Airway clearance techniques for people with acute exacerbation of COPD: a scoping review

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In research and clinical practice, airway clearance techniques for acute exacerbations of COPD vary greatly across countries. Clear guidelines and decision-making factors are lacking, highlighting the crucial need for dedicated research on this topic. https://bit.ly/494IPFH

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Abstract

Introduction Acute exacerbations of COPD (AECOPD) often involve mucus hypersecretion. Thus, management of sputum retention is critical. However, the use of airway clearance techniques (ACTs) in people with AECOPD across different healthcare settings and factors influencing their selection remain unclear.

Objective To identify and map ACTs used for AECOPD in different healthcare settings and the factors influencing clinical decision-making worldwide.

Methods Four electronic databases and grey literature were searched from 1995 to December 2023, with hand-searching of eligible records. The Joanna Briggs Institute methodology for scoping reviews was followed.

Results 25 articles were included: 14 clinical studies, five guidelines/statements and six surveys/audits. Clinical studies reported the use of a wide range of single or combined ACTs, with no clear pattern in using particular ACTs in different parts of the world. Recent guidelines advise using ACTs for certain patients with AECOPD, particularly those with hypersecretion, with most guidelines recommending positive expiratory pressure (PEP) therapy. According to surveys, the most used ACTs in Australia and Europe are active cycle of breathing techniques, PEP or forced expiratory technique, while vibrations are most frequently used in Canada. Factors influencing the selection of specific ACTs include the presence of contraindications, level of dyspnoea, access to resources/equipment and ease of learning/performing the technique. All information was derived from hospital settings.

Conclusions This scoping review identified and mapped ACTs used for people with AECOPD worldwide and their decision-making factors. Future work should focus on community settings.

Introduction

COPD is a common respiratory disease characterised by persistent airflow obstruction and chronic respiratory symptoms [1]. The estimated global prevalence of COPD is greater than 10%, affecting more than 384 million people worldwide [2]. COPD is associated with high morbidity, mortality and healthcare costs, which are anticipated to rise as the world's population ages [3]. Importantly, the majority of this burden is derived from acute exacerbations of COPD (AECOPD) [4].

The management of bronchial secretions is a significant challenge encountered by individuals with COPD [5, 6]. These people commonly experience mucus hypersecretion and airway mucus plugs, which worsen dyspnoea, accelerate forced expiratory volume in 1 s decline and increase the risk of exacerbations and mortality [7, 8]. These clinical issues aggravate during AECOPD as exacerbations are defined as "events characterized by dyspnoea and/or cough and sputum that worsen over ⩽14 days, which may be accompanied by tachypnoea and/or tachycardia and often associated with increased local and systemic inflammation caused by airway infection, pollution, or other insult to the airways" [9, 10]. Prompt management of sputum retention during AECOPD is a common therapeutic goal that can be addressed *via* targeted strategies such as airway clearance techniques (ACTs), however uncertainty remains regarding the precise role that ACTs play during both stable COPD and AECOPD [11] and the resultant impact of heightened sputum production during exacerbations on outcomes, such as treatment failure. ACTs refer to strategies specifically developed to enhance airway clearance and improve the management of sputum-related symptoms [12]. Various techniques have been developed and are used by people with COPD, such as techniques that patients can perform independently, with assistance or by using devices [13, 14]. Systematic reviews have found that ACTs, with the exception of chest percussion, are safe and effective for enhancing sputum expectoration in patients with AECOPD [15, 16]. However, it is unclear which specific ACTs are used worldwide, as this may differ between healthcare settings and countries [17]. To fully understand all available ACTs for people with AECOPD and the factors influencing clinical decision-making, a scoping methodology is appropriate [18]. This can assist healthcare professionals in selecting optimal ACTs and lay a foundation for the development of future clinical recommendations.

The main objective of this scoping review was to identify and map ACTs investigated in research for people with AECOPD. Any healthcare setting (*i.e.*, hospital, home or community) was considered, as management depends on the severity of an exacerbation, which can be handled in either outpatient or inpatient settings [19]. The secondary objectives were to identify the existing local recommendations and current guidelines for the use of ACTs for people with AECOPD, map ACTs used clinically for people with AECOPD per country and healthcare context and identify the factors that influence the selection of ACTs in clinical practice and research.

Methods

The scoping review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-ScR) extension for scoping reviews [20, 21]. The protocol was registered on Open Science Frameworks from the Center for Open Science prior to title and abstract screening.

Search strategy

The scoping review aimed to address the following research questions: 1) which ACTs have been used in research studies for people with AECOPD across any healthcare settings (*e.g.*, inpatient, outpatient, home and community)?; 2) what are the recommendations of current local, national and international guidelines for the use of ACTs in people with AECOPD?; 3) which ACTs are clinically used in the management of people with AECOPD and are there any patterns according to geographical location?; 4) what factors do healthcare professionals consider when they decide which ACT to use? In accordance with these questions, the search strategy was developed by the researchers and a university librarian following the "PCC" (population, concepts, context) framework [21] to locate clinical trials, guidelines, audits and surveys meeting our eligibility criteria.

An initial limited search of the JBI Evidence-Based Practice Database and PubMed was conducted (by C.S.) to identify relevant articles, using free-text words, keywords and MeSH (Medical Subject Heading) terms found in article titles and abstracts. The search strategy was validated using four articles that met the review eligibility criteria and were identified beforehand by the researchers [22–25]. Four databases were searched from 1995 to December 2023, as follows: Medline (PubMed), Embase, CINAHL and Scopus. The full search strategy was adapted to each selected database, using a combination of subject headings and keywords to search titles and abstracts (supplementary material). In addition, reference lists of relevant articles were hand-searched to expand the search. Grey literature was also searched from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) report 2023 and position statements and other practice guidance related to ACTs from national and international physiotherapy association websites. Literature for this review were eligible if published in any of eight languages (English, Portuguese, Danish, Norwegian, Swedish, Spanish, French and Greek). Finally, to ensure inclusion of all relevant studies, unpublished and ongoing research was identified through regular searches on ClinicalTrials.gov and the International Clinical Trials Registry Platform, allowing for the timely addition of newly eligible studies to our scoping review.

Eligibility criteria

Population

Studies on the use of ACTs in adults (⩾18 years old) with AECOPD were considered. Studies investigating the use of ACT in intensive care unit due to severe AECOPD or those in palliative care were excluded. Studies including participants with diseases other than AECOPD were excluded unless the results for patients with AECOPD were reported separately.

Concept

Studies that investigated any or multiple ACTs, *i.e.*, physical strategies specifically developed to promote the mobilisation and removal of excess mucus from the airways and alleviate symptoms associated with mucus retention, were examined. Techniques with different primary objectives, including exercise, respiratory muscle training, breathing pattern retraining and noninvasive ventilation, were excluded. Cough manoeuvres, the physiological mechanism for expectorating sputum, were not considered as an individual ACT, since they are frequently used as a control treatment arm in trials. Studies that used ACTs embedded in other interventions, such as pulmonary rehabilitation, were excluded. Additionally, humidification and pharmacological approaches, such as hypertonic saline, normal saline and mucoactive agents, were excluded [12].

Context

This review encompassed studies that examined the delivery of ACTs in both institutional and noninstitutional settings, *i.e.*, homes and communities, to ensure a comprehensive scope. Examples of relevant settings include hospital inpatient services, outpatient clinics, community services and homecare. The studies included in this review were not restricted based on the location, cultural background or race. Studies published prior to 1995 were excluded due to their potential to be outdated compared to modern clinical practice.

Types of sources

Quantitative, qualitative and mixed-methods study designs, as well as clinical guidelines, audits and surveys on the use of ACTs, were considered for inclusion. Conference abstracts were not included. During the title and abstract screening, individual studies from included systematic reviews were screened for eligibility, yet systematic reviews were excluded from data extraction to avoid duplication of data. For clinical guidelines or position statements, only the most recent version was included.

Study/source of evidence selection

All retrieved records were imported into Covidence (Veritas Health Innovation, Melbourne, Australia), where duplicates were removed. Title and abstracts were screened independently against the inclusion criteria, in pairs, by five investigators (C.S., I.M., S.Y., A.O. and A.S.). To ensure understanding of eligibility criteria and diminish disagreements, a pilot test with 25 articles was conducted. Agreement between reviewers ⩾75% was sought before proceeding with screening [21]. Four reviewers (W.P., L.G., P.C. and C.S.) assessed the full-text reports against the inclusion criteria and those that met them underwent data extraction and analysis. In each screening phase, citations achieving agreement for inclusion by the independent reviewers were included. Disagreements between reviewers were resolved through discussion or by another reviewer (A.S.).

Data extraction

Two independent reviewers (A.O. and B.H.-C.) extracted data from the included papers using a data extraction tool adapted from Peters *et al.* [21]. The tool addressed the review objectives and study design. The extracted data included specifics about the population, concept, context, methods and key outcomes relevant to the scoping review questions. The main results summarising each study's findings were also extracted. To ensure consistency in data extraction and identify any amendments needed in the data extraction tool, both reviewers extracted data from the first three reports. Any disagreements between the reviewers were resolved through discussion or by another reviewer (A.S.). The extracted data were reported in a narrative summary, as answers to our research questions, and key findings were presented in a table format.

Deviations from the initial protocol

Originally, the review intended to include all literature on ACTs in COPD. The scope of the review was then narrowed to focus solely on AECOPD, to allow for a more detailed and manageable analysis, given the extensive volume of research available on ACTs in COPD. Furthermore, we initially intended to include reviews in data selection. We finally excluded these reviews as it duplicated the report of ACT trials.

Results

Studies identified

The literature search identified a total of 19 142 records, including four records that were retrieved by hand-searches of relevant sources. After removing duplicates and applying the eligibility criteria, 147 articles were selected for a full-text screening, of which 25 articles were included in this review, namely 14 clinical studies (58%) [24–37], five guidelines or statements (17%) [38–42] and six audits or surveys (25%) [22, 23, 43–46]. Detailed results are reported in a PRISMA-ScR flow diagram (figure 1) [47, 48].

Overview of the included studies

Clinical studies

The characteristics of the clinical studies included are presented in table 1. Studies were published between 2000 and 2022 and were conducted in Italy (n=2), India (n=2), Indonesia (n=2), the UK (n=1), Turkey (n=1), Australia (n=1), Taiwan (n=1), New Zealand (n=1), Pakistan (n=1), the USA (n=1) and China (n=1) (figure 2); all in hospital settings. The clinical studies primarily consisted of randomised controlled trials (n=11) [24–34]. One of those studies was divided in two parts, the second part being a retrospective cohort study [34]. Other clinical studies included one randomised crossover trial [35], one quasi-experimental study [36] and one case report [37].

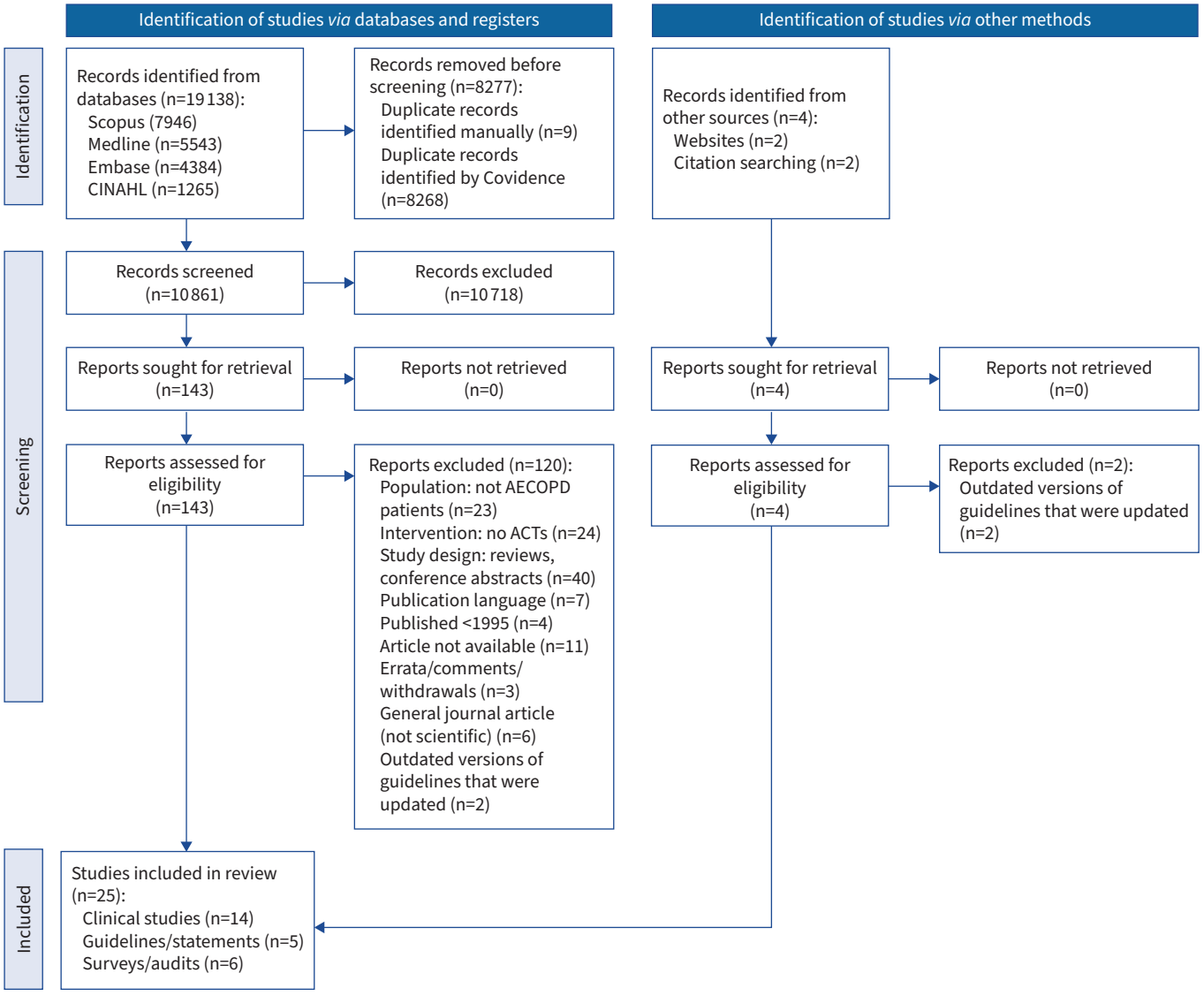

FIGURE 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) scoping review flow diagram. ACT: airway clearance technique; AECOPD: acute exacerbation of chronic obstructive pulmonary disease; CINAHL: Cumulated Index in Nursing and Allied Health Literature.

TABLE 1 Summary of clinical studies assessing the effectiveness of airway clearance techniques (ACTs) in people with an acute exacerbation of COPD (AECOPD)

Study, year, country	Study design	GOLD groups/ grades	Sample size (% of males)	Age mean±SD, years	Sputum burden threshold in eligibility criteria	ACT applied and equipment used (if relevant)	Duration, frequency and length of intervention	Outcomes	Summary
Bellone [35], 2000, Italy	RXT	NR	10 (100)	57.5±6.0	Patients known to produce >30 mL of sputum per day	In randomised order: PD +manual percussion; OPEP (Flutter); ELTGOL	30 min, once daily, 1 day	Sputum production Lung function Saturation	PD+manual percussion, Flutter and ELTGOL are effective in acutely removing secretions without affecting oxygen saturation and lung function in patients with AECOPD Flutter and ELTGOL are more effective than PD in prolonging the secretion removal effect
Kodric [24], 2009, Italy	RCT	NR	EG: 30 (67) CG: 29 (72)	EG: 71.3±8.4 CG: 69.1±8.3	NR	EG: ELTGOL CG: no ACT	EG: 30–40 min, twice daily, 7 days	Sputum production Lung function Saturation Dyspnoea HRQoL Exacerbation frequency	ELTGOL was well tolerated and improved dyspnoea at discharge compared to CG The ELTGOL technique has a limited role in patients with mild exacerbation of moderate to severe COPD with a tendency towards fewer exacerbations and hospitalisations
Babu [26], 2010, India	RCT	NR	EG: 19 (74) CG: 19 (68)	EG: 65±15.9 CG: 58±13.3	NR	EG: PT (positioning#, breathing control, ACBT, huffing or assisted coughing) +on-call PT services CG: PT only	EG: NR, twice daily +on call as needed, NR CG: NR, twice per day, NR	Lung function Dyspnoea Exercise capacity LoS	On-call PT has short-term (at discharge: 4–5 days) improvements in 6-min walk distance, peak expiratory flow rates, maximal inspiration and dyspnoea
Cross [27], 2010, UK	RCT	NR	EG: 258 (55) CG: 264 (59)	EG: 69.1±9.9 CG: 69.6±9.5	Evidence of sputum production on examination	EG: Positioning#+PD +percussion/vibration+ACBT +advice on positioning CG: Advice on positioning +ACBT	EG: At the discretion of the PT and varied according to clinical need: 11.9 min per session, 2.5 sessions per patient CG: NR	HRQoL Symptoms (BCSS) Sputum production LoS Hospital readmission Exercise capacity Cost-effectiveness Outcomes related to ACTs	EG did not improve HRQoL compared to CG This does not mean that manual chest physiotherapy (*i.e.* EG) is of no therapeutic value to patients with COPD in specific circumstances Although the cost-effectiveness analysis suggested that its use was cost-effective, much uncertainty was associated with this finding and it would be difficult to justify providing manual chest physiotherapy on the basis of cost-effectiveness alone
Richa [28], 2010, India	RCT	NR	All groups: 45 (100) NR per group	NR	NR	EG1: ACBT EG2: OPEP (Flutter) CG: PLB	All groups: 15 min, twice daily, until hospital discharge	Lung function Saturation Vital signs (respiratory rate) LoS	Flutter is as effective as the ACBT in improving oxygen saturation without causing any undesirable effects on respiratory rate in patients with acute exacerbation of COPD These techniques can be used in COPD exacerbation according to patient and PT preferences
Goktalay [29], 2013, Turkey	RCT	GOLD 3 and 4	Total sample: 50 (98) EG: 25 (NR) CG: 25 (NR)	EG: 63.6±8.0 CG: 66.5±6.6	NR	EG: HFCWO CG: no ACT	EG: 20 min, three times daily, 5 days	HRQoL BODE index Arterial blood gases LoS	No additional advantages of HFCWO therapy on infective exacerbations in COPD

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TABLE 1 Continued

Study, year, country	Study design	GOLD groups/ grades	Sample size (% of males)	Age mean±SD, years	Sputum burden threshold in eligibility criteria	ACT applied and equipment used (if relevant)	Duration, frequency and length of intervention	Outcomes	Summary
Osadnik [25], 2014, Australia	RCT	NR	EG: 45; (62) CG: 45; (67)	EG: 69.5±9.8 CG: 67.8±11.6	Evidence of sputum expectoration or history of chronic sputum production ("regularly expectorated sputum on most days")	EG: PEP CG: no ACT	EG: 20 min, three times daily, until hospital discharge or until 24 h without sputum production	Symptoms (BCSS) HRQoL LoS Need for ventilatory support BODE index Exacerbation frequency Mortality	Compared to usual care and physical exercise, additive PEP therapy demonstrated minimal benefit in terms of short- and long-term outcomes relevant to patients and healthcare providers
Liao [30], 2015, Taiwan	RCT	NR	EG: 30 (53) CG: 31 (68)	EG: 68 (range 44–89) CG: 70 (range 52–91)	NR	EG: PD+percussion using a vibrating device+PLB CG: no ACT	EG: 30 min percussion-vibration+10 min PLB, twice daily, 4 days	Dyspnoea Cough Exercise capacity Sputum production	Rehabilitation including ACTs reduced symptoms and improved exercise capacity and self-reported sputum clearance in elderly inpatients with AECOPD
Eastwood [31], 2016, New Zealand	RCT	NR	Group 1: 4 (100) Group 2: 4 (75) Group 3: 2 (100)	Group 1: 73±9 Group 2: 74±16 Group 3: 78±11	Exacerbation with reported sputum	G1: ACBT G2: thera-PEP G3: bubble-PEP	All groups: three cycles of 10–12 breaths, three time daily, 1 day	Lung function Symptoms (BCSS) HRQoL Satisfaction Ability to perform ACT LoS	ACBT and bubble-PEP are the most feasible options for secretion clearance interventions in hospital and community settings
Basri [32], 2017, Pakistan	RCT	NR	EG: 30 (60) CG: 30 (43)	EG: 55±3.8 CG: 53±3.7	Patients with pronounced symptoms of sputum retention with coughing	EG: ACBT CG: no ACT	EG: 30–40 min, NR, 2 weeks	Lung function Dyspnoea Saturation	Chest physiotherapy is more effective in improving breathlessness level, oxygen saturation and peak expiratory flow rates in AECOPD along with standard medical treatment than medical treatment alone
Milan [34] (part 1), 2019, USA	RCT	NR	EG: 47 (38) CG¶: 44 (34)	EG: 65.9±12.2 CG¶: 61.8±10.6	Subjective sputum production of >one tablespoon (15 mL) per day for a minimum of 2 days	EG: OPEP (Acapella Choice) CG: sham OPEP¶	All groups: NR, three times daily, until hospital discharge or 5 days (whichever occurs first)	LoS Dyspnoea Sputum production Adherence	Although the addition of OPEP therapy suggests a further reduction in hospital LoS, comprehensive multicentre RCTs are needed to confirm these findings

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TABLE 1 Continued

Study, year, country	Study design	GOLD groups/ grades	Sample size (% of males)	Age mean±SD, years	Sputum burden threshold in eligibility criteria	ACT applied and equipment used (if relevant)	Duration, frequency and length of intervention	Outcomes	Summary
Milan [34] (part 2), 2019, USA	Retrospective cohort study	NR	EG+CG (from study 1): 91 (36) Historical control cohort: 182 (36)	EG+CG: 64.0±11.6 Historical control cohort: 63.1±11.4	Subjective sputum production of >one tablespoon (15 mL) per day for a minimum of 2 days	Cohort 1: OPEP or sham OPEP Historical control cohort: no ACT	EG+CG (from study 1): NR, three times daily, until hospital discharge or 5 days (whichever occurs first)	LoS	Although the addition of OPEP therapy suggests a further reduction in hospital LoS, comprehensive multicentre RCTs are needed to confirm these findings
Rahmad [37], 2020, Indonesia	Case report	NR	One male	60	The patient complained of a productive cough	Cough, PLB, PD, manual clapping	NR, twice daily, 5 days	Lung function Chest expansion Single-breath counting Functional capacity	The programme aimed to control breathing and coughing, strengthen the respiratory muscles, and improve the clearing of the airway Led to improvements in the patient's pulmonary function capacity and quality of life
Pakpahan [36], 2021, Indonesia	Quasi-experimental study	NR	EG1: 30 (77) EG2: 30 (70)	NR	NR	EG1: PD+percussion-vibration +ACBT EG2: PD+percussion-vibration	All groups: 3–5 cycles, once daily, 3 days	Vital signs (respiratory rate) Sputum production	Those performing ACBT exhibited a decrease in respiratory rate with a mean difference of 7 breaths·min^{-1} and presented seven times higher productivity in sputum production compared to the control group
Cheng [33], 2022, China	RCT	NR	EG1: 33 (70) EG2: 32 (66)	EG1: 67.4±6.0 EG2: 68.0±4.8	NR	EG1: HFCWO EG2: ELTGOL	All groups: 15–20 min, NR, 14 days	Lung function Arterial blood gases Inflammatory markers Safety LoS	HFCWO shows more evident improvement in clinical symptoms, blood gas, lung function, and cortisol function-related indicators than ELTGOL in patients with severe AECOPD

Each study investigated the effects of ACT in hospitalised patients with AECOPD. #: Positioning: different from postural drainage, positioning is used to influence regional ventilation.¶: "Sham" OPEP is the Acapella Choice used without its mechanism inside. In that study, it is however referred as "PEP therapy". ACBT: active cycle of breathing technique; BCSS: breathlessness, cough and sputum score; BODE: body mass index, obstruction, dyspnoea and exercise capacity composite score; CG: control group (no airway clearance technique); EG: experimental group; ELTGOL: slow expiration with glottis opened in lateral posture; GOLD: Global initiative for Obstructive Lung Disease; HFCWO: high-frequency chest wall oscillations; HRQoL: health-related quality of life; LoS: length of hospital stay; NR: not reported; OPEP: oscillatory positive expiratory pressure; PD: postural drainage; PEP: positive expiratory pressure; PLB: pursed-lip breathing, PT: physical therapist; RCT: randomised controlled trial; RXT: randomised crossover trial.

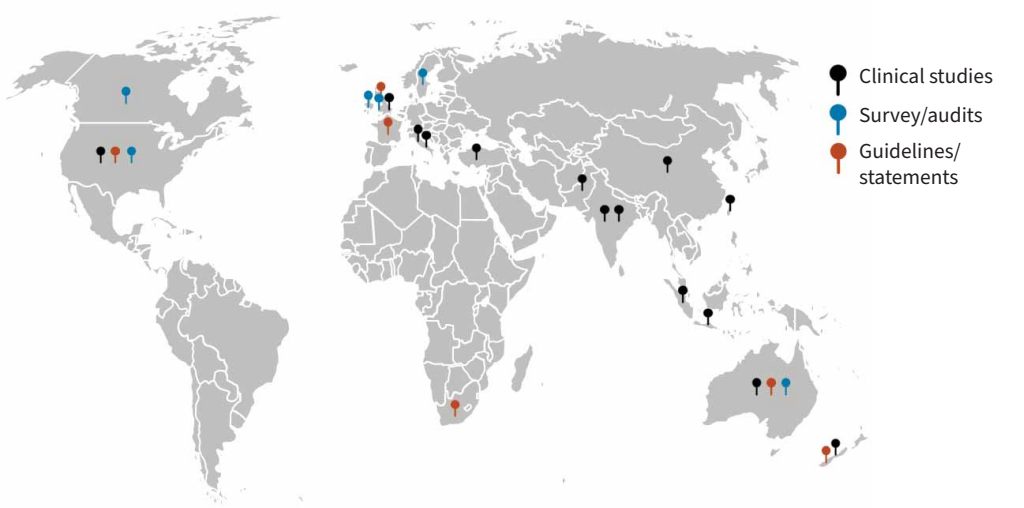

FIGURE 2 Geographical location of studies included in this scoping review.

Overall, 1245 people with AECOPD were examined, with sample sizes ranging from 10 to 264 (excluding the case report). All studies reported gender; a higher proportion of men were represented (n=793; 64%). Mean ages ranged from 53 to 78 years old, although two studies did not report participants' age [28, 36]. Only one study reported participants' severity of airway obstruction, ranging from 3 to 4 in the GOLD classification [29].

Guidelines and statements

The characteristics of the included records are presented in table 2. There were four guidelines [38–41] and one position statement [42], published between 2006 and 2023, in the USA, France, UK, South Africa, and Australia and New Zealand (figure 2), and by six societies (*i.e.*, American College of Chest Physicians, Société de Pneumologie de Langue Française, National Institute for Health and Care Excellence, South African Thoracic Society, Lung Foundation Australia and Thoracic Society of Australia and New Zealand).

Audits and surveys

The characteristics of six included audits and surveys are presented in table 3. Five cross-sectional surveys [22, 23, 44–46] and one retrospective cohort audit [43], conducted between 2006 and 2021 in six countries (*i.e.*, USA, UK, Canada, Australia, Sweden and Ireland) (figure 2), were included. The retrospective cohort study utilised a database from 360 hospitals in the USA, focusing on healthcare utilisation without specifying the response rate [43]. Cross-sectional studies involved postal or electronic surveys sent to physiotherapy managers or senior cardiorespiratory physiotherapists working in hospitals. The number of sites surveyed ranged from 70 to 190 hospitals, with response rates from 35% to 100%. The number of participating physiotherapists ranged from 70 to 189, with most respondents having more than 5 years of clinical experience. Three studies did not report response rates for participating hospital [43–45], four did not report physiotherapists' response rates [22, 23, 43, 46] and three did not report physiotherapists' years of experience [22, 43, 46].

Research questions

ACTs in research

Data from clinical studies were used to identify and map ACTs investigated in research (table 1). Included studies reported ACTs used either alone (n=9) or in a combination with other ACTs (n=6). The ACTs investigated alone were oscillating positive expiratory pressure (OPEP) (Flutter n=2; Acapella n=1; not specified n=1), slow expiration with opened glottis in lateral position (ELTGOL) (n=3), active cycle of breathing techniques (ACBTs) (n=2), high-frequency chest wall oscillation (HFCWO) (n=2) and positive expiratory pressure (PEP) (Thera-PEP n=1; bubble-PEP n=1; not specified n=1). Each combination of ACTs per study was unique, including postural drainage, percussion applied manually or using a vibrating device, positioning, ACBT, huffing or assisted coughing. There was no clear pattern of particular ACTs, individual or combinations, in the different parts of the world.

TABLE 2 Summary of existing guidelines and position statements on airway clearance techniques (ACTs) in patients with acute exacerbation of COPD (AECOPD)

Study, year	Country	Society	Key messages
Braman [38], 2006	USA	American College of Chest Physicians	In patients with an acute exacerbation of chronic bronchitis, the clinical benefits of PD and chest percussion have not been proven and they are not recommended Level of evidence: fair; net benefit: conflicting; grade of recommendation: I
Jouneau [40], 2017	France	Société de Pneumologie de Langue Française	Subject to the presence of a bronchial mucus hypersecretion, there is a low level of evidence that some ACTs have beneficial effects, including manual ACTs such as ELTGOL or ACBT, and instrumental ACTs that apply a positive pressure in the airways such as IPV and PEP
National Institute for Health and Care Excellence [39], 2018 (last updated: 2019)	UK	National Institute for Health and Care Excellence	Consider physiotherapy using PEP devices for selected people with AECOPD to help with clearing sputum
Abdool-Gaffar [37], 2019	South Africa	South African Thoracic Society	Although safe, evidence does not support routine airway clearance in acute exacerbations However, selected patients who present with excessive secretions or an ineffective cough may benefit from airway clearance interventions If required, airway clearance using PEP techniques have greater benefit over other airway clearance methods
Yang [41], 2023	Australia and New Zealand	Lung Foundation Australia and Thoracic Society of Australia and New Zealand	Given the negative impact that exacerbations have on symptoms such as dyspnoea and fatigue, it is important to decide whether performing ACT is appropriate and, if so, choosing the most appropriate technique during this time The choice of ACT should be guided by a physiotherapist experienced in this type of clinical presentation

ACBT: active cycle of breathing technique; ELTGOL: slow expiration with glottis opened in lateral posture; IPV: intrapulmonary percussive ventilation; PD: postural drainage; PEP: positive expiratory pressure.

National and international recommendations

The guidelines and position statements on ACTs exhibit both similarities and distinctions. Two guidelines and one position statement advise the use of ACTs for certain patient populations, particularly those with hypersecretion [39, 40, 42]. Among the specific ACTs, PEP therapy garners the most consensus across guidelines. The French guidelines additionally suggest the use of other ACTs including ACBT, ELTGOL and intrapulmonary percussive ventilation [40]. Conversely, the USA guidelines published in 2006 do not recommend the use of traditional ACTs, such as postural drainage and chest percussion, due to limited evidence on effectiveness [38]. Finally, the most recent guidelines published in 2023 advise that the choice of ACT should be guided by a physiotherapist experienced in AECOPD [41].

ACTs in clinical practice

Audits and surveys provided data on the types of ACTs, frequency and duration of sessions, and settings in which ACTs were used clinically (table 3). Five studies reported data collected from hospital settings [22, 23, 43, 45, 46], whilst one study addressed its survey to registered members of a national physiotherapist society and the workplace of respondents was not reported [44].

The most commonly used ACTs across the audits and surveys were ACBT, PEP, OPEP, directed huffing, postural drainage, percussion and vibration. The frequency of usage for these techniques varied greatly. ACBT was indicated in four surveys, where reported frequency of use was “often or always” for 21–99% of physiotherapists. Similarly, PEP and/or OPEP were commonly used, with four studies indicating “often or always” usage rates between 4% and 94%. Other techniques, such as directed huffing, postural drainage, percussion, vibration or autogenic drainage, were used less consistently, but remained commonly used. In the UK (2007), ACBT was preferred, followed by vibration, shaking and then percussion [46]. In Canada (2009), the top five ACTs used were vibration, facilitated coughing, percussion, postural drainage and the forced expiratory technique (FET) [22]. In Australia (2013), the top five ACTs used were predominantly ACBT or autogenic drainage (although the reported frequency may be skewed by the

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TABLE 3 Summary of audits and surveys on airway clearance techniques (ACTs) in people with acute exacerbation of COPD (AECOPD)

Study, year, country	Study setting	Data collection method	Sites settings	Number of sites and response rate	Number of participants and response rate[#]	Years of experience	Frequency of ACT used and factors influencing which ACT to use	Session frequency/ duration
Lindenauer [43], 2006, USA	Retrospective cohort study	Consultation of a database developed for measuring quality and health care utilisation	360 hospitals throughout the USA	NA	NA	NA	"Chest physiotherapy" (no further description) was reported to be used in 6.2% (4299/69820) patients with AECOPD	NR
Yohannes [46], 2007, UK	Cross-sectional study	Postal survey sent to PT managers, asking them to distribute survey to PTs working with patients admitted with AECOPD	190 PT departments within acute hospital trusts	154/190 (81%)	146 (NR) PTs	NR	Percentage of PTs "always" or "often" employing the following ACTs: ACBT, 88%; vibration, 26%; shaking, 11%; percussion, 8%	NR
Harth [22], 2009, Canada	Cross-sectional study	Postal survey sent to PT managers, asking to distribute survey to PTs predominantly involved in managing patients hospitalised with AECOPD	163 acute care general hospitals throughout Canada	109/163 (66%)	87 (NR) PTs	NR	Percentage of PTs "always" or "frequently" employing the following ACTs: vibration (ICU 42%; ward 43%); facilitated coughing (ICU 45%; ward 39%); percussion (ICU 39%; ward 36%); PD (ICU 35%; ward 32%); FET (ICU 21%; ward 31%); ACBT (ICU 21%; ward 27%); PEP (ICU 10%; ward 9%); OPEP (Flutter) (ICU 4%; ward 7%); AD (ICU 6%; ward 3%)	NR
Osadnik [23], 2013, Australia	Cross-sectional study	Postal survey sent to "a senior cardiorespiratory PT", asking to distribute the survey to survey to all PTs who usually treat patients with AECOPD	112 large or principal referral Australian public hospitals	91/112 (81%)	189 (NR) PTs	⩾5 years' experience: 99/189 (52%)	Percentage of PTs employing "always" or "often"/perceiving as "very effective" or "effective"/considering as "very easy" or "easy" to use, the following ACTs: either ACBT, SMI, DBE or AD, 99%/91%/92%; directed huffing (FET), 81%/93%/58%; directed coughing, 73%/77%/86%; (O-)PEP, 53%/89%/79%; PD+percussion-vibration, 44%/87%/56%; other, 3%/6%/2% Most common factors influencing ACT choice: contraindications or precautions to individual techniques (78%); degree of dyspnoea or work of breathing (72%); access to resources or equipment (66%) Indicators to cease ACT: no evidence of sputum (43%); sputum characteristics return to baseline (41%); whenever patient wants to stop (2%); upon hospital discharge (1%)	5–20 min for 90% of PT

Continued

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TABLE 3 Continued

Study, year, country	Study setting	Data collection method	Sites settings	Number of sites and response rate	Number of participants and response rate[#]	Years of experience	Frequency of ACT used and factors influencing which ACT to use	Session frequency/ duration
Westerdahl [45], 2019, Sweden	Cross-sectional study	A senior cardiorespiratory PT at each hospital was first contacted to develop an email database of all PTs working with patients with AECOPD at their hospital An electronic survey was sent to each identified PT	70 hospitals throughout Sweden responsible for the management of patients with AECOPD	NR	117/153 (76%) PTs	>5 years' experience: 69/117 (59%)	Percentage of PTs employing "always" or "often"/perceiving as "very effective" or "effective"/considering as "very easy" or "easy" to use, the following ACTs: PEP, 90%/94%/69%; directed huffing (FET), 88%/89%/37%; directed coughing, 71%/74%/40%; OPEP, 44%/80%/62%; ACBT, 43%/43%/24%; PD+percussion-vibration; 17%/46%/0%; AD, 1%/11%/6% Most common factors influencing ACT choice: degree of dyspnoea or work of breathing (60%); access to resources or equipment (54%); easiest to master (53%) Indicators to cease ACT: never, patients should perform daily ACT irrespective of clinical status (57%); no evidence of sputum (38%)	5–20 min for 95% of PT
Hanrahan [44], 2021, Ireland	Cross-sectional study	An electronic survey was sent to members of the Chartered PTs in Respiratory Care group and Chartered PT Manager group of the Irish Society of Chartered PT, and to PTs working in COPD outreach and respiratory integrated care services All recipients were encouraged to share the survey with respiratory PTs	PTs working in the Republic of Ireland	NR	70/202 (35%) PTs	>5 years' experience: 59/70 (84%) ⩾10 years experience: 44/70 (63%)	Percentage of PTs employing "always" or "often"/perceiving as "very effective" or "effective"/considering as "very easy" or "easy" to use, the following ACTs: ACBT, 86%/86%/70%; huff, 84%/81%/64%; OPEP (Flutter, Acapella, Cornet), 54%/84%/59%; cough, 51%/49%/64%; manual vibration, 51%/49%/64%; AD, 26%/57%/24%; PEP, 24%/53%/41%; MD, 23%/30%/38%; percussion, 19%/35%/0%; bottle PEP, 11%/40%/42%; GAD, 6%/13%/19%; mechanical vibration, 1%/17%/0% Most common factors influencing ACT choice: easiest to master (73%); access to resources or equipment (64%); degree of dyspnoea (60%); patient preference (59%)	5–20 min for 92% of PT 0–5 min (3%) 5–10 min (40%) 10–15 min (31%) 15–20 min (21%)

[#]: Where applicable, only the number of eligible physiotherapists, *i.e.* physiotherapists that worked with patients admitted with AECOPD patients, are reported. Missing percentages in text or tables have been computed from graphics available in the corresponding article using automeris.io. AD: autogenic drainage; ACBT: active cycle of breathing technique; DBE: deep breathing exercises FET: forced expiratory technique; GAD: gravity-assisted drainage; ICU: intensive care unit; MD: manual drainage; NA: not applicable; NR: not reported; OPEP: oscillating positive expiratory pressure; PD: postural drainage; PEP: positive expiratory pressure; PT: physical therapist; SMI: sustained maximal inspiration.

inclusion of various other breathing techniques), followed by FET, directed coughing, PEP/OPEP and combined postural drainage with percussion-vibration [23]. In Sweden (2019), the top five ACTs used were PEP, FET, directed coughing, OPEP and ACBT [45]. In Ireland (2021), the top five ACTs used were ACBT, huffing, OPEP, manual vibration and autogenic drainage [44]. Three studies reported the duration of ACT sessions, which typically lasted between 5 and 20 min for the majority of patients.

Decision-making factors for the ACTs

Three audits and surveys reported on the factors that influence the choice of ACTs [23, 44, 45] (table 3). Contraindications or precautions related to the use of certain techniques were a major consideration, influencing choices in 78% of respondents. The degree of dyspnoea or work of breathing was another critical factor, reported by 60–72% of respondents. Additionally, access to resources or equipment influenced decisions in 54–64% of respondents. Lastly, the ease of learning/performing the technique was a major factor in one study, reported by 73% of respondents.

Indicators to cease ACTs were reported in two surveys [23, 45]. In Sweden, most physiotherapists (57%) declared that patients should never stop performing ACTs irrespective of their clinical status and 38% advised people with AECOPD to cease ACTs when there was no evidence of sputum. In Australia, there was no apparent consensus on when to cease ACTs. The most commonly reported indicators to cease ACTs were “when there is no evidence of sputum” (43%) followed by “when sputum characteristics return to baseline” (41%).

Discussion

By reviewing a wide range of literature, including clinical studies, recommendations from national and international societies, and clinical practice audits and surveys, this scoping review is the first to provide a comprehensive identification of all ACTs studied and used in people with AECOPD and explores the relevant clinical decision-making factors. As the healthcare settings identified were primarily hospitals, our scoping review focused on the use of ACTs in hospitalised people with AECOPD.

In research, a wide range of ACTs was used alone or in combination, with significant variability and no clear pattern of preference for specific techniques between countries. Such heterogeneity in techniques between studies is consistently documented in people with other respiratory diseases [49, 50] and in patients with clinically stable COPD [11]. Likewise, based on available surveys, a large variety of ACTs are used clinically and the frequency of using specific ACTs substantially varies within each country. ACBT is the most commonly used ACT in people with AECOPD, followed by PEP, OPEP, directed huffing and conventional techniques (postural drainage, percussion and vibration). These surveys yielded results comparable to those observed in individuals with bronchiectasis [12], suggesting that the underlying pathophysiological process may not significantly influence the selection of a specific technique. However, owing to the limited data from other countries than the UK, Australia, Canada, Sweden and Ireland, it was not possible to identify geographical patterns.

As indicated in this study and also previously reported by a systematic review, the variability in the application of ACTs is reflected by the paucity of trials and the absence of high-quality studies regarding the efficacy and safety of ACTs in people with AECOPD [16]. The lack of robust and adequately powered evidence is also present in people with clinically stable COPD, even if ACTs are part of standard management in these patients [11]. This observation likely explains some inconsistencies between guidelines in the key messages about ACTs usage. Due to limited and sometimes conflicting evidence, a prevailing theme across these guidelines is a cautious approach to the routine use of ACTs. In turn, the lack of clear, strongly supported guidelines, leads to confusion and variation in practice. The lack of a standardised approach also complicates the decision-making process for healthcare providers and may contribute to the variable use of ACTs as observed across countries. The heterogeneity in practice is therefore likely shaped by educational backgrounds and training [51], emphasising the need for a strong evidence-based approach to ACT education and training in those who treat people with AECOPD.

Furthermore, access to healthcare is variable across Europe and worldwide. Access to specialist respiratory physiotherapists and ACTs equipment contributes to the variability of ACTs usage amongst countries for people with bronchiectasis [12, 52, 53] and this is likely true for people with AECOPD. Many healthcare settings, particularly in resource-limited environments, may lack the necessary devices or may not prioritise their use due to cost or availability constraints [54]. Conversely, factors such as privately funded healthcare systems, low physiotherapy network density and the absence of universal health insurance may lead individuals to limit visits to healthcare practitioners [55], opting instead to purchasing a one-time ACT

device for independent use. Additionally, there may be an absence of training or familiarity with these techniques among healthcare providers, leading to their underutilisation [56]. In line with this, the aforementioned factors have been identified in this review as important decision-making contributors to decide on the ACT use in people with AECOPD. Only two other factors influencing the choice of ACTs have been identified, *i.e.* contraindications and the level of dyspnoea [23, 44, 45]. Yet, in the specific context of acute exacerbations, many other factors such as fatigue, frailty, patient's motivation, ease to understand and applicate ACT in autonomy, among other things, are anticipated to be integrated into the clinical decision-making process. The complexity of clinical reasoning in selecting specific ACTs necessitates further investigation, to develop a consensus on best practices and improve the standardisation of care, potentially through a Delphi study.

Our review also highlights a significant gap in research from African and South American regions, as well as a paucity of data from settings outside hospitals. Despite the potential for physiotherapists to treat people with AECOPD in the community [57], there is a striking lack of studies examining ACTs in these contexts. Scarce data about using ACTs at home exist in exacerbations of other respiratory diseases such as bronchiectasis [58] and may provide valuable insights for clinicians. Future studies urgently need to address this gap, as understanding the effectiveness and safety of ACTs in diverse environments could improve the access to these therapies in people with AECOPD.

This review has several limitations to acknowledge. First, although we extended our search to the grey literature, it was limited to four databases, potentially missing relevant studies in other sources. However, we performed an extensive review of the reference lists from relevant studies to avoid missing other potentially important papers. The scoping review targeted current literature and practice, thus excluding studies published before 1995 that might be seen outdated. This may have led to the omission of earlier relevant research. Furthermore, the term AECOPD was not included in the literature search and COPD was used instead; however, a *post hoc* search adding the latter term did not retrieve any additional sources. Finally, following the standard scoping review methodology, the quality of included studies has not been assessed. This review has also strengths. The protocol was preregistered on an open science platform before the title and abstract screening, enhancing research transparency and minimising bias. Additionally, the search was conducted in eight languages, not limited to English literature, thereby reducing the risk of missing relevant studies, though not entirely eliminating it.

To conclude, this scoping review revealed that a diverse range of ACTs are used globally, with no clear pattern of preference for particular techniques in different geographic regions. Although recent guidelines advocate for the use of these techniques in patients with AECOPD, particularly those with hypersecretion, there is a lack of clear, strongly supported key messages. Consistent with this, surveys show variability in the most commonly used techniques, with ACBTs, PEP and FETs being favoured in Australia and Europe, while vibrations being more commonly used in Canada. The selection of ACTs is influenced by various factors, including contraindications, severity of dyspnoea, resource availability and the ease of learning and performing the techniques. These results set a foundation for the development of future international clinical guidelines or consensus on the selection of optimal ACTs in order to assist healthcare professionals and stakeholders to better treat people with AECOPD in various healthcare settings. Airway clearance is one of the main problems encountered in AECOPD; therefore, ensuring that future research in investigating ACTs, particularly in the community and homecare, is vital.

Points for clinical practice

- This review identified and mapped ACTs used worldwide for people with AECOPD and the relevant decision-making factors.
- Our results set a foundation for the development of future international clinical guidelines or consensus on the selection of optimal ACTs for AECOPD.

Questions for future research

- Which ACTs are appropriate for managing mucus hypersecretion in people with AECOPD?
- Does the specific clinical context of acute exacerbations, such as tiredness, frailty, motivation, ease of understanding and ability to perform ACTs independently, influence the selection of these techniques?
- What is the role, effectiveness, and safety of ACTs in people with AECOPD in the community?

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