walking resulted in a significant improvement in minute ventilation compared with standard care [15]. No technique demonstrated a positive effect on FEV_1 when compared with standard care or another technique (Fig. 5), despite seven different techniques including it as an outcome measure [13,15,16,20,21,23,24]. Ten to fifteen minutes of percussion in combination with postural drainage produced a small but statistically significant negative short-term effect compared with postural drainage alone [20] and pre–post in another trial [24].

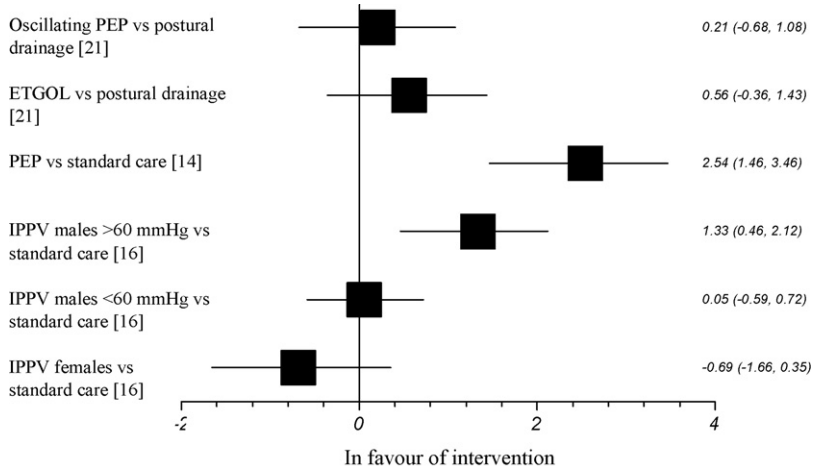

Fig. 2. Forest plot for sputum production. d = standardised mean difference (95% confidence interval). PEP, positive expiratory pressure; ETGOL, expiration with glottis open in lateral position; IPPV, intermittent positive pressure ventilation.

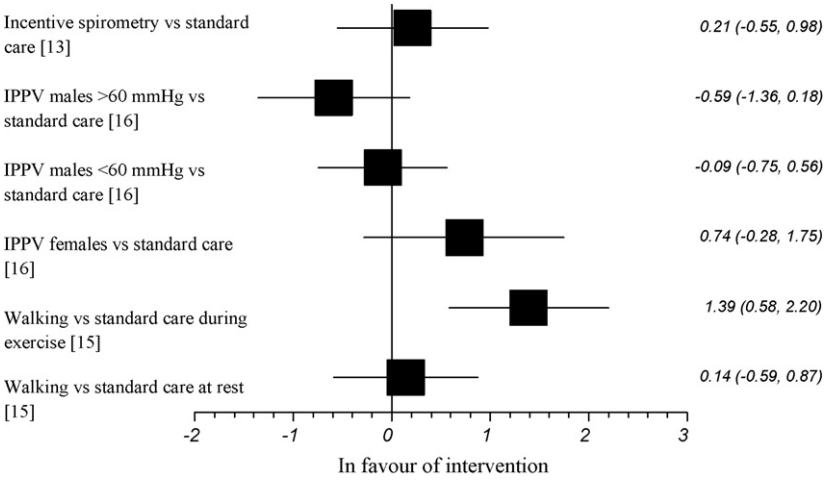

Fig. 3. Forest plot for arterial blood gases (partial pressure of oxygen in arterial blood). d = standardised mean difference (95% confidence interval). IPPV, intermittent positive pressure ventilation.

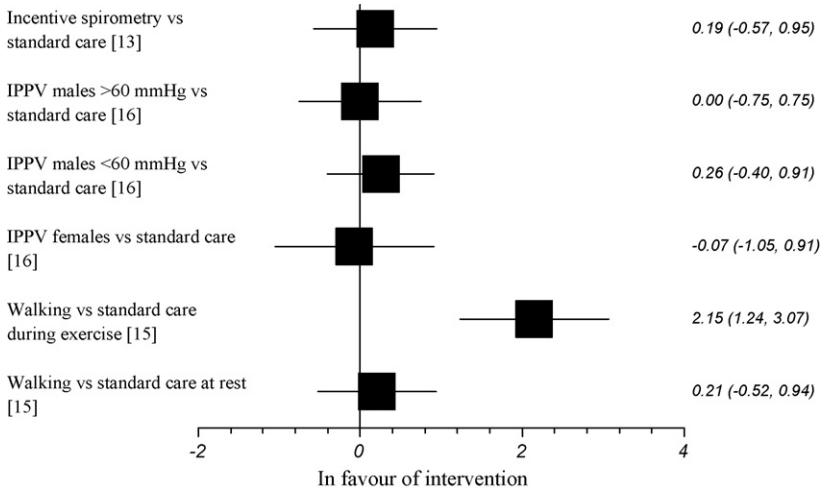

Fig. 4. Forest plot for arterial blood gases (partial pressure of carbon dioxide in arterial blood). d = standardised mean difference (95% confidence interval). IPPV, intermittent positive pressure ventilation.

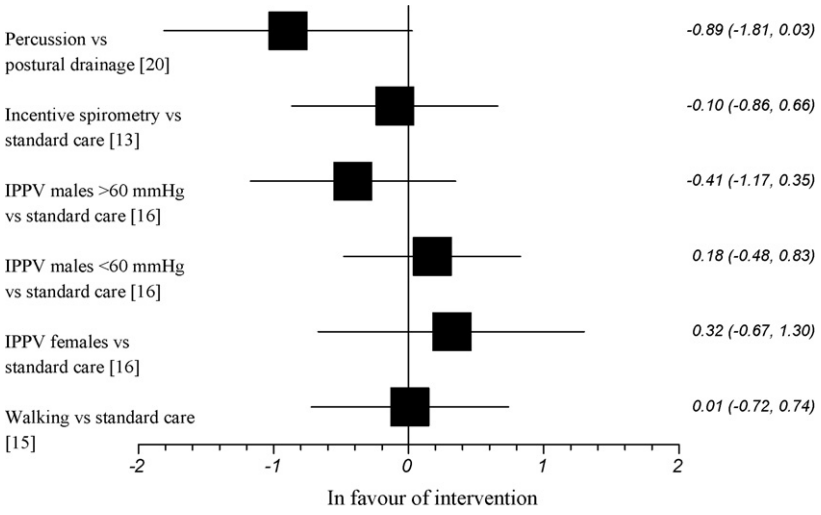

Fig. 5. Forest plot for lung function (forced expiratory volume in 1 second). d = Standardised mean differences (95% confidence interval). IPPV, intermittent positive pressure ventilation.

Non-physiological outcome measures

Perceived level of dyspnoea

Walking five times a day at 75% of maximal walking distance [15] significantly reduced dyspnoea post exercise compared with standard care, as assessed with the Borg score. There was no significant difference in Borg score between the use of rollator and gutter frame [18]. The visual analogue scale was also used to measure the perceived level of dyspnoea in two trials that found no significant difference between incentive spirometry and standard care [13], and a significant worsening in dyspnoea during the administration of deep diaphragmatic breathing [25].

Exercise capacity

Participants who walked five times a day at 75% of maximal walking distance achieved significant improvement in walking distance, lactic acid concentration and oxygen uptake per body weight compared with standard care [15].

Quality of life/function

Quality of life or function were only evaluated in three of the thirteen trials. In one trial, incentive spirometry resulted in a significant improvement on the St George Respiratory Questionnaire compared with standard care [13], while a mean increase in Barthel score favouring the use of gutter frame over rollator was found in another trial [18]. No significant improvement in daily weight, eating, sleeping and exercise score was found when the IPPV group was compared with standard care [16].

Length of stay

The two trials that included length of stay as an outcome measure did not show any significant decrease in hospital length of stay when comparisons were made either between use of IPPV and standard care [16], or between two different gait aids with a walking programme [18].

While not specifically reviewing hospital length of stay, Bellone *et al*. [14] reported that the use of PEP resulted in a decrease of 2.7 days spent on non-IPPV compared with no PEP.

Adverse effects

Of the three trials [14,20,24] that reported how well techniques were tolerated, two trials reported adverse events. The adverse effects occurred immediately after the use of percussion in both trials, resulting in a small but significant decrease in FEV_1 [20,24]. However, FEV_1 returned to baseline after 20 minutes in one trial [20]. The third trial reported that 15% of participants experienced discomfort during use of PEP, but it was not severe enough for them to stop treatment [14]. None of the trials reported any participant withdrawal due to an adverse effect from the techniques.

Best-evidence synthesis

- There is moderate evidence that walking programmes can have beneficial effects on PaO_2 during exercise, exercise capacity and perceived dyspnoea [15,18].
- There is moderate evidence that PEP [14] can increase sputum expectoration, and moderate evidence that IPPV [16] can increase sputum expectoration for males with PaO_2 >60 mmHg.
- There is moderate evidence that the use of PEP can decrease weaning time from non-invasive ventilation [14].
- There is moderate evidence showing a lack of effect with the combination of postural drainage and percussion on sputum expectoration, lung function and arterial blood gases [19–22,24].

- There is limited evidence that percussion can result in a drop in FEV_1 during treatment [20,24].
- There is limited evidence that incentive spirometry leads to an improvement in quality of life [13].
- There is limited evidence that combination therapy does not improve sputum expectoration, arterial blood gases or lung function [17,23].
- There is insufficient evidence to determine whether oscillating PEP and ETGOL can increase sputum expectoration [21].
- There is insufficient evidence to determine whether deep diaphragmatic breathing can improve outcomes [25].
- There is moderate evidence that percussion can have detrimental short-term effects on lung function [14,20,24], but moderate evidence that other chest physiotherapy techniques are safe.

Discussion

According to a recent UK survey [3], 77% of physiotherapists used chest physiotherapy techniques in their management of patients admitted to hospital with an exacerbation of COPD. However, the results of this systematic review indicate that the benefits of chest physiotherapy for patients admitted with an exacerbation of COPD are limited. There is moderate evidence that chest physiotherapy techniques, specifically PEP and IPPV, can increase sputum expectoration, and that a walking programme can improve exercise capacity, PaO_2 during exercise and perceived dyspnoea. There was no evidence available on techniques such as active cycle of breathing specific to this population. Despite this, 88% of physiotherapists in UK always or often use active cycle of breathing with this population [3].

According to one guideline, only patients who produce more than 25 ml of sputum per day or mucus plugging resulting in lobar atelectasis may benefit from chest physiotherapy [7]. An increase in sputum expectoration of less than 25 ml may not require focused treatment. Therefore, clinicians should only consider using chest physiotherapy techniques of PEP and IPPV on patients when sputum expectoration is a problem, and not as a routine management strategy.

Walking programmes may be more effective than other chest physiotherapy techniques for many patients with an acute exacerbation of COPD. Moderate evidence is available indicating that walking programmes lead to benefits in arterial blood gases, dyspnoea and exercise capacity [15,18]. Based on this preliminary evidence, physiotherapists should consider placing more emphasis on a walking programme when treating patients admitted to hospital with an acute exacerbation of COPD.

Exercises including walking programmes have been introduced successfully to patients with stable COPD in the form of pulmonary rehabilitation programmes [1,3]. There is strong evidence from a review of 20 randomised controlled trials and 979 participants that people with stable COPD who performed upper and lower extremity exercises of 6–52 weeks' duration improved their exercise capacity and experienced less shortness of breath [26]. Since there is moderate evidence supporting the use of a walking programme on patients with an acute exacerbation of COPD, introducing the exercise component of pulmonary rehabilitation that includes a walking programme and some strengthening exercises during an acute exacerbation of COPD may allow patients to obtain some of the benefits of pulmonary rehabilitation at an early stage and merits further investigation.

In this review, few trials reported on changes in length of hospital stay or discharge destination, or included measurements of dyspnoea, function or quality of life. Future research needs to include length of stay, functional outcomes and quality-of-life measurements in order to provide a complete picture of the benefits of each technique, and the effects of chest physiotherapy in changing healthcare utilisation with patients admitted to hospital with an exacerbation of COPD.

Safety of physiotherapy techniques

Only three trials [14,20,24] reported on how techniques were tolerated by patients. Two trials [20,24] reported a negative effect on FEV_1 during the use of percussion. This coincided with some suggestions that physiotherapy, particularly percussion, may be harmful to this population [6,27]. However, since percussion did not produce any beneficial effects in patients with an acute exacerbation of COPD, there is no evidence to support its use regardless of the negative effect of percussion on FEV_1.

Comparison with other reviews

The strength of this systematic review is that it evaluated the effectiveness of all areas of chest physiotherapy including walking programmes, postural drainage, PEP, IPPV, percussion and vibrations. Two other systematic reviews [27,28] have partly examined physiotherapy in acute exacerbations of COPD. However, only three trials [19,22,23] from the current review were included in the review by Bach *et al.* [27], and only one trial [23] was included in the review by Jones and Rowe [28]. Both reviews concluded that physiotherapy interventions were either not effective or harmful for patients with an acute exacerbation of COPD. The conclusion of this systematic review is based on evidence from more trials and incorporates a broader definition of chest physiotherapy.

One of the limitations of this review is the inability to compare all interventions against best-practice guidelines as information regarding dosages of certain techniques was not reported. In order to provide an accurate concise systematic review, the quality of interventions used has to be consistent across trials [29]. Of the 13 trials, only the trials examining IPPV, PEP and incentive spirometry included sufficient information about dosage to confidently comment on whether the intervention was based on best-practice guidelines. Only

IPPV and incentive spirometry were consistent with best-practice recommendations [5]. As for postural drainage and percussion, although three of the trials [20,22,24] included these two techniques and described dosages in full, there were differences between the trials and inconsistencies with best-practice guidelines. The duration of treatment for postural drainage across the three trials varied from 15 to 20 minutes, while the degree of tilt, when reported, was consistent at 12° across two trials [20,22]. This differs from the recommended 15 to 20° [5], and thus may have contributed to the technique being ineffective. On the other hand, continuous percussion was performed between 5 and 15 minutes [20,22,24]. This length of time is longer than the recommended time of 1–2 minutes per burst in one position [5], and thus may have resulted in the decrease in FEV_1 during intervention. Therefore, it is possible that a lack of the quality of intervention in the trials evaluating postural drainage and percussion may have influenced the findings of a lack of effect. Future trials should ensure that the dosages and positions of interventions are based on best-practice guidelines.

The other limitation to this review is the presence of a large variety of outcome measures. Thirty-nine different outcome measures were used across the 13 trials, resulting in clinical heterogeneity; therefore, it was not possible to synthesise the results quantitatively and complete a meta-analysis.

Conclusion

PEP and IPPV can increase sputum expectoration for patients admitted to hospital with an acute exacerbation of COPD, suggesting that clinicians should consider using these chest physiotherapy techniques with patients exhibiting an increase in sputum expectoration or difficulty with sputum expectoration, rather than using it as a routine treatment for all patients. There is moderate evidence that the introduction of a walking programme is beneficial and that chest physiotherapy techniques other than percussion are safe for administration to this patient population. As there is moderate evidence that percussion is not beneficial for this patient population, it should not be included as part of the treatment. Future research should consider including more outcome measures on quality of life and healthcare utilisation, improve the quality of interventions by standardising dosages as per best-practice guidelines when possible, and aim to provide further evidence to support the role of walking or exercise programmes in the management of patients admitted to hospital with an exacerbation of COPD.

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