

1 **Title Page;**

2 Title of article; Airway clearance techniques for patients experiencing acute
3 exacerbations of chronic obstructive pulmonary disease in the Republic of Ireland.

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23 **Abstract:**

24 Background and objectives: Airway clearance techniques (ACTs) are commonly
25 prescribed for patients experiencing acute exacerbations of chronic obstructive
26 pulmonary disease (AECOPD), however large variability in practice is commonly
27 observed. This study aimed to explore current physiotherapy practice regarding
28 ACTs for people with AECOPD in the Republic of Ireland.

29 Method: A cross-sectional online survey using multiple-choice questions and Likert
30 scales was distributed to 202 physiotherapy clinicians via direct email and the Irish
31 Society of Chartered Physiotherapists. Main survey themes included use of ACTs in
32 relation to effectiveness and ease of use, and awareness of the literature and
33 guidelines.

34 Results: Seventy responses (35%) were received. The majority of respondents (n=
35 56, 80%) reported prescribing ACTs for more than 60% of patients with AECOPD
36 with the most common techniques being physical activity (n=65, 93%) and active
37 cycle of breathing techniques (n=53, 90%). Sputum management (n= 66, 94%) was
38 the most commonly reported indicator for use of ACTs. The majority of
39 physiotherapists (n=42, 60%) reported being unsure of the literature or finding it
40 conflicting regarding ACTs in AECOPD.

41 Conclusion: Physiotherapists in ROI regularly prescribe ACTs for patients with
42 AECOPD despite a considerable reported lack of awareness of the evidence
43 regarding their effectiveness. Further research is required to determine the reasons
44 for this.

45 **Key words;** exacerbation, chronic obstructive pulmonary disease, sputum, airway
46 clearance techniques, physiotherapist

47 The authors have no conflict of interest to report.

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67 **Introduction and background;**

68 Chronic obstructive pulmonary disease (COPD) is a progressive, irreversible lung
69 disease typically caused by exposure of the airways to noxious substances [1]. It is
70 defined physiologically by a persistent obstructive airflow defect, and characterised
71 by symptoms of breathlessness, cough and sputum production [1]. COPD is the third
72 leading cause of death in the world and accounts for 6% of deaths internationally [2].
73 It is speculated almost 500,000 people (~10% of the population) in the Republic of
74 Ireland (ROI) could have COPD, with almost half of that figure likely to have
75 moderate to advanced disease [3]. Acute exacerbations of COPD (AECOPD) involve
76 acute deterioration of respiratory symptoms beyond normal day-to-day variability that
77 require supplemental therapy [2]. Signs of AECOPD may include productive cough,
78 increased sputum production, change in sputum colour and increased
79 breathlessness [4].

80 In healthy lungs, secretions are cleared via cephalad transportation of mucus by cilia
81 in the lining of the airways. This is recognised as an innate immuno-defence
82 mechanism to protect against adverse effects of foreign particles [6]. In COPD,
83 however, excess sputum and airways secretions are pathological disease
84 components [7] that negatively impact upon this process, with cough and sputum
85 linked to increased frequency of exacerbations and hospitalisation [5]. The presence
86 of an abnormal defence mechanism to protect against excessive airway secretions
87 justifies a role for supportive management strategies that aim to promote secretion
88 clearance. Airway clearance techniques (ACTs) are techniques that aim to clear
89 secretions via use of gravity, breath holding, forced expiratory technique and/or
90 positioning, leveraging on key principles of alveolar interdependence and collateral
91 ventilation [8]. Alveolar interdependence allows air to move into the smaller airways

92 while expanding alveoli exert traction to surrounding poorly inflated alveoli [8]. When
93 peripheral airways are obstructed, collateral ventilation provides alternative routes (in
94 the form of channels) for air to flow [9]. In the literature, ACTs have been proposed to
95 improve airflow to collateral channels and influence alveolar interdependence [9],
96 however supportive evidence has proven challenging to emerge [10].

97 Evidence of clinical effectiveness regarding ACTs for people with AECOPD has
98 existed for some time now, however conclusions in relation to the most effective
99 ACTs are variable [11]. This is likely due to considerable heterogeneity of review
100 methodologies and highly variable quality of individual clinical trials [7,10,12,13]. A
101 small number of studies have explored physiotherapy practice of ACT prescription
102 for the management of patients with AECOPD [15-19], demonstrating large
103 variability in practice. For example, the most prescribed techniques in Australia were
104 ACBT and physical exercise [18], while Swedish physiotherapists reported using
105 PEP masks most [19]. No data exists relating to ROI.

106 In the ROI, use of ACTs by physiotherapists for COPD is outlined by the Health
107 Services Executive (HSE) "End to End COPD Model of Care" clinical guidelines,
108 which are based on the Global Initiative for Obstructive Lung Disease (GOLD)
109 Guidelines [2, 3]. The HSE recommends use of ACTs by physiotherapists treating
110 patients with COPD in the integrated care, acute hospital and COPD outreach
111 settings but does not specify which ACTs are most effective or how to prescribe
112 them.

113 The primary aim of the study was to determine current practice of physiotherapists
114 with respect to ACTs and AECOPD in the ROI. Secondary aims were to explore
115 perceptions of importance and effectiveness of ACTs, to identify factors influencing

116 the prescription of ACTs and to examine physiotherapists awareness of evidence for
117 ACTs in their management of AECOPD.

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119 **Methods**

120 *Procedures*

121 A cross-sectional survey of physiotherapists treating patients with AECOPD in the
122 ROI was implemented during January and February of 2020. The survey was
123 conducted electronically via Survey Monkey due to clinicians' familiarity with the
124 approach and to facilitate timely completion. Physiotherapists working in the ROI in
125 the public or private health system were eligible for inclusion if they were registered
126 with (or pending registration with) the national professional body CORU, and had
127 treated patients with AECOPD within the last 10 years. For the purpose of this study
128 an AECOPD was defined as an acute deterioration of a patients' respiratory
129 symptoms requiring supplemental therapy [2], either in the community or following
130 hospital admission. ACTs were defined as techniques used by a physiotherapist for
131 the purpose of clearing sputum from patients' airways [18].

132 The survey comprised multiple-choice questions and Likert scales, based upon a
133 previously used instrument [18, 19], with alteration of one question and addition of
134 one other. The survey was reviewed by a respiratory clinical nurse specialist, a
135 senior physiotherapist and a respiratory consultant physician in ROI to verify
136 questions were appropriate for target respondents. Permission was granted to
137 distribute the survey via email link to members of the Chartered Physiotherapists in
138 Respiratory Care group (90 physiotherapists) and Chartered Physiotherapists
139 Manager group (88 physiotherapy managers) of the Irish Society of Chartered

140 Physiotherapists (professional body of the ROI). The survey was also emailed to
141 physiotherapists throughout the ROI working in COPD outreach and respiratory
142 integrated care services (approximately 24 physiotherapists), with all recipients
143 encouraged to share the survey with colleagues experienced in respiratory care. In
144 total, the approximate number of survey distributions was 202. To facilitate survey
145 engagement, potential participants were emailed one week prior to initial survey
146 distribution and reminders sent one, two and three weeks afterwards. Survey
147 responses were also anonymised and data pertaining to work location and education
148 history were not recorded. Ethical approval for the study was granted by Ulster
149 University Ethics Board in December 2019.

150 *Data analysis*

151 Data were presented descriptively using frequencies, and percentages. Some data
152 were pooled into fewer categories in order to explore relationships between
153 variables. For example, work experience in the cardiorespiratory field was
154 subdivided as ≤ 5 vs 5 or more years, and similar approaches used for perceived
155 effectiveness and awareness of the evidence regarding ACTs. Statistical significance
156 was set at $p \leq 0.05$. Analyses were conducted using IBM SPSS statistical package
157 version 26 and results presented as column graphs via Microsoft Excel.

158 **Results**

159 *Participants*

160 Responses were received from 70/202 (35% response rate) physiotherapists who
161 self-reported meeting study inclusion criteria. The majority of respondents (n=59,
162 84%) reported greater than 5 years experience, with 63% (n=44) working in cardio-
163 respiratory physiotherapy for at least 10 years. As survey responses were

164 anonymised, data pertaining to workplace (public, private, community or hospital
165 based) were not included.

166 *Current practice*

167 The majority of respondents (n= 56, 80%) reported prescribing ACTs for more than
168 60% of patients with AECOPD with only 7% (n= 5) doing so rarely or never. The
169 number of years working in cardiorespiratory did not appear to influence frequency of
170 prescription of ACTs for patients with AECOPD (p= 0.65). The majority of
171 respondents (n=65, 92%) spent between 5-20 minutes on ACT treatment, with 3%
172 (n=2) spending 0-5 minutes, 40% (n=28) spending 5-10 minutes, 31% (n=22)
173 spending 10-15 minutes and 21% (n=15) spending 15-20 minutes. 96% (n=69) of
174 respondents felt that ACTs were important (very important, fairly important or
175 moderately important). The most commonly prescribed individual ACTs (combined
176 “very often/always” or “often”) were physical activity 93% (n=65), ACBT 90% (n=63)
177 and deep breathing exercises 90% (n=63). A detailed overview of all ACTs is
178 presented in Figure 1.

179 *Perceptions*

180 Physiotherapists perceived the most effective techniques for clearing sputum (very
181 effective/ effective) to be physical activity (n=66, 94%), followed by ACBT (n=63,
182 90%), oscillating PEP (n=62, 89%) and directed huffing (n=60, 86%). With respect to
183 patient mastery of ACTs, respondents perceived physical activity (n=61, 87%), deep
184 breathing (n=61, 86%) and ACBT (n=52, 74%) to be easiest (very easy/easy). There
185 was no statistically significant relationship between perceived importance of
186 ACTs and years of experience working in cardiorespiratory physiotherapy (p=

187 0.439). Frequency of use, perceived effectiveness and perceived ease of patients'
188 mastery of airway clearance techniques is summarised in Figure 1.

189 *Clinical reasoning*

190 The most frequently identified indicators for prescribing ACTs were “difficulty
191 managing secretions” (n=67, 96%) and “recent change in sputum characteristics”
192 (n=63, 90%) (Figure 2). The vast majority of respondents reported their primary aim
193 of prescribing ACTs was “to clear sputum” (n=68, 97%), “to improve oxygenation”
194 (n=59, 84%), “enhance recovery from AECOPD” (n=57, 81%) and “improve quality of
195 life” (n=53, 76%). Physiotherapists’ reasoning for choosing between different ACTs
196 was made on the basis of those deemed “easiest to master” (n=51, 73%), followed
197 by “access to resources/equipment” (n=45, 64%), “degree of dyspnoea” (n=42, 60%)
198 and “patient preference” (41/70, 59%).

199 *Knowledge of literature and guidelines*

200 While 40% (n=28) of respondents believed there was evidence supporting the use of
201 ACTs during AECOPD, 40% (n=28) believed the evidence was “conflicting,
202 inconclusive or non-existent to support or refute use of ACTs”. Twelve respondents
203 (20%) declared feeling “unsure what the current evidence is”. Of the 80% of
204 respondents who felt they were familiar with the literature, no differences were
205 evident in terms of the extent of their experience between those working in
206 cardiorespiratory more or less than 5 years and their awareness of the evidence for
207 the effectiveness for ACTs with AECOPD ($p = 0.534$). There was also no significant
208 relationship between respondents who felt ACTs were important in the management
209 of patients with AECOPD and perception of the strength of evidence to support the
210 practice of ACTs for patients with AECOPD ($p = 0.377$). Fifty (71%) respondents

211 indicated they were not familiar with Irish guidelines for the use of ACTs for patients
212 with AECOPD.

213 **Discussion**

214 This was the first study of its kind to examine current practice of physiotherapists in
215 ROI with respect to ACTs for patients with AECOPD. Results indicate ACTs are
216 commonly used, and physical activity is perceived to be the most effective ACT.

217 There appears to be a high degree of uncertainty, however, regarding the evidence
218 to support this practice and poor awareness of existing national guidelines to support
219 clinicians regarding this area of practice.

220 Treatment session duration (5-20 minutes) among physiotherapists from ROI
221 appears consistent with previous reports [18,19], however the high rate of ACT
222 prescription (93%) was greater than data from Australia (65%) [18] and Sweden
223 (75%) [19]. This is despite similarities in the reported prevalence of COPD between
224 countries. While the relationship between rate of prescription of ACTs and
225 respondents perceived importance of them was not statistically significant in this
226 study, an interesting observation between studies using this survey instrument has
227 been the relationship between perceived importance of ACTs and years working in
228 cardiorespiratory physiotherapy. As in this study, the Westerdahl et al study [19] did
229 not report any significant differences in the frequency of prescription of ACTs and
230 respondents working in cardiorespiratory more or less than 5 years. In Osadnik et al's
231 study [18], however, respondents with less than 5 years experience in
232 cardiorespiratory reported prescribing ACTs more often than those with greater than
233 5 years experience ($p=0.017$). This discrepancy may be reflected in undergraduate
234 and postgraduate curricula, where more emphasis may be placed on teaching ACTs

235 at undergraduate level in Australia. Further research would be warranted and may
236 reveal some disparity in the delivery of such content internationally.

237 Just under half of respondents believed there was evidence to support the use of
238 ACTs during AECOPD. Yet, interestingly, a minority of respondents (36%) reported
239 they consider the evidence when choosing a suitable ACT. This finding has been
240 previously observed [18,19] and may reflect a degree of confusion interpreting the
241 key messages from existing literature. It was concerning to observe the majority of
242 respondents (71%) were unaware of guidelines published by the Health Services
243 Executive in ROI [3] in relation to the management of COPD, although these were
244 only published one month prior to the survey. It would be valuable to examine the
245 factors contributing to this observation.

246 While the use of physical activity as an ACT has not yet been directly examined in
247 people with AECOPD, efficacy data is reported in people with stable cystic fibrosis. A
248 single exercise session in a small adult CF sample (n=14), FEV₁ range 19-108%,
249 was found to improve ease of sputum clearance [24] and a subsequent study by the
250 same group [22] (n=24) found PEP and treadmill exercise augmented sputum
251 clearance equally effectively. The mechanism proposed to explain these findings
252 suggests PA increases peak expiratory flow and water content of viscous secretions,
253 thus facilitating clearance. Differences between populations and pathophysiology of
254 acute exacerbations, however, render it difficult to determine whether such findings
255 would translate to people with AECOPD. Further enquiry into this area of practice
256 would be of benefit to clinicians and patients, particularly in light of a recent study
257 [26] that showed Australian physiotherapists frequently prescribe physical activity for
258 patients with AECOPD, often in conjunction with huffing and coughing. This survey
259 also showed referrals to pulmonary rehabilitation after discharge were very high, in-

260 keeping with Australian guidelines [27] recommending that patients participate in
261 pulmonary rehabilitation within two weeks of hospital discharge. Data suggests that
262 pulmonary rehabilitation within 2 weeks after discharge from hospital with AECOPD
263 can lead to rapid improvements in physical performance, when compared to delayed
264 rehabilitation post COPD [28]. In ROI, The HSE Model of Care document on
265 Pulmonary Rehabilitation [3] recommends referral within 3 weeks of hospital
266 discharge, while The British Thoracic Society [28] advise referring patients on
267 discharge from hospital and enrolling them in a pulmonary rehabilitation programme
268 within one month. It would be interesting to speculate whether uptake of physical
269 activity and/or pulmonary rehabilitation after AECOPD, whilst not typically
270 implemented for the specific purpose of airway clearance, might accelerate recovery
271 of issues related to excessive airway secretions. Furthermore, as 'ease of mastery'
272 was cited as an important factor determining choice of specific ACT, it would be
273 interesting to investigate the patient experience of performing ACTs, including
274 physical activity, during AECOPD to reveal insights to further guide physiotherapy
275 prescription.

276 *Limitations*

277 Findings from this survey need to be considered in light of some limitations. It is
278 difficult to ascertain the precise number of people to whom this survey was
279 distributed due to 'snowballing' recruitment methods and possible overlap of
280 individuals across multiple dissemination sources and workplace settings. The low
281 estimated response rate may mean insights lack some generalisability across
282 broader ROI physiotherapy practice. It would be interesting to speculate whether a
283 blended method of paper-based and online surveys, and a longer timeframe in which
284 to conduct the study, might have optimised responses. As we did not record data of

285 respondents' precise work locations, we were also unable to explore the potential for
286 differences in ACT practice between physiotherapists working in outreach /
287 integrated care sites and those based in hospitals. This would be useful to ascertain
288 in future research. Finally, self-reported questionnaires are known to be susceptible
289 to recall bias, however the nature of questions included in the instrument aimed to
290 minimise this effect.

291 **Conclusion**

292 Physiotherapists in ROI frequently prescribe ACTs for the management of patients
293 with AECOPD and perceive physical activity to be the most effective individual
294 technique despite a lack of evidence to support its rationale for this purpose.
295 Awareness of national ROI guidelines for the management of COPD was very low
296 and further investigation is warranted to better understand the reasons for this.

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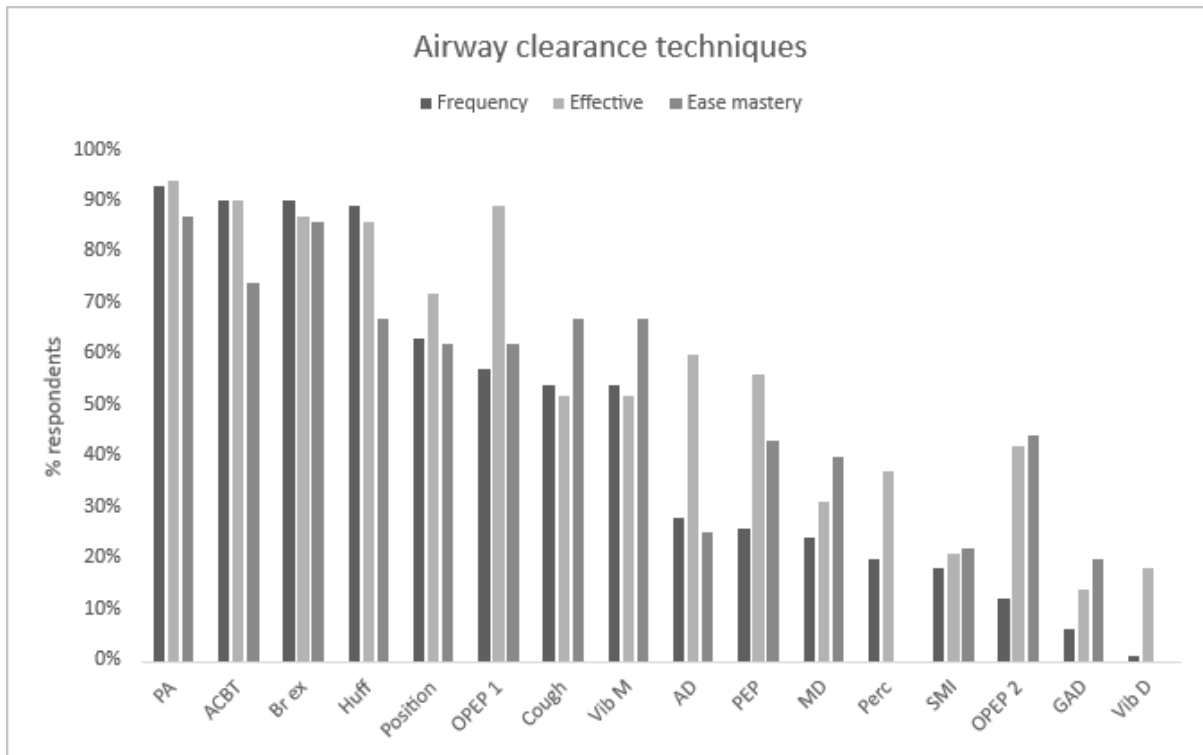
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419 Figure 1



421 Figure 1. Frequency of use, perceived effectiveness and perceived ease of patients’
 422 mastery of airway clearance techniques by physiotherapists in the Republic of
 423 Ireland. For each of frequency, effectiveness and mastery, Likert options were
 424 combined as follows; Frequency; very often or always/often. Effectiveness; very
 425 effective/ effective. Mastery; very easy/easy

426 PA= physical activity; ACBT= active cycle of breathing techniques; Huff= huffing; Br ex= breathing
 427 exercise; Position = positioning; OPEP 1= oscillating PEP device (Flutter, Acapella, Cornet); Cough=
 428 coughing; Vib M= manual vibration; AD= autogenic drainage; PEP= positive expiratory pressure; MD=
 429 manual drainage; Perc= percussions; SMI= sustained maximal inspiration; OPEP 2= oscillating PEP
 430 (bubble/bottle); GAD= gravity assisted drainage; Vib D= mechanical vibration via device

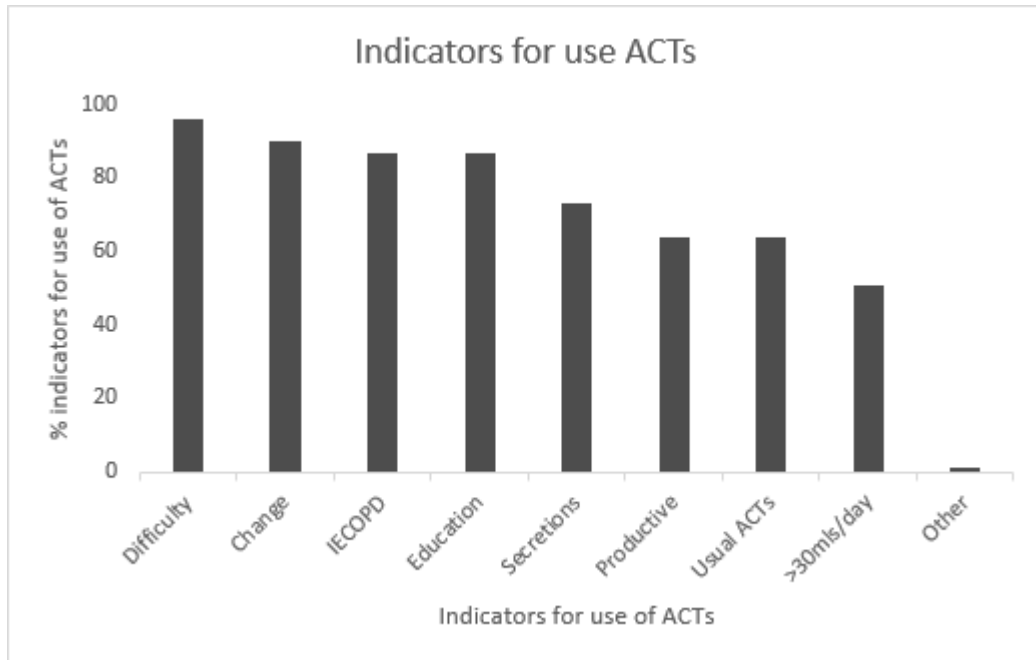
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435 Figure 2



437 Figure 2. Indicators for use of ACTs by physiotherapists in the Republic of Ireland.

438 Difficulty= difficulty managing secretions; Change= a recent change in sputum characteristics;

439 IECOPD= clinical signs suggestive of infectious exacerbation; Education= patient in need of

440 education; Secretions- presence of secretions; Productive= anyone with productive cough; Usual

441 ACTs= patients who usually perform ACTs as part of management of their condition; >30mls/day=

442 patients who produce >30mls sputum/day; Other.

443