Effect of airway clearance techniques in patients experiencing an acute exacerbation of chronic obstructive pulmonary disease: a systematic review

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CRD summary
The authors concluded that vibration, positive expiratory pressure mask and applying positive pressure to airways had beneficial effects on some outcomes in patients with acute exacerbation of chronic obstructive pulmonary disease. In light of possible publication bias and the low quality and small number of included trials, the reliability of the authors’ conclusions is unclear.

Authors’ objectives
To evaluate the safety and effectiveness of airway clearance techniques in patients with acute exacerbations of chronic obstructive pulmonary disease.

Searching
MEDLINE, EMBASE, PEDro, CINAHL and the Cochrane Library were searched up to February 2009 for articles published in English. Search terms were reported.

Study selection
Randomised controlled trials (RCTs) or randomised cross-over trials that exclusively recruited patients with acute exacerbations of chronic obstructive pulmonary disease were eligible for inclusion. Eligible trials were required to evaluate non-invasive airway clearance techniques compared with usual care, or to evaluate a regimen including a specific non-invasive airway clearance technique compared with the regimen without the technique. Trials that specifically evaluated non-invasive positive pressure ventilation or early rehabilitation were excluded.

Outcomes eligible for inclusion were: desirable or undesirable changes in resting lung function (measured by forced expiratory volume in one second - FEV₁); gas exchange or symptoms; sputum weight or volume; reduction in length of stay in hospital; or decreased need for non-invasive positive pressure ventilation.

Included trials evaluated: breathing exercises, chest vibration, manual percussion in postural drainage, and intermittent positive pressure breathing compared with optimal medical care; manual percussion added to postural drainage plus deep breathing and huffing compared with postural drainage, deep breathing and huffing; spontaneous coughing and mechanical vibration of affected segments in forward lean sitting compared with forward lean sitting alone; cycles of tidal volume breathing through positive expiratory pressure mask, assisted coughing and undisturbed breathing compared with assisted coughing alone; and intrapulmonary percussive ventilation compared with optimal medical care. The majority of participants were inpatients; two trials included patients in intensive care. All participants were treated with bronchodilator therapy; in four trials some patients received supplementary oxygen. The trial duration ranged from two days to approximately 9.4 days.

One reviewer selected the studies for review. A second reviewer was consulted if the eligibility of a study was unclear.

Assessment of study quality
The validity of the included trials was assessed using the PEDro scale. This ten item checklist assessed inclusion criteria, randomisation, allocation concealment, blinding, drop-outs, use of intention-to-treat analyses, comparability of groups at baseline, and use of between-groups analyses. The maximum score was 10 points.

Two reviewers independently performed the validity assessment, with disagreements resolved by discussion.

Data extraction
Data were extracted independently by two reviewers using a standard data extraction form.
Methods of synthesis
The trials were combined in a narrative synthesis and grouped according to the outcomes of resting lung function, sputum expectoration and clearance of inhaled radio-labelled particles, gas exchange, symptoms, need for and duration of non-invasive positive pressure ventilation and length of stay in hospital.

Results of the review
Five trials were included for review (n=173 patients). One trial scored 6 on the PEDro, one trial scored 5, two trials scored 4 and one trial scored 3. The median PEDro score was 4 points. Two trials reported sufficient detail to permit replication.

Resting lung function (two trials): One trial found that adding chest wall vibration to a regimen of spontaneous coughing did not result in a statistically significant improvement measured by forced expiratory volume in one second (FEV₁).

Another trial found that adding manual percussion to postural drainage, followed by breathing exercises and huffing, resulted in a statistically significant decrease of 7.3% (SD 6.5; p<0.1) in FEV₁.

Sputum expectoration and clearance of inhaled particles (four trials): Three trials found statistically significant positive effects of postural drainage combined with breathing exercises, chest wall vibration, percussion and intermittent positive pressure breathing (p<0.05), adding chest wall vibration to spontaneous coughing in a forward leaning position (p=0.04), and adding non-oscillating positive expiratory pressure via a face mask to assisted coughing (p<0.01) on sputum clearance. Adding percussion to postural drainage, breathing exercises and huffing did not improve clearance of inhaled radio-labelled particles.

Gas exchange (four trials): One trial reported a statistically significant increase in arterial oxygen saturation 30 minutes after chest wall vibration combined with spontaneous coughing in patients requiring supplemental oxygen (p=0.02) compared with spontaneous coughing only. Three other trials did not show statistically significant benefits of intrapulmonary percussive ventilation, positive expiratory pressure mask or manual percussion on gas exchange compared with control treatments.

Use of non-invasive positive pressure ventilation (two trials): Intrapulmonary percussive ventilation resulted in a statistically significant reduction in the need for non-invasive positive pressure ventilation compared with control treatment (p<0.05; one trial). Positive expiratory pressure mask resulted in a statistically significant reduction in the duration of non-invasive positive pressure ventilation (p<0.01; one trial).

Length of stay in hospital (two trials): Intrapulmonary percussive ventilation was associated with a statistically significant reduction in the length of stay in hospital compared with control groups (p<0.05; one trial). However, postural drainage, breathing exercises, chest wall vibration, percussion and intermittent positive pressure breathing were not associated with a statistically significant reduction in the length of stay in hospital compared with usual care (one trial).

Authors' conclusions
Airway clearance techniques other than continuous chest wall percussion were safe in patients with acute exacerbations of chronic obstructive pulmonary disease. Vibration and non-oscillating positive expiratory pressure facilitated sputum expectoration; techniques applying positive pressure to airways may reduce the use of non-invasive positive pressure ventilation and length of hospital stay in patients with respiratory failure.

CRD commentary
The review addressed a clear question with well-defined inclusion criteria. Several relevant databases were searched. The search was restricted to the English language and no attempts were made to identify unpublished data, so language and publication bias could not be ruled out. Appropriate steps were taken during the validity assessment and data extraction processes to minimise the risk of reviewer error and bias. However, there remained the possibility of error and bias in the process for study selection.

A suitable validity assessment was conducted, but the trials were of generally low quality. The decision to combine the trials in a narrative synthesis was appropriate, given the high levels of clinical heterogeneity between trials. However,
the authors only reported summary p-values, so the findings were difficult to interpret.

In light of the possibility of publication bias, the low quality of included trials and the small number of trials available, the reliability of the authors’ conclusions is unclear.

Implications of the review for practice and research

Practice: The authors stated that clinicians should take steps to minimise worsening airflow obstruction during chest wall percussion, use vibration or non-oscillating positive expiratory pressure in patients with high levels of airway secretions, and use techniques that place a positive pressure on airways in patients with respiratory failure.

Research: The authors did not state any implications for research.

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.