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Inhospital Physiotherapy for Acute Exacerbations of Chronic Obstructive Pulmonary Disease (AECOPD): A Rapid Review

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Conflict of Interest Statement

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Rapid Review Methodology

Clinical questions are developed by the Division of Evidence Development and Standards at Health Quality Ontario in consultation with experts, end-users, and/or applicants in the topic area. A systematic literature search is then conducted to identify relevant systematic reviews, health technology assessments, and meta-analyses; if none are located, the search is expanded to include randomized controlled trials (RCTs), and guidelines. Systematic reviews are evaluated using a rating scale developed for this purpose. If the systematic review has evaluated the included primary studies using the GRADE Working Group criteria (http://www.gradeworkinggroup.org/index.htm), the results are reported and the rapid review process is complete. If the systematic review has not evaluated the primary studies using GRADE, the primary studies included in the systematic review are retrieved and a maximum of two outcomes are graded. If no well-conducted systematic reviews are available, RCTs and/or guidelines are evaluated. Because rapid reviews are completed in very short timeframes, other publication types are not included. All rapid reviews are developed and finalized in consultation with experts.

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List of Abbreviations

AMSTAR	Assessment of Multiple Systematic Reviews
COPD	Chronic obstructive pulmonary disease
CI	Confidence interval(s)
FEV_1	Forced expiratory volume in 1 section
HQO	Health Quality Ontario
HRQOL	Health-related quality of life
MD	Mean difference
n	Sample size
NPPV	Noninvasive positive pressure ventilation
OR	Odds ratio
OHTAC	Ontario Health Technology Advisory Committee
PEP	Positive expiratory pressure
RCT	Randomized controlled trial
RR	Relative risk

Background

As legislated in Ontario's *Excellent Care for All Act*, Health Quality Ontario's mandate includes the provision of objective, evidence-informed advice about health care funding mechanisms, incentives, and opportunities to improve quality and efficiency in the health care system. As part of its Quality-Based Funding (QBF) initiative, Health Quality Ontario works with multidisciplinary expert panels (composed of leading clinicians, scientists, and administrators) to develop evidence-based practice recommendations and define episodes of care for selected disease areas or procedures. Health Quality Ontario's recommendations are intended to inform the Ministry of Health and Long-Term Care's Health System Funding Strategy.

For more information on Health Quality Ontario's Quality-Based Funding initiative, visit www.hqontario.ca.

Objective of Analysis

The objective of this rapid review is to evaluate the effectiveness and safety of inhospital physiotherapy for individuals with acute exacerbations of chronic obstructive pulmonary disease (COPD).

Clinical Need and Target Population

Chronic obstructive pulmonary disease is a disease state that is characterized by a limitation in airflow that is not fully reversible. This airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases. (1) The natural history of COPD involves periods of worsening symptoms known as acute exacerbations. There is some debate about the best definition for 'exacerbations.' A consensus definition developed by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) defines an acute exacerbation as "an event in the natural course of the disease characterized by a change in the patient's baseline dyspnea, cough, and/or sputum that is beyond normal day-to-day variations, is acute in onset, and may warrant a change in regular medication." (2) Patients may also experience a variety of other symptoms such as worsening exercise tolerance, fatigue, malaise, and decreased oxygen saturation. (3)

Two-thirds of COPD exacerbations are caused by an infection of the tracheobronchial tree or by air pollution. The cause is unknown in the remaining cases. (2;4) Risk factors for exacerbations include disease severity, winter months, and a previous exacerbation over the past 8 weeks. (3;5) The frequency of exacerbations seems to vary with disease severity. Using data from the Inhaled Steroids in Obstructive Lung Disease Study (ISOLDE Study), the European Respiratory Society Study on COPD, and the Copenhagen City Lung Study, Donaldson et al (3) found that patients with severe disease (GOLD category III) experienced an average of 3.43 exacerbations per year, whereas patients with moderate disease (GOLD category II) experienced an average of 2.68 exacerbations per year. (3)

Exacerbations have an important impact on patients and on the health care system. For patients, exacerbations result in decreased quality of life, potential permanent loss in lung function, and increased risk of mortality. For patients with severe exacerbations that require hospitalization, estimates of inpatient mortality range from 4% to 30%. Higher hospital mortality rates are observed for patients admitted with respiratory failure. Mortality following discharge is also high. Data from the United Kingdom shows a 14% mortality rate within 3 months of readmission, and data from the United States shows a 43% mortality rate after 12 months. (3) In addition, exacerbations of COPD are a leading cause of emergency

department visits and hospitalizations, particularly in winter. The health care burden associated with exacerbations is high—inpatient costs have been estimated to account for 70% of total health care costs for COPD treatment. (6;7)

Inhospital Physiotherapy

Individuals hospitalized with acute exacerbations of COPD may receive physiotherapy during their hospital stay. Physiotherapists may utilize a number of chest physiotherapy techniques for COPD patients aimed at improving lung function or facilitating the removal of airway secretions. (8)

Airway Clearance Techniques

Airway clearance techniques involve the application of external forces to enhance the removal of sputum (mucous secretions from the lungs) from the airway. (9;10) There are numerous airway clearance techniques, including conventional/traditional chest physiotherapy methods (e.g., postural drainage, percussion, and vibration), breathing exercises (e.g., the active cycle of breathing technique and autogenic drainage), hand-held positive expiratory pressure (PEP) devices (e.g., mask, mouthpiece or oscillatory PEP devices), and mechanical devices that are applied externally to the chest wall (e.g., high-frequency chest wall oscillation). (10-12)

Early Mobilization Programs

Acute exacerbations of COPD have a substantial impact on the individual. Studies have shown acute exacerbations negatively impact health-related quality of life (HRQOL), pulmonary function, and survival. (13) Studies have also shown decreased skeletal muscle strength and quadriceps muscle strength in those individuals hospitalized for an acute exacerbation. (13) A number of factors contribute to these findings, one of which is inactivity during the hospital stay, which may lead to muscle atrophy. (13;14) In addition, the reduced activity level and muscle strength may continue beyond discharge from hospital. (13) Pitta et al (13) showed that individuals with reduced activity levels 1 month after a hospital discharge for an acute exacerbation of COPD were more likely to be readmitted the following year, although this was a small, observational study. Therefore, early mobilization of individuals during their hospitalization has been proposed to help prevent the decline in muscle performance and activity levels.

Ontario Context

Harth et al (15) conducted a survey of physiotherapists at Canadian acute care hospitals with more than 250 beds to determine the current practice patterns of physiotherapists in the management of individuals hospitalized with acute exacerbations of COPD. Thirty-six Ontario hospitals responded (66.6% response rate), but as the paper does not provide the results by province, the aggregate results are presented here.

For those patients being treated in a hospital ward, more than 70% of respondents reported using the following treatment methods ‘always or frequently’ (defined as use 61% to 100% of the time): pursed lip breathing (72%), walking (78%), transfer training (75%), and bed mobility exercises (78%). Fifty-seven percent and 42% of respondents used lower and upper limb resistance exercises ‘always or frequently,’ respectively, while fewer than 50% of respondents used airway clearance techniques ‘always or frequently.’ (15)

In the intensive care setting, bed mobility and transfer training were used most commonly (68% and 57% of respondents used these techniques ‘always or frequently’), while less than 50% of respondents used airway clearance techniques ‘always or frequently’. (15) Of those using airway clearance techniques, vibration and facilitated coughing were used most frequently. (15)

Physiotherapists may include education as a part of the treatment they provide. The survey found that, among other topics, physiotherapists often provide education on breathing exercises, airway clearance techniques, and whole-body exercise. (15)

Rapid Review

Research Question

What is the effectiveness and safety of inhospital rehabilitation for individuals with acute exacerbations of COPD?

Research Methods

Literature Search

A literature search was performed on October 12, 2012, using OVID MEDLINE, OVID MEDLINE In-Process and Other Non-Indexed Citations, OVID EMBASE, EBSCO Cumulative Index to Nursing & Allied Health Literature (CINAHL), the Wiley Cochrane Library, and the Centre for Reviews and Dissemination database, for studies published from January 1, 2006, until October 12, 2012. Titles and abstracts were reviewed by a single reviewer and, for those studies meeting the eligibility criteria, full-text articles were obtained. Reference lists were also examined for any additional relevant studies not identified through the search.

Inclusion Criteria

- English language full-reports
- published between January 1, 2006, and October 12, 2012
- systematic reviews, health technology assessments, and meta-analyses
- analyses that compare the intervention with control group (no intervention or sham intervention)

Exclusion Criteria

- Analyses in which discrete results on individuals with acute exacerbations of COPD cannot be abstracted
- abstracts and conference proceedings
- duplicate publications (publications that have been superseded by newer analyses on the same topic or studies that report the same outcomes for the study population)
- analyses that compared different methods of inhospital physiotherapy
- studies examining pulmonary rehabilitation

Outcomes of Interest

- Hospital or intensive care unit length of stay
- Need for ventilation (invasive or noninvasive ventilation)
- Hospital readmissions
- Mortality
- HRQOL
- Lung function

- Gas exchange
- Symptoms
- Sputum clearance
- Functional capacity

Quality of Evidence

The Assessment of Multiple Systematic Reviews (AMSTAR) measurement tool was used to assess the methodological quality of systematic reviews. (16)

The quality of the body of evidence for each outcome was examined according to the GRADE Working Group criteria. (17) The overall quality was determined to be very low, low, moderate, or high using a step-wise, structural methodology.

Study design was the first consideration; the starting assumption was that randomized controlled trials are high quality, whereas observational studies are low quality. Five additional factors—risk of bias, inconsistency, indirectness, imprecision, and publication bias—were then taken into account. Limitations in these areas resulted in downgrading the quality of evidence. Finally, 3 main factors that may raise the quality of evidence were considered: large magnitude of effect, dose response gradient, and accounting for all residual confounding factors. (17) For more detailed information, please refer to the latest series of GRADE articles. (17)

As stated by the GRADE Working Group, the final quality score can be interpreted using the following definitions:

High	Very confident that the true effect lies close to the estimate of the effect
Moderate	Moderately confident in the effect estimate—the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Confidence in the effect estimate is limited—the true effect may be substantially different from the estimate of the effect
Very Low	Very little confidence in the effect estimate—the true effect is likely to be substantially different from the estimate of effect

Results of Literature Search

The database search yielded 255 citations published between January 1, 2006, and October 12, 2012 (with duplicates removed). Articles were excluded based on information in the title and abstract. The full texts of potentially relevant articles were obtained for further assessment. Figure 1 shows the breakdown of when and for what reason citations were excluded from the analysis.

Six studies (5 systematic reviews and one systematic review of reviews) met the inclusion criteria. The reference lists of the included studies and health technology assessment websites were hand searched to identify any additional potentially relevant studies, and no additional citations were identified.

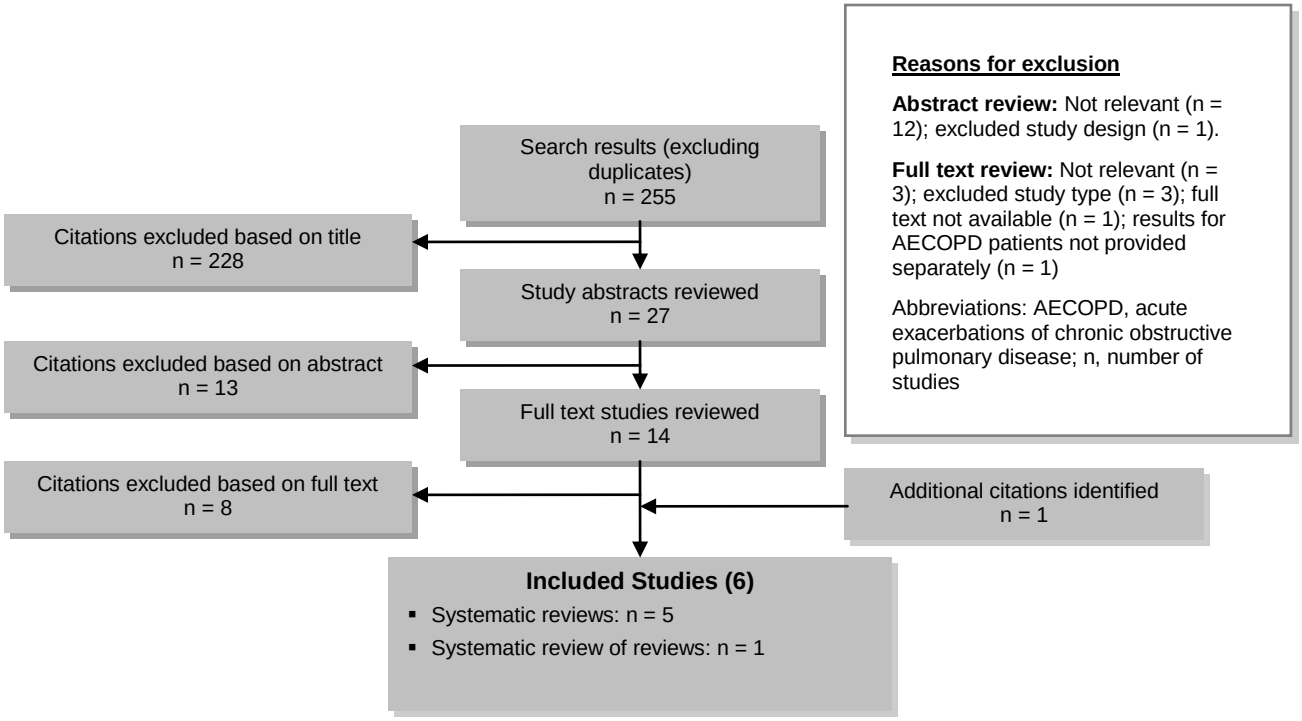

Figure 1: Citation Flow Chart

Nowobilski et al (18) conducted a systematic review of systematic reviews, narrative reviews, and clinical practice guidelines published between January 1, 2000, and July 1, 2010. Seven systematic reviews, 4 narrative reviews, and 4 clinical practice guidelines were included, as well as the direct examination of primary literature in this area. The summary of the evidence provided by Nowobilski et al (18) does not always clearly identify whether the population of interest is stable or acute exacerbations of COPD so it is challenging to extract meaningful conclusions on the acute exacerbation population of interest. Overall, Nowobilski et al (18) concludes that there is limited evidence to support the use of airway clearance techniques in individuals with COPD because the majority of the studies have serious methodological limitations and do not evaluate important outcomes such as hospital length of stay, health-related quality of life, and exercise capacity. (18)

Three of the systematic reviews identified focus specifically on inhospital physiotherapy for individuals with acute exacerbations of COPD, although the Cochrane Collaboration systematic review by Osadnik et al (10) also includes a separate analysis on the stable COPD population. (8;10;11) The systematic reviews by Osadnik et al (10) and Hill et al (11) evaluate airway clearance techniques while the systematic review by Tang et al (8) evaluates both airway clearance techniques and early mobilization programs.

Osadenik et al (10) included 9 studies: 7 randomized controlled trials (RCTs) and 2 randomized cross-over trials. There was substantial clinical heterogeneity across trials, including different methods of physiotherapy, use of cointerventions, different types of care provided to the control groups, different study designs (RCT versus cross-over), and different outcomes. However, whenever possible, the authors conducted meta-analyses. In addition to the pooled results, the authors also reported subgroups for those studies using positive expiratory pressure (PEP) airway clearance methods and those that used non-PEP methods. (10) Using the AMSTAR measurement tool to assess the methodological quality of the systematic review, Osadenik et al (19) had an overall score of 8 out of 11 (refer to Table A1 in Appendix 2 for more details).

Hill et al (11) included 5 studies: 3 RCTs and 2 randomized cross-over trials. There was substantial heterogeneity across these 5 trials in terms of the included population (where patients were recruited from and whether hypersecretive patients were targeted), outcomes assessed, and physiotherapy techniques used. As a result, Hill et al (11) did not pool the results of the studies, and presented by the type of physiotherapy technique. Using the AMSTAR measurement tool to assess the methodological quality of the systematic review, Hill et al (11) had an overall score of 4 out of 10[1] (refer to Table A1 in Appendix 2 for more details).

Tang et al (8) included 13 trials: 5 RCTs, 1 randomized parallel groups trial, 2 non-randomized clinical controlled trials, and 5 single group pre-post trials. Given the heterogeneity across studies in terms of physiotherapy techniques, Tang et al (8) reported the results by type of technique. Using the AMSTAR measurement tool to assess the methodological quality of the systematic review, Tang et al (8) had an overall score of 4 out of 10[1] (refer to Table A1 in Appendix 2 for more details).

If an included systematic review did not use GRADE to assess the quality of the body of evidence, the intention was to re-evaluate the quality of the primary literature using GRADE. Each of the 3 systematic reviews assessed the quality of evidence, however, only the review by Osadenik et al (10) used GRADE. Since it was not feasible to obtain the full text of all of the primary literature during the timelines of the rapid review, the evidence from Hill et al (11) and Tang et al (8) was not reassessed using GRADE. Instead, the authors' assessment of the evidence is provided.

Airway Clearance Techniques

Hospital Length of Stay

Osadenik et al (10) identified 3 studies that reported on hospital length of stay and found a statistically significant reduction in favour of physiotherapy when the 3 trials were pooled (mean difference [MD], −0.75 days; 95% confidence interval [CI], −1.38 to −0.11). However, this significant reduction was driven by the significant reduction (MD, −1.10 days; 95% CI, −1.89 to −0.31) found in 1 study in the PEP-subgroup which compared intrapulmonary percussive ventilation[2] used 3 times per day with a control group in acute exacerbation patients with mild respiratory acidosis.

Using GRADE to assess the quality of evidence, Osadenik et al (10) found the overall quality of evidence on hospital length of stay to be low quality.

Need for and Duration of Ventilatory Assistance

Osadenik et al (10) identified 4 studies that reported on the need for invasive or noninvasive ventilatory assistance. The results of the pooled analysis found a significant reduction in the need for increased ventilatory assistance (n, 171; odds ratio [OR], 0.21; 95% CI, 0.05–0.85). (10) However, the statistical significance of this reduction is only maintained in the PEP subgroup (PEP: OR, 0.11; 95% CI, 0.01–0.87; non-PEP: OR, 0.47; 95% CI, 0.07–3.36; test for subgroup difference, $P = 0.31$; $I^2 = 4.1\%$). (10) Hill et al (11) also identified the significant reduction in the need for increased ventilatory assistance based on 1 study, the larger of the 2 trials in the PEP subgroup. Of note, this trial was conducted in patients with mild respiratory acidosis. (11) Using GRADE to assess the quality of evidence, Osadenik et al (10) found the overall quality of evidence on the need for ventilator assistance to be low quality.

Similarly, Osadenik et al (10) identified 2 studies that examined the duration of use of noninvasive positive pressure ventilation (NPPV) and found a significant reduction in favour of the physiotherapy

[1] Maximum possible score was reduced to 10 because the question regarding the appropriateness of the methods used to combine the findings was not applicable to this systematic review as the studies were not pooled due to clinical heterogeneity across studies.

[2] Intrapulmonary percussive ventilation devices deliver high frequency short bursts of air through a face mask or mouthpiece to create an internal vibration within the patients' airways that helps to clear sputum. (11)

group (n = 54; MD, −2.05 days; 95% CI, −2.60 to −1.51). (10) This significant reduction was driven by 1 study in the PEP subgroup that compared positive expiratory pressure treatment delivered by mask plus assisted coughing with coughing alone in patients with copious secretions and hypercapnic respiratory failure, which was also reported by Hill et al (11). Using GRADE to assess the quality of evidence, Osadenik et al (10) found the overall quality of evidence on the duration of ventilator assistance to be of low quality.

Health-Related Quality of Life

Conflicting results were observed for HRQOL. Both Tang et al (8) and Osadenik et al (10) included 1 study that assessed HRQOL using the St. George's Respiratory Questionnaire. However, while Osadenik et al (10) reported no difference at discharge or 1-month follow-up, Tang et al (8) found a significant improvement in HRQOL when comparing incentive spirometry with usual care.

Lung Function

Percussion airway clearance techniques may have a short-term adverse effect on lung function measured by forced expiratory volume in 1 second (FEV_1). Tang et al (8) identified 2 studies which evaluated percussion methods which both reported statistically significantly short-term reductions in lung function measured by FEV_1 in the percussion group. (8) While Hill et al (11) also reported the results of 1 of these 2 studies, the authors noted that the method for administration of percussion was outdated and more current methods (short periods of percussion interspersed with periods of controlled/relaxed breathing) may prevent the decline in FEV_1. (11)

The impact of other airway clearance techniques on lung function reported by Hill et al (11) and Osadenik et al (10) were conflicting and varied by technique. Overall conclusions on this topic were not possible based on the information provided in the systematic reviews.

Sputum Clearance

Overall, the results on sputum clearance were mixed. Osadenik et al (10), Hill et al (11), and Tang et al (8) found that chest wall vibration and PEP-mask therapy were found to temporarily (for up to 1 hour) increase sputum expectoration in patients with copious secretions. However, in these 2 studies, the expectoration was assessed using the wet weight of sputum—a measure that is often inaccurate due to contamination by saliva—so it is difficult to conclude whether these results are meaningful. Both reviews also reported the results of studies (1 study in Hill et al (11) and 2 studies in Osadenik et al (10)) that measured sputum clearance using clearance of inhaled radiolabeled particles which did not find a significant difference in sputum clearance between the airway clearance and control groups. Osadenik et al (10) also reported no significant different in sputum volume between the groups in the 2 other studies that looked at short-term (24 hour) results.

Gas Exchange

Overall, the results on sputum clearance were mixed. While Osadenik et al (10) primarily reported negative findings, Hill et al (11) and Tang et al (8) both reported mixed results with no consistent impacts on gas exchange outcomes.

Breathlessness

Conflicting results were observed regarding breathlessness, but different methods of airway clearance were used in the 2 studies. Osadenik et al (10) identified a study that compared expiration with glottis open in lateral position with the control group that reported statistically and clinically significantly greater improvement in self-reported breathlessness using the Borg scale in the airway clearance group. Tang et al (8) identified a before-after study which found a significant worsening of breathlessness associated with deep diaphragmatic breathing.

Other Outcomes
Osadenik et al (10) reported a number of additional outcomes that were not included in the other systematic reviews. Overall, no statistically significant differences were observed between the airway clearance techniques and the control groups for the following outcomes:

- Future exacerbations (2 studies, n = 155)
- Need for hospitalizations due to respiratory causes (2 studies, n = 155)
- Time to exacerbation (1 study, n = 59)
- Time to hospitalization (1 study, n = 59)
- ICU length of stay (1 study, n = 35; MD, 0.64 days; 95% CI, −3.16 to 4.44)
- Short-term mortality (4 studies, n = 161; OR, 0.72; 95% CI, 0.14–3.80) (10)
- Long-term mortality (2 studies, n = 107; OR, 0.82; 95% CI, 0.26–2.63) (10)

Early Mobilization Programs
Tang et al (8) was the only systematic review that included an evaluation of early mobilization methods. One RCT and 1 randomized parallel groups trial were identified; however, the randomized parallel groups trial compared different walking programs using 2 different walking aids (gutter frame and rollator), rather than comparing a walking program with a control group. Based on the 1 RCT with 29 participants, compared with standard care, walking programs:

- Statistically significantly improved arterial blood gases
- Statistically significantly improved lung function measured by minute ventilation
- Statistically significantly reduced breathlessness measured by the Borg scale after exercise
- Statistically significantly improved exercise capacity measured by walking distance, lactic acid concentration, and oxygen uptake per body weight

Tang et al (8) evaluated the quality of evidence using the Physiotherapy Evidence Database (PEDro) scale which has a maximum of 10 possible points. The walking program RCT scored 5 out of 10, which exceeded Tang et al's (8) cut off of 4 to identify lower quality studies. However, according to their quality evaluation, the RCT had serious methodological limitations, including lack of allocation concealment, lack of blinding of subjects, therapists, or assessors, and not including all subjects in the analysis. (8) While some of these outcomes are objective, making lack of blinding less of a problem, these are still important methodological concerns. In addition, patients were enrolled in the study 6 to 8 days after admission to the hospital, once their exacerbation had stabilized, and then they were enrolled in a 10-day program. A 2008 Canadian study estimated that the average hospital length of stay for a severe exacerbation was 10 days. (20) Therefore, the generalizability of this intervention to the Ontario context is limited.

The remaining 2 systematic reviews examined airway clearance techniques for individuals with both stable and acute chronic obstructive pulmonary disease. (21;22) These reviews provide some limited results and conclusions for the acute exacerbation population. Given the limited focus on the population of interest, the quality of these 2 systematic reviews was not assessed using AMSTAR.

The systematic review by Ides et al (22) provides a summary of the results of 1 study comparing intrapulmonary percussive ventilation with a standard treatment control group in individuals with acute exacerbations of COPD and mild respiratory acidosis. The study found a significant decline in the number of exacerbations that worsened in the physiotherapy group compared with the control group, and a

corresponding significantly reduced hospital length of stay. (22) In addition, the study found significant improvements in gas exchange (increase in the partial pressure of oxygen in the arterial blood and decrease in the partial pressure of carbon dioxide in the arterial blood). (22) As a result, the study authors concluded that intrapulmonary percussive ventilation is safe for use in individuals with acute exacerbations of COPD. (22) This study was included in 3 systematic reviews reported above.

The systematic review by Langer et al (21) reported on 1 study that evaluated the effectiveness of daily resistance training in hospitalized patients with acute exacerbations of COPD. This study found that the training counteracted the decline in leg muscle force and did not cause any adverse effects. As a result of this study and other evidence which is not fully described, Langer et al (21) recommends that patients receive training strategies during an acute exacerbation hospitalization, so as to enable the patient to return to pulmonary rehabilitation as soon as possible. Resistance training, transcutaneous electrical neuromuscular stimulation, and interval training are identified by Langer et al (21) to be most appropriate for these patients. However, the evidence supporting these methods over others is not presented.

Conclusions

Airway clearance techniques

There is low quality evidence that certain airway clearance techniques have beneficial impacts on some outcomes, as described below:

- Airway clearance techniques that apply a positive pressure to the airways, such as intrapulmonary percussive ventilation and positive expiratory pressure (PEP), reduce the need for, and duration of, ventilation.
- Intrapulmonary percussive ventilation reduces the hospital length of stay in COPD patients with acute exacerbations of COPD and mild respiratory acidosis.
- Some airway clearance techniques may increase sputum expectoration, but the results of the supporting studies may be inaccurate given the method of measurement used.

Given the low quality of evidence, further research may change the estimate of effect.

Early mobilization programs

One systematic review identified 1 small RCT that assessed the effectiveness of walking programs compared to standard care. Although the study found statistically significant improvements for a number of patient outcomes, including exercise capacity and lung function for the walking program compared to standard care, the quality of evidence is poor and not generalizable to the Ontario context. However, the positive outcomes observed indicate that this may be a good area for future high-quality research.

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Appendices

Appendix 1: Literature Search Strategies

Search date: October 12, 2012
Databases searched: OVID MEDLINE, MEDLINE In-Process and Other Non-Indexed Citations, EMBASE; Cochrane Library; CRD; CINAHL

Q: Effectiveness and safety of physiotherapy for patients admitted to hospital for an acute exacerbation of COPD
Limits: 2006-current; English
Filters: health technology assessments, systematic reviews, and meta-analyses

Database: Ovid MEDLINE(R) <1946 to October Week 1 2012>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <October 10, 2012>, Embase <1980 to 2012 Week 40>

Search Strategy:

#	Searches	Results
1	exp Pulmonary Disease, Chronic Obstructive/ use mesz	19331
2	Chronic Obstructive Lung Disease/ use emez	61150
3	Chronic Bronchitis/ use emez	7321
4	(chronic adj2 obstructive adj2 (lung* or pulmonary or airway* or airflow or respiratory) adj (disease* or disorder*)).ti,ab.	61579
5	(copd or coad).ti,ab.	53256
6	chronic airflow obstruction.ti,ab.	1094
7	exp Emphysema/	39935
8	((chronic adj2 bronchitis) or emphysema).ti,ab.	53951
9	or/1-8	174206
10	Physical Therapy Modalities/ use mesz	26466
11	physiotherapy/ use emez	45913
12	physical medicine/	6076
13	exp kinesiotherapy/ use emez	41108
14	(physiotherap* adj2 chest).mp.	1481
15	exp Exercise Therapy/ use mesz	26442
16	Occupational Therapy/	28038
17	respiratory therapy/ use mesz	5511
18	Breathing Exercises/ use mesz or breathing exercise/ use emez	6402
19	Drainage, Postural/ use mesz or Postural Drainage/ use emez	670
20	Percussion/	2415
21	exp Vibration/	60103
22	Intermittent Positive-Pressure Ventilation/	4345
23	Early Ambulation/ use mesz	1796
24	mobilization/ use emez	14664
25	(active cycle adj2 breath*).mp.	100
26	((lung or pulmonary) adj2 hygien*).mp.	163

27	autogenic drainage*.mp.	88
28	incentive spirometr*.mp.	409
29	acapella*.mp.	51
30	((airway or secretion or sputum) adj clearance technique*).mp.	234
31	(sputum adj2 (clear* or mobili*)).mp.	297
32	airway clearance*.mp. use emez	669
33	((continuous or oscillating) adj2 positive expiratory pressure*).mp.	44
34	thoracic expansion exercise*.mp.	17
35	((physio* or therap*) adj2 (percussion or humidification)).mp.	365
36	(walk* adj2 (therap* or program*)).mp.	2964
37	((accelerat* or earl*) adj (ambulation or mobilisation or mobilization or recover*)).mp.	15136
38	((physical or respiratory) adj (therap* or physiotherap*)).mp.	60662
39	((physical* adj (therap* or train*)) or (train* adj (aerobic* or resistance or strength*)) or exercise* or kinesiotherap* or physiotherap* or physio-therap*).ti,ab.	447901
40	or/10-39	648081
41	9 and 40	13759
42	Meta Analysis.pt.	36957
43	Meta Analysis/ use emez	66280
44	Systematic Review/ use emez	53571
45	exp Technology Assessment, Biomedical/ use mesz	8872
46	Biomedical Technology Assessment/ use emez	11395
47	(meta analy* or metaanaly* or pooled analysis or (systematic* adj2 review*) or published studies or published literature or medline or embase or data synthesis or data extraction or cochrane).ti,ab.	292262
48	((health technolog* or biomedical technolog*) adj2 assess*).ti,ab.	3668
49	or/42-48	352098
50	41 and 49	489
51	limit 50 to english language	454
52	limit 51 to yr="2006 -Current"	285
53	remove duplicates from 52	185
54	from 53 keep 1-185	185

Cochrane Library

ID	Search	Hits
#1	MeSH descriptor: [Pulmonary Disease, Chronic Obstructive] explode all trees	1838
#2	chronic near/2 obstructive near/2 (lung* or pulmonary or airway* or airflow or respiratory) next (disease* or disorder*):ti,ab,kw OR copd or coad:ti,ab,kw OR chronic airflow obstruction:ti,ab,kw	7234
#3	MeSH descriptor: [Emphysema] explode all trees	92
#4	(chronic near/2 bronchitis) or emphysema:ti,ab,kw	1932
#5	#1 or #2 or #3 or #4	8822
#6	MeSH descriptor: [Physical Therapy Modalities] this term only	2216
#7	MeSH descriptor: [Drainage, Postural] this term only	52
#8	MeSH descriptor: [Exercise Therapy] explode all trees	5384
#9	MeSH descriptor: [Percussion] this term only	47
#10	MeSH descriptor: [Vibration] this term only	559
#11	MeSH descriptor: [Intermittent Positive-Pressure Ventilation] this term only	178
#12	MeSH descriptor: [Breathing Exercises] this term only	444
#13	MeSH descriptor: [Occupational Therapy] this term only	452
#14	MeSH descriptor: [Respiratory Therapy] this term only	447
#15	MeSH descriptor: [Physical Medicine] this term only	15
#16	MeSH descriptor: [Early Ambulation] this term only	258
#17	(physiotherap* near/2 chest) or (active cycle near/2 breath*) or ((lung or pulmonary) near/2 hygien*) or autogenic drainage* or incentive spirometr* or acapella* or ((airway or secretion or sputum) adj clearance technique*) or (sputum near/2 (clear* or mobili*)) or ((continuous or oscillating) near/2 positive expiratory pressure*) or thoracic expansion exercise* or ((physio* or therap*) near/2 (percussion or humidification)) or (walk* near/2 (therap* or program*)) or ((accelerat* or earl*) near (ambulation or mobilisation or mobilization or recover*)) or ((physical or respiratory) near (therap* or physiotherap*)) or ((physical* near (therap* or train*)) or (train* near (aerobic* or resistance or strength*)) or exercise* or kinesiotherap* or physiotherap* or physio-therap*):ti	32046
#18	#6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17	34682
#19	#5 and #18 from 2006 to 2012	665
#20	MeSH descriptor: [Meta-Analysis] explode all trees	75
#21	MeSH descriptor: [Technology Assessment, Biomedical] explode all trees	523
#22	meta analysis:pt	477
#23	(meta analy* or metaanaly* or pooled analysis or (systematic* near/2 review*) or published studies or published literature or medline or embase or data synthesis or data extraction or cochrane):ti,ab	34059
#24	((health technolog* or biomedical technolog*) near/2 assess*):ti,ab	638
#25	#20 or #21 or #22 or #23 or #24	34960
#26	#19 and #25	67

CRD

Line	Search	Hits
1	MeSH DESCRIPTOR Pulmonary Disease, Chronic Obstructive EXPLODE ALL TREES	298
2	(chronic adj2 obstructive adj2 (lung* OR pulmonary OR airway* OR airflow OR respiratory) adj (disease* OR disorder*)):TI OR (copd OR coad):TI OR (chronic airflow obstruction):TI	249
3	MeSH DESCRIPTOR Emphysema EXPLODE ALL TREES	19
4	((chronic adj2 bronchitis) OR emphysema):TI	51
5	#1 OR #2 OR #3 OR #4	386
6	MeSH DESCRIPTOR physical therapy modalities	365
7	MeSH DESCRIPTOR drainage, postural	3
8	MeSH DESCRIPTOR exercise therapy EXPLODE ALL TREES	613
9	MeSH DESCRIPTOR percussion	1
10	MeSH DESCRIPTOR vibration	18
11	MeSH DESCRIPTOR intermittent positive-pressure ventilation	4
12	MeSH DESCRIPTOR breathing exercises	43
13	MeSH DESCRIPTOR occupational therapy	67
14	MeSH DESCRIPTOR respiratory therapy	38
15	MeSH DESCRIPTOR physical medicine	3
16	MeSH DESCRIPTOR early ambulation	22
17	((physiotherap* near2 chest) or (active cycle near2 breath*) or ((lung or pulmonary) near2 hygien*) or autogenic drainage* or incentive spirometr* or acapella* or ((airway or secretion or sputum) adj clearance technique*) or (sputum near2 (clear* or mobili*)) or ((continuous or oscillating) near2 positive expiratory pressure*) or thoracic expansion exercise* or ((physio* or therap*) near2 (percussion or humidification)) or (walk* near2 (therap* or program*)) or ((accelerat* or earl*) near (ambulation or mobilisation or mobilization or recover*)) or ((physical or respiratory) near (therap* or physiotherap*)) or ((physical* near (therap* or train*)) or (train* near (aerobic* or resistance or strength*)) or exercise* or kinesiotherap* or physiotherap* or physio-therap*)):TI	862
18	#6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17	1438
19	#5 AND #18	44
20	(#19):TI FROM 2006 TO 2012	30

CINAHL

#	Query	Limiters/Expanders	Results
S41	S36 and S39	Limiters - Published Date from: 20060101-20131231; English Language Search modes - Boolean/Phrase	69
S40	S36 and S39	Search modes - Boolean/Phrase	122
S39	S37 or S38	Search modes - Boolean/Phrase	48114
S38	(health technology N2 assess*) or meta analy* or metaanaly* or	Search modes - Boolean/Phrase	48114

	pooled analysis or (systematic* N2 review*) or published studies or medline or embase or data synthesis or data extraction or cochrane		
S37	(MH "Meta Analysis") or (MH "Systematic Review")	Search modes - Boolean/Phrase	21033
S36	S6 and S35	Search modes - Boolean/Phrase	1859
S35	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34	Search modes - Boolean/Phrase	144578
S34	(physical* N1 (therap* or train*)) or (train* N1 (aerobic* or resistance or strength*)) or exercise* or kinesiotherap* or physio-therap*	Search modes - Boolean/Phrase	104370
S33	(physical or respiratory) N1 (therap* or physiotherap*)	Search modes - Boolean/Phrase	41254
S32	(accelerat* or earl*) N1 (ambulation or mobilisation or mobilization or recover*)	Search modes - Boolean/Phrase	1277
S31	walk* N2 (therap* OR program*)	Search modes - Boolean/Phrase	492
S30	(physio* or therap*) N2 (percussion or humidification)	Search modes - Boolean/Phrase	26
S29	thoracic expansion exercise*	Search modes - Boolean/Phrase	10
S28	((continuous or oscillating) N2 positive expiratory pressure*)	Search modes - Boolean/Phrase	7
S27	airway clearance*	Search modes - Boolean/Phrase	272
S26	sputum N2 (clear* or mobili*)	Search modes - Boolean/Phrase	28
S25	(active cycle N2 breath*)	Search modes - Boolean/Phrase	26
S24	((airway OR secretion OR sputum) N clearance technique*)	Search modes - SmartText Searching	557
S23	acapella*	Search modes - Boolean/Phrase	9
S22	incentive spirometr*	Search modes - Boolean/Phrase	79
S21	autogenic drainage*	Search modes - Boolean/Phrase	13
S20	pulmonary hygiene	Search modes - Boolean/Phrase	14
S19	lung hygiene	Search modes - SmartText Searching	73
S18	(MH "Early Ambulation")	Search modes - Boolean/Phrase	281
S17	(MH "Intermittent Positive Pressure Ventilation")	Search modes - Boolean/Phrase	272
S16	(MH "Vibration")	Search modes - Boolean/Phrase	1373
S15	(MH "Percussion")	Search modes - Boolean/Phrase	188
S14	(MH "Drainage, Postural")	Search modes - Boolean/Phrase	90
S13	(MH "Breathing Exercises+")	Search modes - Boolean/Phrase	958
S12	(MH "Respiratory Therapy")	Search modes - Boolean/Phrase	2444
S11	(MH "Occupational Therapy")	Search modes - Boolean/Phrase	10349
S10	(MH "Therapeutic Exercise+")	Search modes - Boolean/Phrase	24536
S9	(MH "Physical Medicine")	Search modes - Boolean/Phrase	802
S8	(MH "Chest Physical Therapy+")	Search modes - Boolean/Phrase	483
S7	(MH "Physical Therapy+")	Search modes - Boolean/Phrase	60743
S6	S1 or S2 or S3 or S5	Search modes - Boolean/Phrase	9484

S5	chronic bronchitis or emphysema	Search modes - Boolean/Phrase	1880
S4	(MH "Emphysema+")	Search modes - Boolean/Phrase	1189
S3	copd or coad	Search modes - Boolean/Phrase	5022
S2	(chronic obstructive and (lung* or pulmonary or airway* or airflow or respiratory) and (disease* or disorder*))	Search modes - Boolean/Phrase	7495
S1	(MH "Pulmonary Disease, Chronic Obstructive+")	Search modes - Boolean/Phrase	6022

Appendix 2: AMSTAR Checklist

Table A1: Results of Assessment of Systematic Review Quality Using AMSTAR

Question	Score and Details		
	Hill et al (11)	Osadenik et al (10)	Tang et al (8)
1. Was an a priori design provided?	1 (yes)	1 (yes)	1 (yes)
2. Was there duplicate study selection and data extraction?	0 (no): duplicate data extraction was conducted, but not for study selection	1 (yes)	0 (no): duplicate study extraction was conducted, but it is not specified whether duplicate study selection was utilized
3. Was a comprehensive literature search performed?	0 (no): literature search was not supplemented by grey literature and contacting experts	1 (yes)	0 (no): literature search was not supplemented by grey literature and contacting experts
4. Was the status of publication (i.e., grey literature) used as an inclusion criteria?	1 (yes)	1 (yes)	0 (can't answer): no information was provided in the publication regarding any restrictions on language, grey literature, etc
5. Was a list of the studies (included and excluded) provided?	0 (no): a list of excluded studies was not included	1 (yes)	0 (no): a list of excluded studies was not included
6. Were the characteristics of the included studies provided?	1 (yes)	1 (yes)	1 (yes)
7. Was the scientific quality of the included studies assessed and documented?	1 (yes)	1 (yes)	1 (yes)
8. Was the scientific quality of the included studies used appropriately in formulating conclusions?	1 (yes)	1 (yes): quality of evidence was considered in sensitivity analyses	1 (yes)
9. Were the methods used to combine the findings of the studies appropriate?	n/a: studies were not combined due to clinical heterogeneity	0 (no): there is substantial clinical heterogeneity across trials, particularly relating to the type of intervention used, so it is difficult to draw conclusions from the results. Often, 1 study drove significant results	n/a: studies were not combined due to clinical heterogeneity

10. Was the likelihood of publication bias assessed?	0 (no): assessment of publication bias was not reported	0 (no): while the methods included assessment of publication bias, the authors noted that this was not possible due to the small number of studies	0 (no): assessment of publication bias was not reported
11. Was the conflict of interest stated?	0 (no): conflict of interest statements were included for the authors of the systematic review but not for the authors of the individual studies included in the review	0 (no): conflict of interest statements were included for the authors of the systematic review but not for the authors of the individual studies included in the review	0 (no): conflict of interest statements were included for the authors of the systematic review but not for the authors of the individual studies included in the review
TOTAL SCORE	**4 out of 10[a]**	**8 out of 11**	**4 out of 10[a]**

[a]Maximum possible score was reduced to 10 because the question regarding the appropriateness of the methods used to combine the findings was not applicable to this systematic review as the studies were not pooled due to clinical heterogeneity across studies.

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