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## Healthcare providers' perception, and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study.

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Title: Healthcare providers' perception, and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study

Saeed M. Alghamdi <sup>1\*</sup>, Abdulaziz A. Alzahrani <sup>1</sup>, Yousef M. Alshahrani <sup>2</sup>, Abdulhadi A. Alruwaithi <sup>2</sup>, Abdulelah M. Aldhahir <sup>3</sup>, Abdullah S. Alsulayyim <sup>3</sup>, Rayan A. Siraj <sup>4</sup>, Abdulelah H. Almansour <sup>5</sup>, Ali M. Alasmari <sup>6</sup>, Jaber S. Alqahtani <sup>7</sup>, Abdullah M Alanazi <sup>8</sup>, Siraj T. Jaishi <sup>9</sup>, Bader Allehyani <sup>10</sup>, Nicholas S Hopkinson <sup>11</sup>.

**Affiliation:**

1. Respiratory Care Program, Clinical technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
2. Emergency Medical Services Program, Clinical technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
3. Respiratory Therapy Department, Faculty of Applied Medical Sciences, Jazan University, Jazan 45142, Saudi Arabia
4. Department of Respiratory Care, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia
5. Family and Community Medicine Department, College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam 34212, Saudi Arabia
6. College of Medical Rehabilitation, Taibah University, Madinah 42353, Saudi Arabia
7. Department of Respiratory Care, Prince Sultan Military College of Health Sciences, Dammam, 34313, Saudi Arabia
8. Department of Respiratory Therapy, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, Riyadh 11481, Saudi Arabia
9. Respiratory care Unit, Al-Noor Specialist Hospital, Makkah 24241, Saudi Arabia
10. Respiratory care department, King Abdullah Medical City, Makkah 24211, Saudi Arabia
11. National Heart and Lung Institute, Imperial College London, London SW3 6LY, UK

**\*Corresponding author:** Dr Saeed Alghamdi Email: smghamdi@uqu.edu

Respiratory Care Program, Clinical technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia

## Abstract

**Objectives:** Removing secretions from the airway can be difficult in chronic obstructive pulmonary disease. Mucus clearance devices (MCDs) are proposed as an alternative option in disease management to aid people with COPD in airway clearance. In this study we aim to assess healthcare provider level of awareness about MCDs and COPD management, and to identify current clinical practices related to them in COPD in Saudi Arabia.

**Design:** A cross-sectional study

**Methods:** A cross-sectional study was conducted between 1 August and 31 December 2022. A valid questionnaire consisted of four themes, demographics, awareness, recommendations, and clinical practices, for MCDs with COPD patients used to collect data. Convenience sampling were employed to recruit participants. The targeted population were HCPs who worked with COPD patients.

**Results:** Overall, 1188 HCPs (44.4% female) completed the questionnaire. Of the respondents 54.2% were aware of Flutter and 23.8% of Acapella existence, followed by 5.4% of the positive expiratory pressure (PEP) mask. 40.7% of the respondents chose Acapella, and 22.3% chose Flutter for COPD management. 75% would usually or always consider the use of MCDs with COPD patients who had daily difficulty clearing mucus, whereas 55.9% would sometimes or usually consider the use of MCDs with COPD patients who produced and was able to clear mucus with cough. In clinical practice, 380 (32%) of the respondents would prescribe MCDs, 378 (31.8%) would give them without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them.

**Conclusion:** HCPs are aware of the existence of MCDs and their benefits for sputum clearance. HCPs believe that MCDs are beneficial in sputum clearance with stable and exacerbated COPD patients.

### Strengths and limitations of this study

- The study added value to the literature regarding the knowledge gap of MCDs use in treating individuals with COPD.
- The participants in this study were from diverse clinical centers, and they were all dealing with COPD.
- We used a validated survey that researchers from other countries used to collect data about MCDs preference in COPD care.
- Data were collected could serve as a baseline for future work in the evaluation of MCD use with COPD patients.

## Introduction

Mucus clearance is defined as a mechanism for removing secretions from the airway, either by coughing or using an adjunct device.<sup>1-3</sup> Clearing mucus is one of the most crucial goals in chronic obstructive pulmonary disease (COPD) management.<sup>4 5</sup> When coughing is ineffective in clearing mucus, secretions accumulate in the airways and cause infections resulting in patient deterioration. Mucus clearance devices (MCDs) are proposed as an alternative option to aid people with COPD in airway clearance.<sup>4 5</sup> Despite, the traditional therapeutic approaches of mucus clearance, there are different MCDs available in the market to aid airway clearance; however, little is known about their short-term or long-term effects on clinical outcomes.<sup>6</sup> The handheld MCD is a small portable device which is activated by the patient exhaling against a resistance valve. This process creates vibrations which keeping the airway open. These vibrations facilitate the movement of mucus, making it simpler to expel.<sup>7</sup>

Recent systematic reviews and retrospective prescribing data related to using MCDs in people with COPD suggest that they can improve clinical outcomes and health-related quality of life.<sup>3 6 8</sup> Although there has been an incremental effort in the use of MCDs in clinics, the use rate of these devices, as well as the attitudes and perceptions of using them from the perspective of healthcare practitioners (HCPs) have not been evaluated in clinical practice.<sup>8</sup> This may be due to a lack of awareness about MCDs and their advantages for managing COPD, a practice gap where these devices are not considered to be a viable alternative to pharmaceuticals or a lack of standards and guidelines concerning adopting the use of MCDs in routine clinical practice.<sup>3</sup> A randomized clinical trial of regularly used MCDs with sputum producers in COPD patients showed that they can reduce coughing frequency, improve cough-related quality of life and enhance mucus expectorations.<sup>9</sup> Another double-blind randomized clinical trial using MCDs with COPD patients found that they improved maximum inspiratory pressure.<sup>10</sup>

In clinical practice, the perceived usefulness of MCDs in COPD management is lacking among HCPs. A cross-sectional study involving 44 physicians concluded that 65.5% of HCPs appeared unaware of the COPD management guidelines.<sup>11</sup> Also, our group previously reported that the lack of experienced staff as well as insufficient knowledge were considered to be significant barriers in COPD management in Saudi Arabia.<sup>12</sup> Furthermore, neither international nor local COPD management guidelines emphasized the existence of MCDs as a non-pharmacological treatment for excessive mucus production.<sup>13-15</sup> To help increase awareness, it is important to identify the levels of

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2  
3 awareness of MCDs and how to prescribe them. Accordingly, this study aims to assess  
4 HCPs' level of awareness about MCDs and COPD management, and to identify current  
5 clinical practices related to them in COPD in Saudi Arabia.  
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## 11 12 13 Methods

### 14 Study design

15 The survey was conducted using an online platform (Survey Monkey) between 1 August  
16 and 31 December 2022.  
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### 19 20 21 Questionnaire

22  
23 The survey was originally developed and validated by our research group.<sup>3</sup> This survey  
24 had been used in COPD clinical studies before and was only available in English (Online  
25 supplement). The online survey (SurveyMonkey.com) consisted of four themes,  
26 demographics, awareness, recommendations, and clinical practices, for MCDs with  
27 COPD patients. The questionnaire focused on the assessment of MCD use with COPD  
28 patients, including levels of awareness and clinical practices. We defined MCDs as any  
29 physical device used to assist in mucus clearance.<sup>16</sup> COPD exacerbation was defined as  
30 any deterioration in the symptoms requiring medical assistance.<sup>13</sup> The participant could  
31 answer the multiple-choice questions using a 5-point Likert scale (i.e., "always", "usually",  
32 "sometimes", "rarely", "never"). The summary and aim of the study and information about  
33 the principal investigator were presented to participants before they began filling out the  
34 questionnaire. The survey did not collect any personal information. The participants were  
35 asked whether they agreed to participate or not. Upon completing the survey, the  
36 following additional statement was provided: 'By answering "yes" or "no" to the survey  
37 questions, you give your consent for your anonymous data to be used for research  
38 purposes'. If the participant answered "yes" the page opened to the survey, and if they  
39 responded "no", they exited the survey. Approximately 10-15 minutes were needed to  
40 complete the survey.  
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### 44 45 Data collection and sampling strategy

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47 Methods for convenience sampling were employed to recruit study participants. The  
48 questionnaires were distributed online. Professional bodies managing respiratory  
49 diseases were invited to participate in the data collection. These included the Saudi  
50 Society of Family and Community Medicine, the Saudi Thoracic Society (STS), the Saudi  
51 Society of Respiratory Care the Saudi Physical Therapy Association and the Saudi  
52 Nurses Association. These bodies posted the survey via their social networks (LinkedIn,  
53 Twitter, WhatsApp, and Telegram) to reach a wider audience of Saudi HCPs. In addition,  
54 five authorities from five different medical centers in five different Saudi Arabian provinces  
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contributed to the data collection to ensure countrywide sample representation as well as to guarantee that all of Saudi Arabia's geographical regions were covered. The targeted population in this study were HCPs who worked with COPD patients, and this was stated clearly in the consent form as well as the invitation to this study.

### Ethical approval

Institutional Review Board approval for the study was obtained from Umm Al-Qura University, ID number HAPO-02-K-012-2022-09-1205.

### Statistical analysis

The analysis was performed using the Statistical Package for Social Sciences (SPSS software, V.26). Percentages and frequencies were used to report categorical variables. A chi-square test was used to determine the statistically significant difference between categorical variables. Statistical significance was considered if the  $p < 0.05$ .

### Results

Overall, 1188 HCPs (44.4% female) completed the online survey between 1 August and 31 December 2022. Most of the respondents (75%) worked in government hospitals, while 14.5% worked in rehabilitation centers, and 10.5% worked in primary care clinics. Most of the participants had a bachelor's degree (68.4%), and 55 (4.6%) of them had completed residency or fellowship programs. Respiratory therapists accounted for 30% of the participants, followed by family physicians (19.3%), and nurses (15.6%). The majority of respondents had 3–4 (34.8%) or 5–6 (28.1%) years of clinical experience in caring for individuals with COPD, while 22.8% had 1–2 years. (**Table1**)

*Table 1. Characteristics of the study participants.*

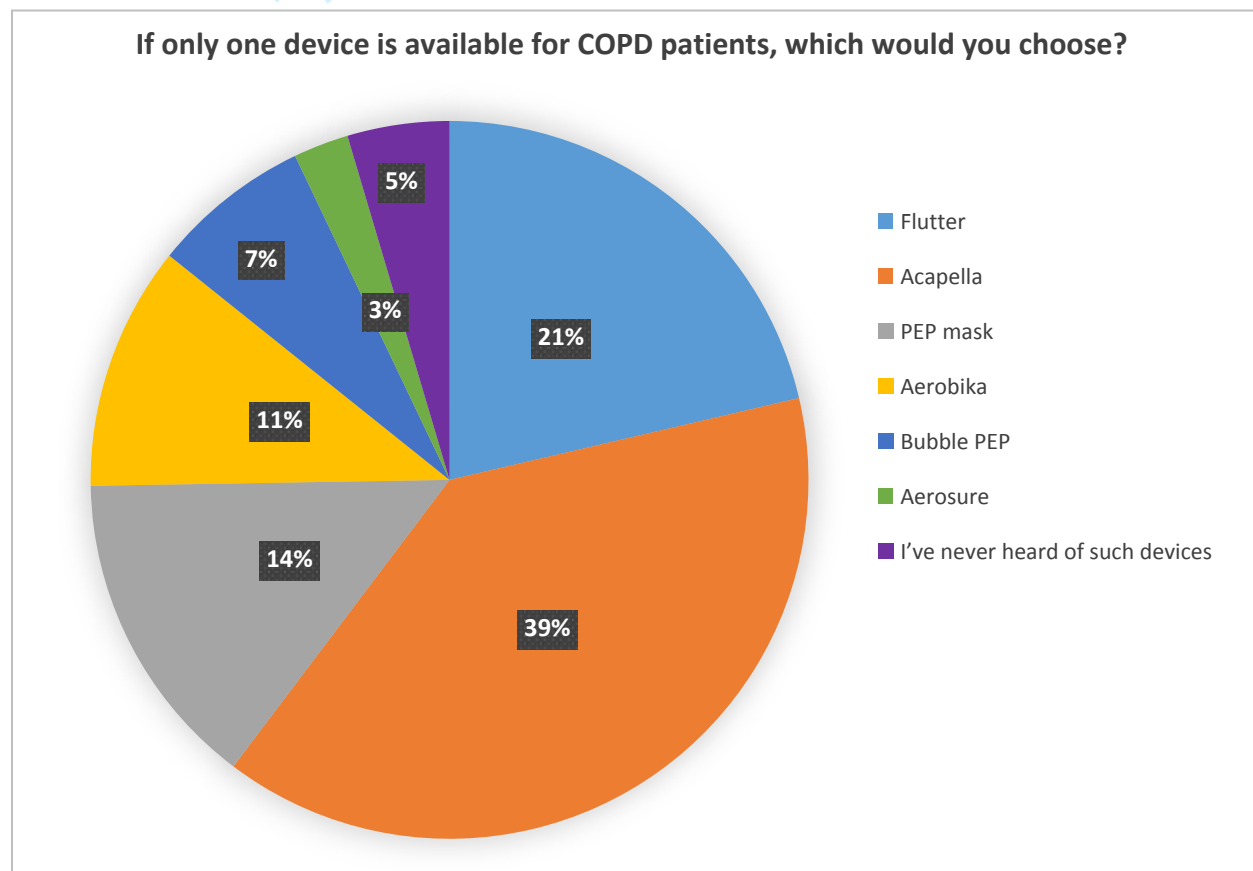
<b>Gender</b>	<b>Frequency (%)</b>
Male	661 (55.6%)
Female	527 (44.4%)
<b>Age</b>	
20–30	699 (58.8%)
31–40	329 (27.7%)
41–50	114 (9.6%)
51–60	38 (3.2%)
>60	8 (0.75%)
<b>Nationality</b>	
Saudi	1023 (86.1%)

Non-Saudi	165 (13.9%)
<b>Medical centers</b>	
Governmental/private hospitals	891 (75.0%)
Rehabilitation centers	172 (14.5%)
Primary care clinics	125 (10.5%)
<b>Geographical location</b>	
Central Region	184 (15.5%)
Eastern Region	218 (18.4%)
Northern Region	122 (10.3%)
Southern Region	452 (38.0%)
Western Region	212 (17.8%)
<b>Academic and clinical qualifications</b>	
Associate diploma	105 (8.8%)
Bachelor's degree	812 (68.4%)
Master's degree	159 (13.4%)
Medical Board Residency/Fellowship	55 (4.6%)
PhD degree	56 (4.7%)
<b>Role (Profession)</b>	
General physicians	135 (11.4%)
Family physicians	229 (19.3%)
Pulmonary physicians	98 (8.2%)
Nursing staff	185 (15.6%)
Respiratory therapists	356 (30%)
Physiotherapists	67 (5.6%)
Others	118(9.9%)
<b>Years of experience with COPD patients</b>	
1–2 years	271(22.8%)
3–4 years	413(34.8%)
5–6 years	341(28.7%)
7–8 years	76(6.4%)
> 8 years	87(7.3%)

### Awareness about MCDs

The second theme in the survey dealt with awareness regarding MCDs. In general, we found that of the respondents 54.2% were aware of Flutter and 23.8% of Acapella, followed by 5.4% being aware of the positive expiratory pressure (PEP) mask. For COPD care, 40.7% of the respondents chose Acapella, and 22.3% chose Flutter for COPD management; these are the most commonly prescribed MCDs. As an option for COPD care, 15.1% of the respondents chose PEP masks, 11.5% chose Aerobika, 7.5% chose Bubble PEP, and 2.6% chose Aerosure. **Figure 1.**

Figure 1. Pie Chart for the awareness about MCDs in COPD.



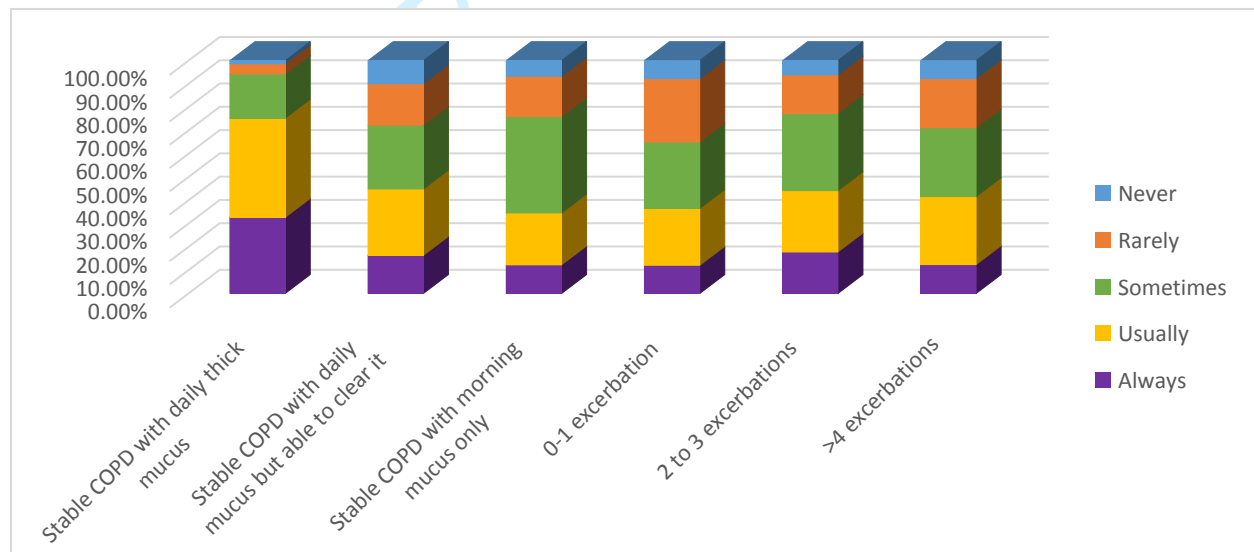
### Recommending MCDs for COPD management in clinical practice

The third theme in the survey dealt with recommending MCDs for COPD management in clinical practice. Of the respondents, 75% said they would usually or always consider the use of an MCD with a COPD patient who had daily difficulty clearing mucus, whereas

55.9% of the respondents said they would sometimes or usually consider the use of an MCD with a COPD patient who produced the mucus and was able to clear it with a cough. Of the respondents, 63% said they would sometimes or usually consider the use of an MCD with a COPD patient who produced mucus in the morning only.

When the HCPs were asked about how often they would recommend using an MCD for COPD patients with exacerbations, there was a range in their responses. 51.6% said they would rarely or sometimes consider using an MCD for a COPD who had exacerbations 0–1 times per year, 59.7% would sometimes or usually consider using an MCD for a COPD patient who had 2–3 exacerbations per year, and 58.7% of the HCPs would sometimes or usually consider using an MCD with a COPD patient who had 3–4 exacerbations. Figure 2

Figure 2. Recommending MCDs



### Clinical practice for using MCDs

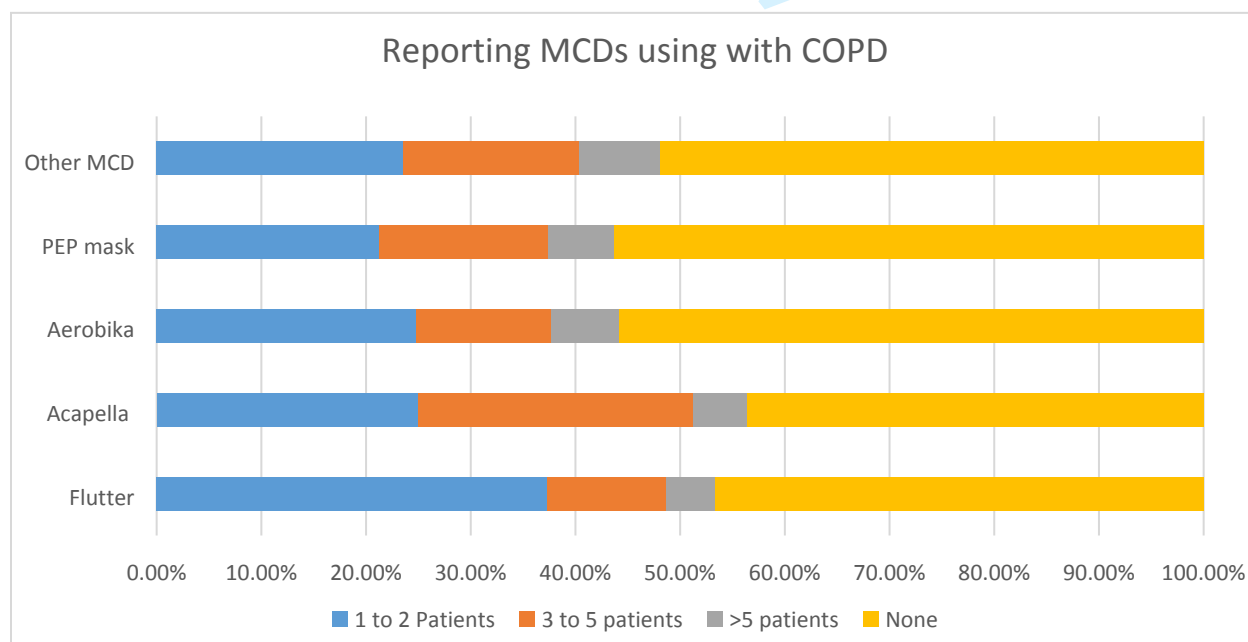
When the participants were asked about how many patients with COPD had started on MCDs in the last six months, 441 (37.1%) of the respondents started with Flutter, 297 (25%) of the respondents started with Acapella, 295 (24.8%) started with Aerobika, and 253 (21.3%) started with a PEP mask with at least one COPD patient. Table 2

In providing MCDs in clinical practice, 380 (32%) of the respondents said they would prescribe MCDs, 378 (31.8%) said they would give them without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them (Figure 3). Most of the respondents prescribed or recommended MCDs for COPD patients based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline for COPD (20.1%), followed by the Saudi Thoracic Society (STS) guidelines (20%). Supplemental Table.

Table 2. MCDs used with COPD patients in the last six months

MCDs	Frequencies for using MCDs			
	1–2 patients	3–5 patients	>5 patients	None
<b>Flutter</b>	441 (37.1%)	134 (11.3%)	56(4.7%)	557 (46.4%)
<b>Acapella</b>	297 (25.0%)	313 (26.3%)	60(5.1%)	518 (43.6%)
<b>Aerobika</b>	295 (24.8%)	153 (12.9%)	77(6.5%)	663 (55.8%)
<b>PEP mask</b>	253 (21.3%)	191 (16.1%)	75(6.3%)	669 (56.3%)
<b>Other MCDs</b>	279 (23.5%)	201 (16.9%)	91(7.7%)	617 (51.9%)

Figure 3. MCDs used with COPD patients in the last six months



## Discussion

This is the first Saudi national study to report the use of MCDs in clinical practice. The results of the current study demonstrate that awareness about MCDs in clinical practice exists in general but there are disparities between preferences among HCPs. Flutter and Acapella were the most frequently prescribed devices compared to other MCDs in COPD management. Among all the participants, using MCDs was accepted in such management but there were different responses regarding the use of MCDs with exacerbated patients. The data on prescribing MCDs revealed that the Acapella and Flutter devices were favored in the clinical setting. The treatment recommendation for COPD were based on the GOLD guidelines.

In clinical settings, patients with COPD with persistent productive coughs are common but there are few steps taken to deal with this.<sup>6</sup> Our results demonstrate that awareness about assisting COPD patients with MCDs is present among HCPs in Saudi Arabia but there are differences in their responses regarding the role of MCDs in treating COPD. This is perhaps because of the lack of evidence that emphasizes the importance of using non-pharmacological treatment in COPD management.<sup>8 15</sup> In addition, MCDs have received less attention as a treatment for stable and exacerbated COPD patients. This is, perhaps, owing to a lack of knowledge<sup>11 12</sup> or the lack of adopting guideline recommendations about the potential role of MCDs in COPD management.<sup>11</sup>

In our results, the HCPs had a strong preference for Flutter (54.2%) and Acapella for mucus clearance. But with COPD management, Acapella, particularly, was the most favored device. This is consistent with a survey that was carried out previously in the UK concerning MCDs for COPD patients.<sup>3</sup> In that research, HCPs were more likely to use Acapella for COPD management compared to other MCDs.<sup>3</sup>

Current evidence supports the use of both Acapella and Flutter as common options for airway clearance therapy for COPD, but there are many other MCDs available.<sup>17-19</sup> It is the case that MCDs receive less attention in clinical practice because of the lack of awareness about their effectiveness in COPD management. However, evidence is still emerging to support their use in this management.<sup>9 10</sup> For example, our recent randomized clinical trial of using Acapella treatment versus the active cycle of breathing technique in stable COPD patients over three months yielded promising results. The study demonstrated significant values for the regular use of these devices. After three months of regular use of the Acapella MCD in stable COPD patients, cough-related quality of life, as well as mucus clearance, significantly improved.<sup>8 9</sup>

In COPD management, increased mucus clearance and the control of symptoms via MCDs is a desirable goal, and clinicians must consider this in treating COPD patients.<sup>17 20</sup> Our analysis has revealed that recommendations for MCDs for COPD patients were

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3 following different guidelines to those being used to prescribe them. This is an indicator  
4 that clinical practice is missing the best practice strategy by not recommending MCDs.<sup>11</sup>  
5 <sup>12 21</sup>However, it must be remembered that domestic clinical practice guidelines cannot be  
6 generalized to fit all clinical centers and hospitals in Saudi Arabia as there are other  
7 aspects to be considered, such as the cost and availability of the devices. <sup>12</sup>  
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10 Our findings show that, in general, most clinicians would give MCDs to COPD patients  
11 with or without prescriptions. This is attributed to the fact that these devices, like any other  
12 non-pharmacological treatments, have fewer contraindications compared to  
13 pharmacological treatment.<sup>5</sup> In addition, managing COPD and controlling symptoms  
14 requires a bundle of treatments, of which MCDs are but one. <sup>22</sup>  
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17 At the clinician level, family physicians numbered the fewest clinicians in terms of  
18 providing MCDs for COPD patients (data shown in the supplementary). This may be  
19 because of the physicians' generally limited perception concerning the benefits of non-  
20 pharmacological treatments, including MCDs in COPD management. This was explored  
21 by Al Dahair et al., who reported the perceptions of Saudi Arabian physicians concerning  
22 non-pharmacological treatment for COPD.<sup>12</sup> A lack of experience and lack of enough  
23 information were considered to be challenges in clinical practice.<sup>12</sup> Perhaps real-time  
24 clinical data on MCD prescriptions would give us a clearer picture of their use in clinical  
25 settings.  
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28 Our findings show that recommending MCDs is usually driven by medical judgment rather  
29 than clinical guidelines. Similarities have been found regarding MCD prescribing in  
30 different parts of the world.<sup>5 19 23</sup> This may be attributed to the growing clinical evidence  
31 regarding MCD effectiveness in COPD management.<sup>8</sup> In Saudi Arabia, there are a limited  
32 number of advanced COPD clinics that provide comprehensive COPD management,  
33 including MCD training. <sup>12 24 25</sup> The use of MCDs, like any other airway clearance  
34 technique, needs training for both patients and HCPs.<sup>26</sup> The establishment of telehealth  
35 approaches to deliver training, conduct follow-ups with patients, and to monitor adherence  
36 to MCD guidelines has already been proposed.<sup>9</sup> This approach was found suitable and  
37 effective during the COVID-19 outbreak for demonstrating, instructing, and following up  
38 with COPD patients who used MCDs.<sup>9</sup>  
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42 According to this study, MCD preference could be driven by their availability at the clinical  
43 center or the features of the MCD itself. For example, Acapella devices have certain  
44 mechanical advantages, such as being gravity-independent, which allow the patient to  
45 use the device in any position. <sup>27</sup> This field of research is growing globally and there are  
46 always new devices that provide the same functions and help COPD patients with sputum  
47 clearance. Future research may focus on comparing these devices one-to-one to further  
48 inform the medical guidelines, as well as help reach a clinical consensus.  
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51 As this is the first national survey about MCDs in Saudi Arabia, several lessons have been  
52 learned from this research. First, we have found that the perceived benefits of MCDs  
53 among clinicians vary. Second, it seems that medical judgment and recommendations  
54 guide the application of MCDs rather than the clinical guidelines. At present, the clinical  
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3 guidelines for COPD management still neglect the use of MCDs. Third, there is still  
4 insufficient data related to the use of MCDs compared to mucolytics or medications. It is  
5 hoped that the data from this study will inform the current practice regarding MCDs in  
6 general, as well as with COPD patients, as an option in clinical practice.  
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## 8 9 **Strengths and Limitations**

10  
11 This study has several strengths. First, it is the first national Saudi cross-sectional study  
12 to explore and report on MCD use in clinical practice. Second, the participants in this  
13 study were from diverse clinical centers, and they were all dealing with COPD, thus,  
14 offering extended validity for the results presented here. These results could serve as a  
15 baseline for future work in this growing field of the evaluation of MCD use. However, they  
16 must be interpreted with caution. The survey focused on four MCDs while there are many  
17 more in use in clinical practice. Even though our sample covers HCPs from multiple  
18 backgrounds, we may not have captured the full response to and all the perceptions of  
19 others regarding the use of MCDs in clinical practice. It would be helpful if future research  
20 compared our data with clinical or prescription data.  
21  
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## 23 24 **Conclusion**

25  
26 HCPs are aware of the existence of MCDs and their benefits for sputum clearance. HCPs  
27 believe that MCDs are beneficial in sputum clearance with stable and exacerbated COPD  
28 patients. However, real-time clinical data recording the use of MCDs is lacking, and  
29 further efforts are required to explore the real-time usage of MCDs.  
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39 Twitter: @COPDdoc @saeedmordy  
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43 Contributors: SMA and NSH were responsible for the conceptualization, designing, and  
44 obtaining ethical approval for the study. AAA, YMA, AAR, ASA, RAS contribute to data  
45 collection. AHA, AMA were responsible for planning and run analysis. JSQ, AMZ  
46 contribute to methodology and management. STJ and BA contribute to supervise on  
47 data collection and comments on manuscript. All authors approved the final version of  
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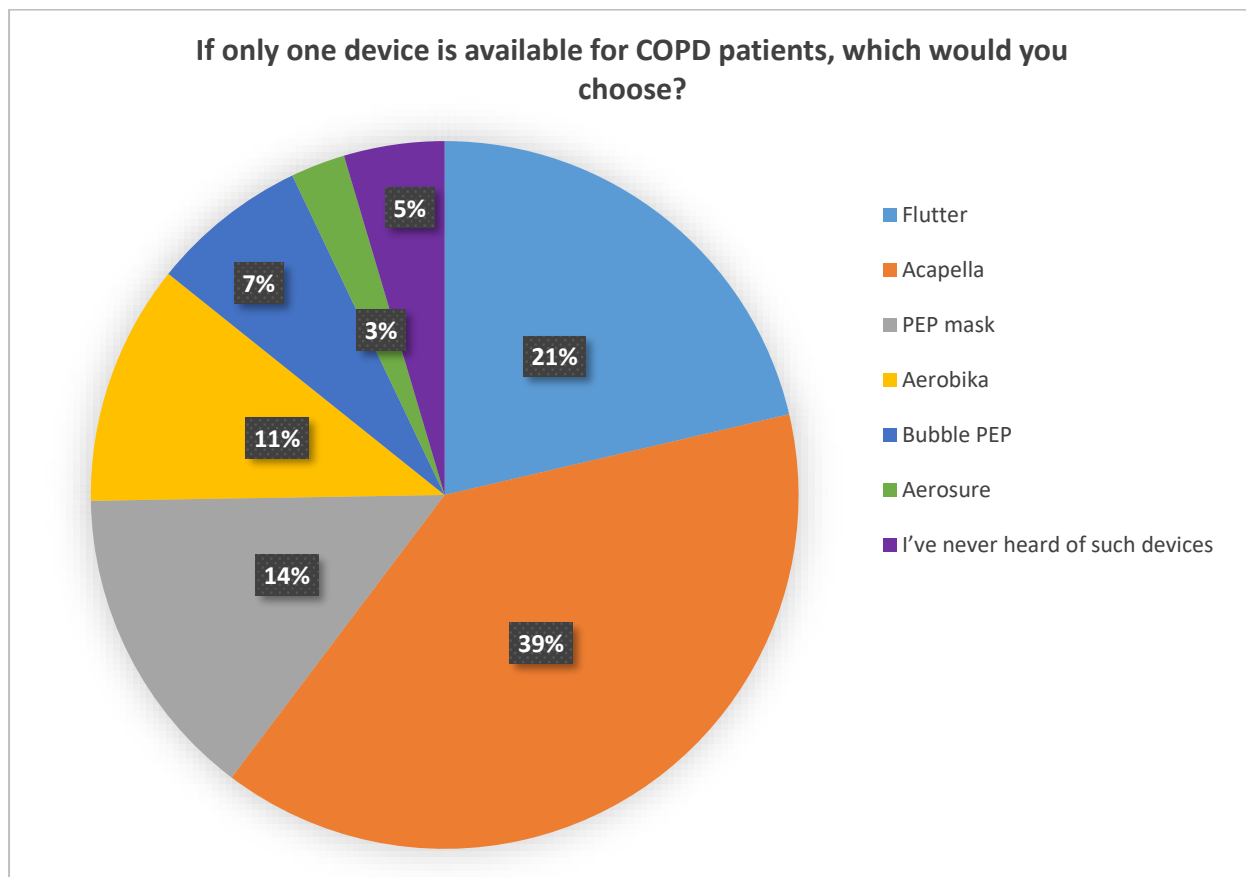
## Figure legend:

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3 Figure 1. Pie Chart for the awareness about MCDs in COPD.  
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5 Figure 2. Recommending MCDs  
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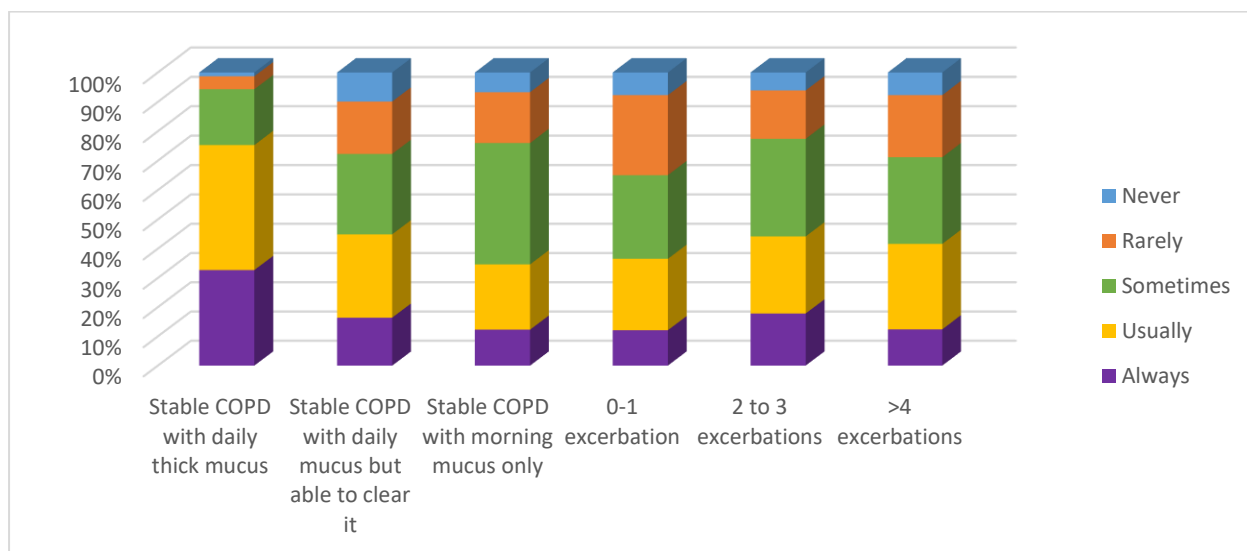
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8 Figure 3. MCDs used with COPD patients in the last six months  
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Figure 1. Pie Chart for the awareness about MCDs in COPD.



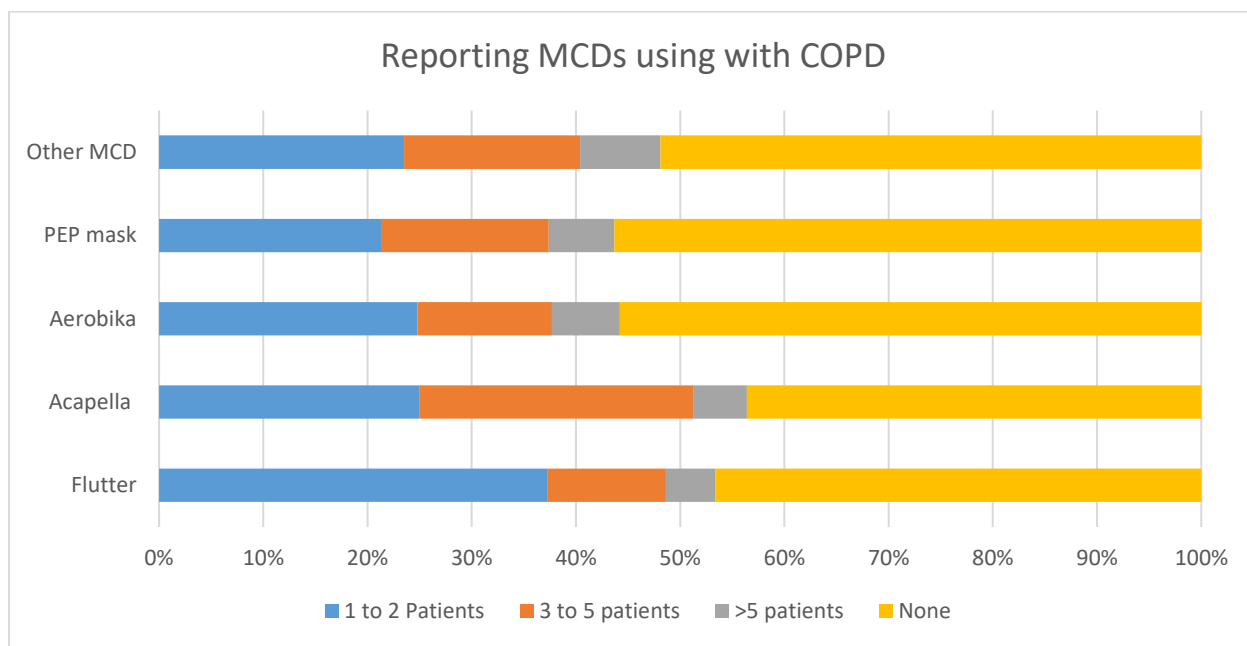
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Figure 1. Recommending MCDs



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Figure 1. MCDs used with COPD patients in the last six months



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Table 1. Providing MCDs in clinics

Item	Frequency (%)
I advise patients to buy their own	116 (9.8%)
I don't provide them	314 (26.4%)
I have them available to give to patients	378 (31.8%)
Prescription	380 (32.0%)
AARC guidelines for COPD	15.70%
Domestic clinical practice guidelines at the center/hospital	16.10%
GOLD guidelines for COPD	20.10%
NICE guidelines for COPD	15.00%
STS guidelines for diagnosis and management of COPD	16.65%



# BMJ Open

## Perception and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study of healthcare providers in Saudi Arabia.

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Title: Perception and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study of healthcare providers in Saudi Arabia

Saeed M. Alghamdi <sup>1\*</sup>, Abdulaziz A. Alzahrani <sup>1</sup>, Yousef M. Alshahrani <sup>2</sup>, Abdulhadi A. Al ruwaithi <sup>2</sup>, Abdulelah M. Aldhahir <sup>3</sup>, Abdullah S. Alsulayyim <sup>3</sup>, Rayan A. Siraj <sup>4</sup>, Abdulelah H. Almansour <sup>5</sup>, Ali M. Alasmari <sup>6</sup>, Jaber S. Alqahtani <sup>7</sup>, Abdullah M Alanazi <sup>8</sup>, Siraj T. Jaishi <sup>9</sup>, Bader Allehyani <sup>10</sup>, Nicholas S Hopkinson <sup>11</sup>.

**Affiliation:**

1. Respiratory Care Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
2. Emergency Medical Services Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
3. Respiratory Therapy Department, Faculty of Applied Medical Sciences, Jazan University, Jazan 45142, Saudi Arabia
4. Department of Respiratory Care, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia
5. Family and Community Medicine Department, College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam 34212, Saudi Arabia
6. College of Medical Rehabilitation, Taibah University, Madinah 42353, Saudi Arabia
7. Department of Respiratory Care, Prince Sultan Military College of Health Sciences, Dammam 34313, Saudi Arabia
8. Department of Respiratory Therapy, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, Riyadh 11481, Saudi Arabia
9. Respiratory Care Unit, Al-Noor Specialist Hospital, Makkah 24241, Saudi Arabia
10. Respiratory Care Department, King Abdullah Medical City, Makkah 24211, Saudi Arabia
11. National Heart and Lung Institute, Imperial College London, London SW3 6LY, UK

**\*Corresponding author:** Dr Saeed M. Alghamdi

Email: [smghamdi@uqu.edu.sa](mailto:smghamdi@uqu.edu.sa)

Respiratory Care Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia

## Abstract

**Objectives:** Clearing secretions from the airway can be difficult for people with chronic obstructive pulmonary disease (COPD). Mucus clearance devices (MCDs) are an option in disease management to help with this, but healthcare provider awareness and knowledge about them as well as current clinical practice in Saudi Arabia are not known.

**Design:** A cross-sectional online survey consisting of four themes; demographics, awareness, recommendations, and clinical practice, for MCDs with COPD patients.

**Setting:** Saudi Arabia

**Participants:** 1188 healthcare providers including general practitioners, family physicians, pulmonologists, nursing staff, respiratory therapists, and physiotherapists.

**Primary outcome measures:** Healthcare providers' level of awareness about MCDs, and the identification of current clinical practices of COPD care in Saudi Arabia.

**Results:** 1188 healthcare providers (44.4% female) completed the survey. Regarding devices, 54.2% were aware of the Flutter, 23.8% the Acapella, and 5.4% the positive expiratory pressure (PEP) mask. 40.7% of the respondents identified the Acapella, and 22.3% the Flutter as first choice for COPD management. 75% would usually or always consider their use in COPD patients reporting daily difficulty clearing mucus, whereas 55.9% would sometimes or usually consider the use of MCDs with COPD patients who produced and were able to clear mucus with cough. In clinical practice, 380 (32%) of the respondents would prescribe MCDs, 378 (31.8%) would give MCDs without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them.

**Conclusion:** Healthcare providers are aware of the existence of MCDs and their benefits for sputum clearance and believe that MCDs are beneficial for sputum clearance in some COPD patients.

### Strengths and limitations of this study

- The first study to provide insights about the levels of awareness of mucus clearance devices in treating individuals with chronic obstructive pulmonary disease in Saudi Arabia.
- Different healthcare providers from different health care faculties were included in the study.
- The cross-sectional nature of the study does not include audit of clinical data, which would give us a clearer picture about MCDs preferences.

## Introduction

Mucus clearance is defined as the removal of secretions from the airway, including by coughing or using an adjunct device.(1-3) Clearing mucus is one of the most crucial goals in chronic obstructive pulmonary disease (COPD) management.(4 5) When coughing is ineffective in clearing mucus, secretions accumulate in the airways and cause infections resulting in patient deterioration. Mucus clearance devices (MCDs) are proposed as an alternative option to aid people with COPD in airway clearance.(4 5) Despite, the traditional therapeutic approaches of mucus clearance, there are different MCDs available in the market to aid airway clearance; however, little is known about their short-term or long-term effects on clinical outcomes.(6) The handheld MCD is a small portable device which is activated by the patient exhaling against a resistance valve. This process creates vibrations which keeping the airway open. These vibrations facilitate the movement of mucus, making it simpler to expel.(7) Literature presented a variety of mucus devices (eg, Flutter (Allergan, Dublin, Ireland), Acapella (Smiths-Medical, Dublin, Ohio, USA), Lung Flute (Medical Acoustics, Buffalo, New York, USA), RC-Cornet (Cegla Medical Technology, Montabaur, Germany) and Aerobika (Monaghan Medical, Plattsburgh, New York, USA).(6)

Recent systematic reviews and retrospective prescribing data related to using MCDs in people with COPD suggest that they can improve clinical outcomes and health-related quality of life.(3 6 8) Although there has been an incremental effort in the use of MCDs in clinics, the use rate of these devices, as well as the attitudes and perceptions of using them from the perspective of healthcare practitioners (HCPs) have not been evaluated in clinical practice. (8) This may be due to a lack of awareness about MCDs and their advantages for managing COPD, a practice gap where these devices are not considered to be a viable alternative to pharmaceuticals or a lack of standards and guidelines concerning adopting the use of MCDs in routine clinical practice.(3) A randomized clinical trial of regularly used MCDs with sputum producers in COPD patients showed that they can reduce coughing frequency, improve cough-related quality of life and enhance mucus expectorations. (9) Another double-blind randomized clinical trial using MCDs with COPD patients found that they improved maximum inspiratory pressure.(10)

Across the world, the perceived usefulness of MCDs in COPD management is lacking among HCPs.(11-13) In Saudi Arabia, guidelines for COPD care were established in 2014 but are still premature and need further amendments.(13) As recent evidence indicates, there are a number of challenges in formulating, structuring, and expanding COPD care services in the kingdom, including a lack of awareness about national guidelines, a lack of hospital capacity, and a lack of trained healthcare professionals.(13 14) A cross-sectional study involving 44 physicians concluded that 65.5% of HCPs appeared unaware of the COPD management guidelines.(15) Also, our group previously reported that the lack of experienced staff as well as insufficient knowledge were considered to be significant barriers in COPD management in Saudi Arabia.(16) Furthermore, neither international nor local COPD management guidelines emphasized the existence of MCDs

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3 as a non-pharmacological treatment for excessive mucus production.(13 17-19) To fill this  
4 gap, it is important to identify the levels of awareness of MCDs and the routine care of  
5 prescribing adjunct sputum devices. Accordingly, this study aims to assess HCPs' level  
6 of awareness about MCDs and COPD management, and to identify current clinical  
7 practices related to their use in COPD in Saudi Arabia.  
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## 10 11 Methods

### 12 Study design

13 The survey was conducted using an online platform (Survey Monkey) between 1 August  
14 and 31 December 2022.  
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### 18 Questionnaire

19 The survey was originally developed and validated by a team of respiratory medicine  
20 experts including assessment of face and content validity.(3) This survey had been used  
21 in COPD clinical studies before and was only available in English (Online supplement).  
22 The online survey (SurveyMonkey.com) consisted of four themes, demographics,  
23 awareness, recommendations, and clinical practices, for MCDs with COPD patients. The  
24 questionnaire focused on the assessment of MCD use with COPD patients, including  
25 levels of awareness and clinical practices. We defined MCDs as any physical device used  
26 to assist in mucus clearance.(20) COPD exacerbation was defined as any deterioration  
27 in the symptoms requiring additional treatment.(17) The participant could answer the  
28 multiple-choice questions using a 5-point Likert scale (i.e., "always", "usually",  
29 "sometimes", "rarely", "never"). The summary and aim of the study and information about  
30 the principal investigator were presented to participants before they began filling out the  
31 questionnaire. The survey did not collect any personal information. The participants were  
32 asked whether they agreed to participate or not. Upon completing the survey, the  
33 following additional statement was provided: 'By answering "yes" or "no" to the survey  
34 questions, you give your consent for your anonymous data to be used for research  
35 purposes'. If the participant answered "yes" the page opened to the survey, and if they  
36 responded "no", they exited the survey. Approximately 10-15 minutes were needed to  
37 complete the survey.  
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### 46 Data collection

47 The questionnaires were distributed online. Professional bodies managing respiratory  
48 diseases were invited to participate in the data collection. These included the Saudi  
49 Society of Family and Community Medicine, the Saudi Thoracic Society (STS), the Saudi  
50 Society of Respiratory Care the Saudi Physical Therapy Association and the Saudi  
51 Nurses Association. These bodies posted the survey via their social networks (LinkedIn,  
52 Twitter, WhatsApp, and Telegram) to reach a wider audience of Saudi HCPs. In addition,  
53 five authorities from five different medical centers in five different Saudi Arabian provinces  
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3 contributed to the data collection to ensure countrywide sample representation as well as  
4 to guarantee that all of Saudi Arabia's geographical regions were covered. The targeted  
5 population in this study were HCPs who worked with COPD patients, and this was stated  
6 clearly in the consent form as well as the invitation to this study.  
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### 10 11 Ethical approval

12 Institutional Review Board approval for the study was obtained from Umm Al-Qura  
13 University, ID number HAPO-02-K-012-2022-09-1205.  
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### 16 17 Sample size calculation

18 Study participants were recruited using convenience sampling techniques. A primary  
19 focus of the study was to reach general practitioners, family physicians, pulmonologists,  
20 nursing staff, respiratory therapists, and physiotherapists who manage patients with  
21 COPD. Due to the exploratory nature of this study, a sample size calculation was not  
22 required.  
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### 26 27 Statistical analysis

28 The analysis was performed using the Statistical Package for Social Sciences (SPSS  
29 software, V.26). Percentages and frequencies were used to report categorical variables.  
30 A chi-square test was used to determine the statistically significant difference between  
31 categorical variables. Statistical significance was considered if the  $p < 0.05$ .  
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### 36 37 Patient and public involvement

38 No patients involved.  
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### 42 Results

43 Overall, 1188 HCPs (44.4% female) completed the online survey between 1 August and  
44 31 December 2022. Most of the respondents (75%) worked in government hospitals,  
45 while 14.5% worked in rehabilitation centers, and 10.5% worked in primary care clinics.  
46 Most of the participants had a bachelor's degree (68.4%), and 55 (4.6%) of them had  
47 completed residency or fellowship programs. Respiratory therapists accounted for 30%  
48 of the participants, followed by family physicians (19.3%), and nurses (15.6%). The  
49 majority of respondents had 3–4 (34.8%) or 5–6 (28.1%) years of clinical experience in  
50 caring for individuals with COPD, while 22.8% had 1–2 years. **(Table1)**  
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Table 1. Characteristics of the study participants.

<b>Gender</b>	<b>Frequency (%)</b>
Male	661 (55.6%)
Female	527 (44.4%)
<b>Age</b>	
20–30	699 (58.8%)
31–40	329 (27.7%)
41–50	114 (9.6%)
51–60	38 (3.2%)
>60	8 (0.75%)
<b>Nationality</b>	
Saudi	1023 (86.1%)
Non-Saudi	165 (13.9%)
<b>Medical centers</b>	
Governmental/private hospitals	891 (75.0%)
Rehabilitation centers	172 (14.5%)
Primary care clinics	125 (10.5%)
<b>Geographical location</b>	
Central Region	184 (15.5%)
Eastern Region	218 (18.4%)
Northern Region	122 (10.3%)
Southern Region	452 (38.0%)
Western Region	212 (17.8%)
<b>Academic and clinical qualifications</b>	
Associate diploma	105 (8.8%)
Bachelor's degree	812 (68.4%)
Master's degree	159 (13.4%)
Medical Board Residency/Fellowship	55 (4.6%)
PhD degree	56 (4.7%)
<b>Role (Profession)</b>	
General physicians	135 (11.4%)
Family physicians	229 (19.3%)
Pulmonary physicians	98 (8.2%)
Nursing staff	185 (15.6%)
Respiratory therapists	356 (30%)
Physiotherapists	67 (5.6%)
Others	118(9.9%)
<b>Years of experience with COPD patients</b>	
1–2 years	271(22.8%)
3–4 years	413(34.8%)
5–6 years	341(28.7%)
7–8 years	76(6.4%)
> 8 years	87(7.3%)

**Note:** Data are presented as frequencies and percentages. **COPD**, chronic obstructive pulmonary disease.

### Awareness of mucus clearance devices

The second theme in the survey dealt with awareness regarding MCDs. 54.2% of the respondents were aware of flutter and 23.8% of acapella devices, followed by 5.4% for the positive expiratory pressure (PEP) mask. For COPD care, 40.7% of the respondents chose acapella, and 22.3% chose flutter as their preferred device; these are the most commonly prescribed MCDs. As an option for COPD care, 15.1% of the respondents chose PEP mask, 11.5% chose Aerobika, 7.5% chose Bubble PEP, and 2.6% chose Aerosure. **Figure 1.**

### Recommending MCDs for COPD management in clinical practice

The third theme in the survey dealt with recommending MCDs for COPD management in clinical practice. Of the respondents, 75% said they would usually or always consider the use of an MCD with a COPD patient who had daily difficulty clearing mucus, whereas 55.9% of the respondents said they would sometimes or usually consider the use of an MCD with a COPD patient who produced the mucus and was able to clear it with a cough. Of the respondents, 63% said they would sometimes or usually consider the use of an MCD with a COPD patient who produced mucus in the morning only.

When the HCPs were asked about how often they would recommend using an MCD for COPD patients with exacerbations, there was a range in their responses. 51.6% said they would rarely or sometimes consider using an MCD for a COPD who had exacerbations 0–1 times per year, 59.7% would sometimes or usually consider using an MCD for a COPD patient who had 2–3 exacerbations per year, and 58.7% of the HCPs would sometimes or usually consider using an MCD with a COPD patient who had >4 exacerbations. **Figure 2**

### Clinical practice for using MCDs

When the participants were asked about how many patients with COPD had started on MCDs in the last six months, 441 (37.1%) of the respondents had started flutter, 297 (25%) of the respondents started acapella, 295 (24.8%) started aerobika, and 253 (21.3%) started a PEP mask in at least one COPD patient. **Table 2**

In providing MCDs in clinical practice, 380 (32%) of the respondents said they would prescribe MCDs, 378 (31.8%) said they would give MCDs without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them (Figure 3). Most of the respondents prescribed or recommended MCDs for COPD patients based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline for COPD (20.1%), followed by the Saudi Thoracic Society (STS) guidelines (20%). Supplemental Table.

*Table 2. Clinical practice for using MCDs in the last six months (n=1188).*

MCDs	Frequencies for using MCDs			
	1–2 patients	3–5 patients	>5 patients	None
Flutter	441 (37.1%)	134 (11.3%)	56(4.7%)	557 (46.4%)
Acapella	297 (25.0%)	313 (26.3%)	60(5.1%)	518 (43.6%)
Aerobika	295 (24.8%)	153 (12.9%)	77(6.5%)	663 (55.8%)
PEP mask	253 (21.3%)	191 (16.1%)	75(6.3%)	669 (56.3%)
Other MCDs	279 (23.5%)	201 (16.9%)	91(7.7%)	617 (51.9%)

**Note:** Data are presented as frequencies and percentages. **MCDs**, mucus clearance devices

## Discussion

This is the first Saudi national study to report the use of MCDs in clinical practice. The results demonstrate that awareness about MCDs in clinical practice exists in general but there are differences in preferences for device among HCPs as well as around the threshold of symptoms where a device would be recommended. flutter and acapella were the most frequently prescribed devices compared to other MCDs in COPD management. Among all the participants, using MCDs were accepted in such management but there were different responses regarding the use of MCDs with exacerbated patients. The data on prescribing MCDs revealed that the acapella and flutter devices were favored in the clinical setting. The treatment recommendation for COPD was based on the GOLD guidelines.

In clinical settings, patients with COPD with persistent productive coughs are common but there are few steps taken to deal with this.(6 21) Our results demonstrate that awareness about assisting COPD patients with MCDs is present among HCPs in Saudi Arabia but there are differences in their responses regarding the role of MCDs in treating COPD. This is perhaps because of the lack of evidence that emphasizes the importance of using non-pharmacological treatment in COPD management.(8 13) In addition, MCDs have received less attention as a treatment for stable and exacerbated COPD patients. This is, perhaps, owing to a lack of knowledge (13 15 16) or the lack of adopting guideline recommendations about the potential role of MCDs in COPD management.(15)

HCPs had a strong preference for flutter and acapella for mucus clearance. But with COPD management, acapella, particularly, was the most favored device. This is consistent with a survey that was carried out previously in the UK concerning MCDs for COPD patients.(3) In that research, HCPs were more likely to use acapella for COPD management compared to other MCDs.(3)

Current evidence supports the use of both acapella and flutter as common options for airway clearance therapy for COPD, but there are many other MCDs available. (22-24) It is the case that MCDs receive less attention in clinical practice because of the lack of awareness about their effectiveness in COPD management. However, evidence is still emerging to support their use in this management.(9 10) For example, a recent

1  
2  
3 randomized clinical trial of using acapella treatment versus the active cycle of breathing  
4 technique in stable COPD patients over three months yielded promising results. The  
5 study demonstrated significant values for the regular use of these devices. After three  
6 months of regular use of the acapella in stable COPD patients, cough-related quality of  
7 life, as well as mucus clearance, significantly improved.(8 9)  
8  
9

10 In COPD management, increased mucus clearance and the control of symptoms via  
11 MCDs is a desirable goal, and clinicians must consider this in treating COPD patients.(22  
12 25) Our analysis has revealed that recommendations for MCDs for COPD patients were  
13 following different guidelines to those being used to prescribe them. This is an indicator  
14 that clinical practice is missing the best practice strategy by not recommending MCDs.(15  
15 16 26)However, it must be remembered that domestic clinical practice guidelines cannot  
16 be generalized to fit all clinical centers and hospitals in Saudi Arabia as there are other  
17 aspects to be considered, such as maturity of COPD care in the kingdom as well as the  
18 cost and availability of the devices. (13 16 27)  
19  
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21 Our findings show that, in general, most clinicians would give MCDs to COPD patients  
22 with or without prescriptions. This is attributed to the fact that these devices, like any other  
23 non-pharmacological treatments, have fewer contraindications compared to  
24 pharmacological treatment.(5) In addition, managing COPD and controlling symptoms  
25 require a bundle of treatments, of which MCDs are but one. (28)  
26  
27

28 At the clinician level, family physicians numbered the fewest clinicians in terms of  
29 providing MCDs for COPD patients. This may be because of the physicians' generally  
30 limited perception concerning the benefits of non-pharmacological treatments, including  
31 MCDs in COPD management. This was explored by Al Dahair et al., who reported the  
32 perceptions of Saudi Arabian physicians concerning non-pharmacological treatment for  
33 COPD.(16) A lack of experience and lack of enough information were considered to be  
34 challenges in clinical practice.(16) Perhaps real-time clinical data on MCD prescriptions  
35 would give us a clearer picture of their use in clinical settings.  
36  
37

38 Our findings show that recommending MCDs is usually driven by medical judgment rather  
39 than clinical guidelines. Similarities have been found regarding MCD prescribing in  
40 different parts of the world.(5 24 29) This may be attributed to the growing clinical  
41 evidence regarding MCD effectiveness in COPD management.(8) In Saudi Arabia, there  
42 are a limited number of advanced COPD clinics that provide comprehensive COPD  
43 management, including MCD training.(16 27 30) The use of MCDs, like any other airway  
44 clearance technique, needs training for both patients and HCPs.(31) The establishment  
45 of telehealth approaches to deliver training, conduct follow-ups with patients, and to  
46 monitor adherence to MCD guidelines has already been proposed.(9) This approach was  
47 found suitable and effective during the COVID-19 outbreak for demonstrating, instructing,  
48 and following up with COPD patients who used MCDs.(9 32 33)  
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52 According to this study, MCD preference could be driven by their availability at the clinical  
53 center or the features of the MCD itself. For example, acapella devices have certain  
54 mechanical advantages, such as being gravity-independent, which allow the patient to  
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3 use the device in any position. (34) This field of research is growing globally and there  
4 are always new devices that provide the same functions and help COPD patients with  
5 sputum clearance. Future research may focus on comparing these devices one-to-one to  
6 further inform the medical guidelines, as well as help reach a clinical consensus.  
7

8  
9 As this is the first national survey about MCDs in Saudi Arabia, several lessons have been  
10 learned from this research. First, we have found that the perceived benefits of MCDs  
11 among clinicians vary. Second, it seems that medical judgment and recommendations  
12 guide the application of MCDs rather than the clinical guidelines. At present, the clinical  
13 guidelines for COPD management in Saudi Arabia still neglect the use of MCDs. Third,  
14 there is still insufficient data related to the use of MCDs compared to mucolytics or  
15 medications. It is hoped that the data from this study will inform the current practice  
16 regarding MCDs in general, as well as with COPD patients, as an option in clinical  
17 practice.  
18

### 19 20 Strengths and Limitations

21  
22 This study has several strengths. First, it is the first national Saudi cross-sectional study  
23 to explore and report on MCDs use in clinical practice. Second, the participants in this  
24 study were from multiple clinical centers, and they were all dealing with COPD, thus,  
25 offering extended validity for the results presented here. These results could serve as a  
26 baseline for future work in this growing field of the evaluation of MCD use. However, they  
27 must be interpreted with caution. The survey focused on four MCDs while there are many  
28 more in use in clinical practice. Even though our sample covers HCPs from multiple  
29 backgrounds, we may not have captured the full response to and all the perceptions of  
30 others regarding the use of MCDs in clinical practice. It would be helpful if future research  
31 compared our data with clinical or prescription data.  
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### 35 36 Conclusion

37  
38 HCPs are aware of the existence of MCDs and their benefits for sputum clearance. HCPs  
39 believe that MCDs are beneficial in sputum clearance with stable and exacerbated COPD  
40 patients. However, real-time clinical data recording the use of MCDs is lacking, and  
41 further efforts are required to explore the actual usage of MCDs.  
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49 Twitter: @COPDdoc @saeedmordy

50  
51 Contributors: SMA and NSH were responsible for the conceptualization, designing,  
52 obtaining ethical approval for the study, and wrote the first version of the manuscript.  
53 AAA, YMA, AAR, ASA, and RAS did the acquisition of the data and data validity. AHA,  
54 AMA, JSQ, AMZ, STJ and BA planed and run statistical analysis of the data and interpret  
55 data. SMA, NSH, AAA, YMA, AAR, ASA, RAS, AHA, AMA, JSQ, AMZ, STJ and BA  
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3 contributed to and approved the final version of this manuscript. SMA has full  
4 responsibility for the work and/or the conduct of the study, had access to the data, and  
5 controlled the decision to publish.  
6

7  
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10

11 Competing interests: None  
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13 Patient consent for publication: None.  
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15 Data sharing statement: Data are available upon reasonable request.  
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18 Word count: 3105  
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## 50 **Figure legends**

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52 Figure 1. Mucus clearance device preference (n=1188).  
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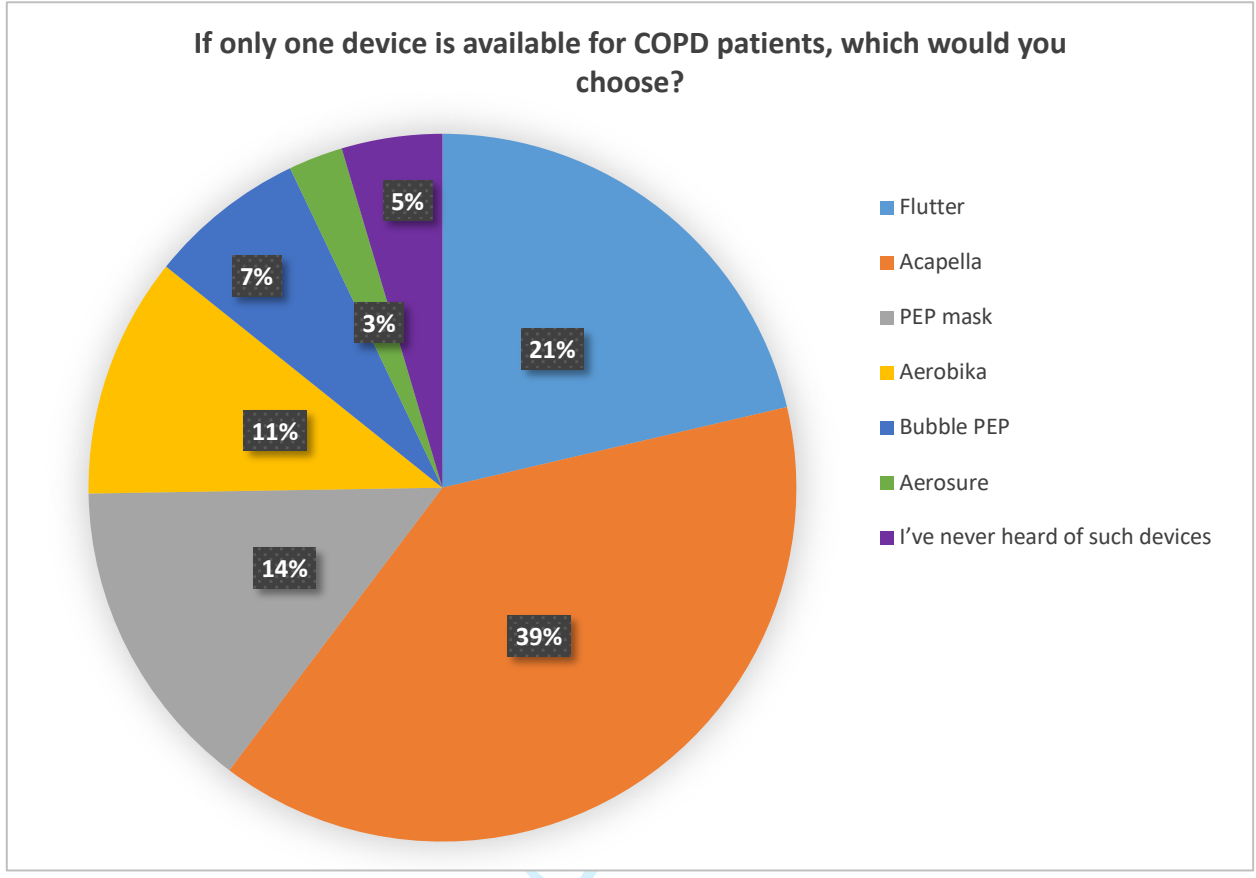
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3 Figure 2. Threshold to consider use of mucus clearance devices for COPD  
4 management (n=1188).  
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7 Figure 3. Clinical practice for using MCDs in the last six months (n=1188).  
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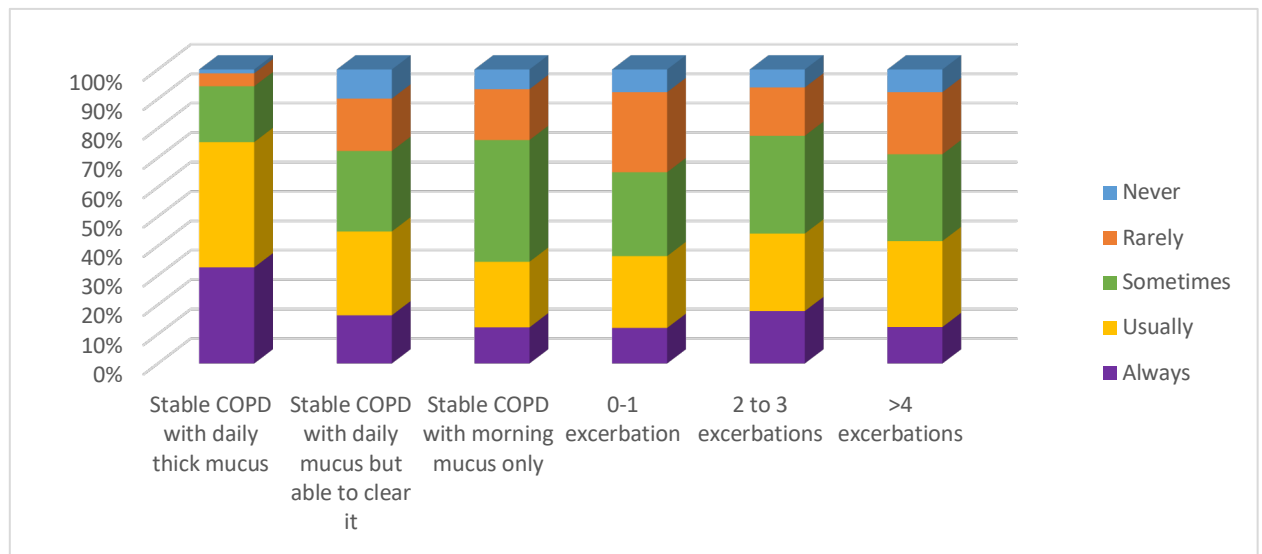
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Figure 1. Mucus clearance device preference (n=1188).



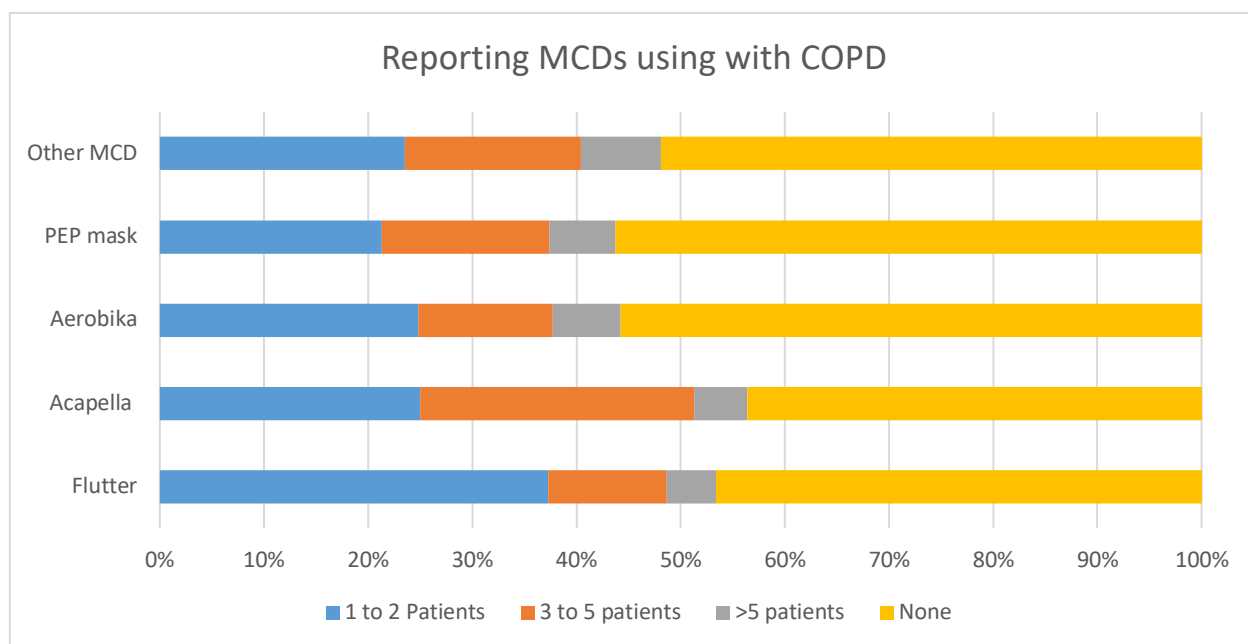
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Figure 2. Threshold to consider use of mucus clearance devices for COPD management (n=1188).



Peer review only

Figure 3. Clinical practice for using MCDs in the last six months (n=1188).



# Use of sputum clearance devices in patients with COPD in Saudi Arabia

Sputum clearance devices like the Acapella and Flutter can be used to aid sputum clearance. We are interested in finding out about health professionals' experience with their use in people with COPD.

The survey is about short-term and long-term home and clinical use. The results will be analysed anonymously by researchers at Umm Al-Qura University. There are no right or wrong answers, we are trying to find out about professional's attitudes and experiences. The survey should take less than 5 minutes to complete.

If you have any questions please free to contact the project coordinator

By completing the survey questions, you freely agree to engage in this study and offer your agreement to utilize your anonymous data for research purposes.

\* Indicates required question

## Demographic data

1. Please indicate your age \*

Mark only one oval.

- 20 - 30
- 31-40
- 41-50
- 51-60
- 61-70

2. Please pick your gender \*

Mark only one oval.

- Male
- Female

3. Your nationality \*

Mark only one oval.

- Saudi
- Non-Saudi

4. Geographic location \*

Mark only one oval.

- Central region
- Northern region
- Southern region
- Eastern region
- Western region

5. Academic qualification \*

Mark only one oval.

- Associate diploma
- Bachelor degree
- Master degree
- PhD degree

6. Please tick one box which best describes your role in your clinical centre/ Hospital \*

Mark only one oval.

- General physician
- Family medicine doctor
- Pulmonology
- Respiratory Therapy
- Nurse
- Physiotherapy
- Other: \_\_\_\_\_



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7. Where do you work? - pick one description that fits the best for you \*

Mark only one oval.

- General practice/ Local primary care centre
- Governmental Hospital
- Privet clinic/ Hospital
- Rehabilitation centers

8. Are you still intern/ under training program / under preceptorship program? \*

Mark only one oval.

- Yes
- No

9. How many years you were certified/registered? \*

Mark only one oval.

- 1-2 years
- 3-4 years
- 5-6 years
- 7-8 years
- > 8 years

W only

10. Which of the following sputum clearance devices are you aware of? **Choose all that apply** \*

Tick all that apply.



Flutter



Acapella



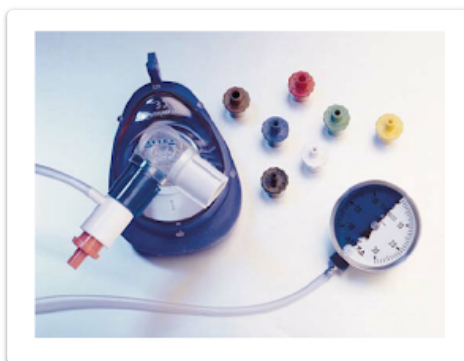
Aerobika



Aerosure



Bubble PEP



PEP mask

Other: \_\_\_\_\_

Option 7

11. Device preference - if only one device is available for COPD patients, which would you choose? \*  
pick one

Mark only one oval.

- Flutter
- Acapella
- Aerobika
- PEP mask
- Bubble mask
- Other: \_\_\_\_\_

How often would you consider the use of sputum clearance device to help sputum clearance in the following situation? For this question assume that the person has been taught active cycle of breathing techniques or standard care for sputum clearance in your place.

**Please answer the following scenarios**

12. COPD patient with daily difficult to clear thick sputum \*

Mark only one oval.

- Always
- Usually
- Sometimes
- Rarely
- Never

13. COPD patient producing sputum throughout the day but able to clear it \*

Mark only one oval.

- Always
- Usually
- Sometimes
- Rarely
- Never

14. COPD patient with morning sputum only \*

1  
2 *Mark only one oval.*

- 3  
4  Always  
5  Usually  
6  Sometimes  
7  Rarely  
8  Never  
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15. COPD patient who only has sputum with exacerbations. Has 0-1 exacerbations/year \*

16  
17 *Mark only one oval.*

- 18  
19  Always  
20  Usually  
21  Sometimes  
22  Rarely  
23  Never  
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16. COPD patients who only has sputum with exacerbations. Has 2-3 exacerbations/year \*

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31 *Mark only one oval.*

- 32  
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34  Always  
35  Usually  
36  Sometimes  
37  Rarely  
38  Never  
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17. COPD patients who only has sputum with exacerbations. Has >4 exacerbations/year \*

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46  
47 *Mark only one oval.*

- 48  
49  Always  
50  Usually  
51  Sometimes  
52  Rarely  
53  Never  
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18. How many patients with COPD have you actually started on the following devices in the last 12 months? \*

Mark only one oval per row.

	None	1-2	3-5	>5
<b>Flutter</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Acapella</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Aerobika</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>PEP mask</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Other devices</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. How would you usually provide sputum clearance device to a COPD patient (pick the one that applies most commonly)? \*

Mark only one oval.

- I don't provide them
- I have them available to give to patients
- Prescription
- Advise patient to buy their own

#### Policy and Guidelines

20. Do you recommend sputum device in COPD based on clinical practice guidelines? \*

Mark only one oval.

- Yes
- No

21. If yes, which guidelines?

Mark only one oval.

- GOLD guidelines for COPD
- NICE guidelines for COPD
- AARC guidelines for COPD
- Saudi Thoracic Society guidelines for diagnosis and management of COPD
- Domestic clinical practice guidelines at your center/hospital

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## Google Forms

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*Supplemental Table 1: Providing MCDs in clinics*

<b>Item</b>	<b>Frequency (%)</b>
I advise patients to buy their own	116 (9.8%)
I don't provide them	314 (26.4%)
I have them available to give to patients	378 (31.8%)
Prescription	380 (32.0%)
AARC guidelines for COPD	15.70%
Domestic clinical practice guidelines at the center/hospital	16.10%
GOLD guidelines for COPD	20.10%
NICE guidelines for COPD	15.00%
STS guidelines for diagnosis and management of COPD	16.65%



## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (page 2) (b) Provide in the abstract an informative and balanced summary of what was done and what was found (page 2)
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (Page 4)
Objectives	3	State specific objectives, including any prespecified hypotheses (Page 5)
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper (Page 5)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (Page 5)
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (N/A) <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls (N/A) <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (Page 5) (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed (N/A) <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case (N/A)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (Page 6)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (Page 5)
Bias	9	Describe any efforts to address potential sources of bias (N/A)
Study size	10	Explain how the study size was arrived at (Page 6)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (Page 6)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (Page 6) (b) Describe any methods used to examine subgroups and interactions (N/A) (c) Explain how missing data were addressed (N/A) (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed (N/A) <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (Page 6) (e) Describe any sensitivity analyses (N/A)

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<b>Results</b>		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (Page 6) (b) Give reasons for non-participation at each stage (N/A) (c) Consider use of a flow diagram (N/A)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (Pages 7-10) (b) Indicate number of participants with missing data for each variable of interest (N/A) (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount) (N/A)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time (N/A) <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure (N/A) <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures (Pages 7-10)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (N/A) (b) Report category boundaries when continuous variables were categorized (N/A) (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (N/A)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (N/A)
<b>Discussion</b>		
Key results	18	Summarise key results with reference to study objectives (Page 11)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (Page 13)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (Pages 11 -13)
Generalisability	21	Discuss the generalisability (external validity) of the study results (Page 13)
<b>Other information</b>		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (Page 13)

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Perception and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study of healthcare providers in Saudi Arabia.

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Keywords:	RESPIRATORY MEDICINE (see Thoracic Medicine), Pulmonary Disease, Chronic Obstructive, Chronic airways disease < THORACIC MEDICINE

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Title: Perception and clinical practice regarding mucus clearance devices with chronic obstructive pulmonary disease: A cross-sectional study of healthcare providers in Saudi Arabia

Saeed M. Alghamdi <sup>1\*</sup>, Abdulaziz A. Alzahrani <sup>1</sup>, Yousef M. Alshahrani <sup>2</sup>, Abdulhadi A. Al Ruwaihithi <sup>2</sup>, Abdulelah M. Aldhahir <sup>3</sup>, Abdullah S. Alsulayyim <sup>3</sup>, Rayan A. Siraj <sup>4</sup>, Abdulelah H. Almansour <sup>5</sup>, Ali M. Alasmari <sup>6</sup>, Jaber S. Alqahtani <sup>7</sup>, Abdullah M. Alanazi <sup>8</sup>, Siraj T. Jaishi <sup>9</sup>, Bader Allehyani <sup>10</sup>, Nicholas S. Hopkinson <sup>11</sup>.

**Affiliation:**

1. Respiratory Care Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
2. Emergency Medical Services Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia
3. Respiratory Therapy Department, Faculty of Applied Medical Sciences, Jazan University, Jazan 45142, Saudi Arabia
4. Department of Respiratory Care, College of Applied Medical Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia
5. Family and Community Medicine Department, College of Medicine, Imam Abdulrahman Bin Faisal University, Dammam 34212, Saudi Arabia
6. College of Medical Rehabilitation, Taibah University, Madinah 42353, Saudi Arabia
7. Department of Respiratory Care, Prince Sultan Military College of Health Sciences, Dammam 34313, Saudi Arabia
8. Department of Respiratory Therapy, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, Riyadh 11481, Saudi Arabia
9. Respiratory Care Unit, Al-Noor Specialist Hospital, Makkah 24241, Saudi Arabia
10. Respiratory Care Department, King Abdullah Medical City, Makkah 24211, Saudi Arabia
11. National Heart and Lung Institute, Imperial College London, London SW3 6LY, UK

**\*Corresponding author:** Dr Saeed M. Alghamdi

Email: [smghamdi@uqu.edu.sa](mailto:smghamdi@uqu.edu.sa)

Respiratory Care Program, Clinical Technology Department, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, 24382, Saudi Arabia

## Abstract

**Objectives:** Clearing secretions from the airway can be difficult for people with chronic obstructive pulmonary disease (COPD). Mucus clearance devices (MCDs) are an option in disease management to help with this, but healthcare provider awareness and knowledge about them as well as current clinical practice in Saudi Arabia are not known.

**Design:** A cross-sectional online survey consisting of four themes; demographics, awareness, recommendations, and clinical practice, for MCDs with COPD patients.

**Setting:** Saudi Arabia

**Participants:** 1188 healthcare providers including general practitioners, family physicians, pulmonologists, nursing staff, respiratory therapists, and physiotherapists.

**Primary outcome measures:** Healthcare providers' level of awareness about MCDs, and the identification of current clinical practices of COPD care in Saudi Arabia.

**Results:** 1188 healthcare providers (44.4% female) completed the survey. Regarding devices, 54.2% were aware of the Flutter, 23.8% the Acapella, and 5.4% the positive expiratory pressure (PEP) mask. 40.7% of the respondents identified the Acapella, and 22.3% the Flutter as first choice for COPD management. 75% would usually or always consider their use in COPD patients reporting daily difficulty clearing mucus, whereas 55.9% would sometimes or usually consider the use of MCDs with COPD patients who produced and were able to clear mucus with cough. In clinical practice, 380 (32%) of the respondents would prescribe MCDs, 378 (31.8%) would give MCDs without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them.

**Conclusion:** Healthcare providers are aware of the existence of MCDs and their benefits for sputum clearance and believe that MCDs are beneficial for sputum clearance in some COPD patients.

### Strengths and limitations of this study

- The sample size in this study was 1188 healthcare practitioners, which represented both physicians and non-physicians from different geographical locations in Saudi Arabia.
- The data was collected using validated questionnaire about preference of mucus clearance devices.
- The study unable to capture actual usage of mucus clearance devices in clinical practice due to unavailable prescribing data.
- The study included the common options for airway clearance therapy for COPD but there are many other mucus clearance devices available.



## Introduction

Mucus clearance is defined as the removal of secretions from the airway, including by coughing or using an adjunct device.(1-3) Clearing mucus is one of the most crucial goals in chronic obstructive pulmonary disease (COPD) management.(4 5) When coughing is ineffective in clearing mucus, secretions accumulate in the airways and cause infections resulting in patient deterioration. Mucus clearance devices (MCDs) are proposed as an alternative option to aid people with COPD in airway clearance.(4 5) Despite, the traditional therapeutic approaches of mucus clearance, there are different MCDs available in the market to aid airway clearance; however, little is known about their short-term or long-term effects on clinical outcomes.(6) The handheld MCD is a small portable device which is activated by the patient exhaling against a resistance valve. This process creates vibrations which keeping the airway open. These vibrations facilitate the movement of mucus, making it simpler to expel.(7) Literature presented a variety of mucus devices (eg, Flutter (Allergan, Dublin, Ireland), Acapella (Smiths-Medical, Dublin, Ohio, USA), Lung Flute (Medical Acoustics, Buffalo, New York, USA), RC-Cornet (Cegla Medical Technology, Montabaur, Germany) and Aerobika (Monaghan Medical, Plattsburgh, New York, USA).(6)

Recent systematic reviews and retrospective prescribing data related to using MCDs in people with COPD suggest that they can improve clinical outcomes and health-related quality of life.(3 6 8) Although there has been an incremental effort in the use of MCDs in clinics, the use rate of these devices, as well as the attitudes and perceptions of using them from the perspective of healthcare practitioners (HCPs) have not been evaluated in clinical practice. (8) This may be due to a lack of awareness about MCDs and their advantages for managing COPD, a practice gap where these devices are not considered to be a viable alternative to pharmaceuticals or a lack of standards and guidelines concerning adopting the use of MCDs in routine clinical practice.(3) A randomized clinical trial of regularly used MCDs with sputum producers in COPD patients showed that they can reduce coughing frequency, improve cough-related quality of life and enhance mucus expectorations. (9) Another double-blind randomized clinical trial using MCDs with COPD patients found that they improved maximum inspiratory pressure.(10)

Across the world, the perceived usefulness of MCDs in COPD management is lacking among HCPs.(11-13) In Saudi Arabia, guidelines for COPD care were established in 2014 but are still premature and need further amendments.(13) As recent evidence indicates, there are a number of challenges in formulating, structuring, and expanding COPD care services in the kingdom, including a lack of awareness about national guidelines, a lack of hospital capacity, and a lack of trained healthcare professionals.(13 14) A cross-sectional study involving 44 physicians concluded that 65.5% of HCPs appeared unaware of the COPD management guidelines.(15) Also, our group previously reported that the lack of experienced staff as well as insufficient knowledge were considered to be significant barriers in COPD management in Saudi Arabia.(16) Furthermore, neither international nor local COPD management guidelines emphasized the existence of MCDs

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3 as a non-pharmacological treatment for excessive mucus production.(13 17-19) To fill this  
4 gap, it is important to identify the levels of awareness of MCDs and the routine care of  
5 prescribing adjunct sputum devices. Accordingly, this study aims to assess HCPs' level  
6 of awareness about MCDs and COPD management, and to identify current clinical  
7 practices related to their use in COPD in Saudi Arabia.  
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## 10 11 Methods

### 12 Study design

13 The survey was conducted using an online platform (Survey Monkey) between 1 August  
14 and 31 December 2022.  
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### 18 Questionnaire

19 The survey was originally developed and validated by a team of respiratory medicine  
20 experts including assessment of face and content validity.(3) This survey had been used  
21 in COPD clinical studies before and was only available in English (Online supplement).  
22 The online survey (SurveyMonkey.com) consisted of four themes, demographics,  
23 awareness, recommendations, and clinical practices, for MCDs with COPD patients. The  
24 questionnaire focused on the assessment of MCD use with COPD patients, including  
25 levels of awareness and clinical practices. We defined MCDs as any physical device used  
26 to assist in mucus clearance.(20) COPD exacerbation was defined as any deterioration  
27 in the symptoms requiring additional treatment.(17) The participant could answer the  
28 multiple-choice questions using a 5-point Likert scale (i.e., "always", "usually",  
29 "sometimes", "rarely", "never"). The summary and aim of the study and information about  
30 the principal investigator were presented to participants before they began filling out the  
31 questionnaire. The survey did not collect any personal information. The participants were  
32 asked whether they agreed to participate or not. Upon completing the survey, the  
33 following additional statement was provided: 'By answering "yes" or "no" to the survey  
34 questions, you give your consent for your anonymous data to be used for research  
35 purposes'. If the participant answered "yes" the page opened to the survey, and if they  
36 responded "no", they exited the survey. Approximately 10-15 minutes were needed to  
37 complete the survey.  
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### 46 Data collection

47 The questionnaires were distributed online. Professional bodies managing respiratory  
48 diseases were invited to participate in the data collection. These included the Saudi  
49 Society of Family and Community Medicine, the Saudi Thoracic Society (STS), the Saudi  
50 Society of Respiratory Care the Saudi Physical Therapy Association and the Saudi  
51 Nurses Association. These bodies posted the survey via their social networks (LinkedIn,  
52 Twitter, WhatsApp, and Telegram) to reach a wider audience of Saudi HCPs. In addition,  
53 five authorities from five different medical centers in five different Saudi Arabian provinces  
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3 contributed to the data collection to ensure countrywide sample representation as well as  
4 to guarantee that all of Saudi Arabia's geographical regions were covered. The targeted  
5 population in this study were HCPs who worked with COPD patients, and this was stated  
6 clearly in the consent form as well as the invitation to this study.  
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### 10 11 Ethical approval

12 Institutional Review Board approval for the study was obtained from Umm Al-Qura  
13 University, ID number HAPO-02-K-012-2022-09-1205.  
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### 16 17 Sample size calculation

18 Study participants were recruited using convenience sampling techniques. A primary  
19 focus of the study was to reach general practitioners, family physicians, pulmonologists,  
20 nursing staff, respiratory therapists, and physiotherapists who manage patients with  
21 COPD. Due to the exploratory nature of this study, a sample size calculation was not  
22 required.  
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### 26 27 Statistical analysis

28 The analysis was performed using the Statistical Package for Social Sciences (SPSS  
29 software, V.26). Percentages and frequencies were used to report categorical variables.  
30 A chi-square test was used to determine the statistically significant difference between  
31 categorical variables. Statistical significance was considered if the  $p < 0.05$ .  
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### 36 37 Patient and public involvement

38 No patients involved.  
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### 42 Results

43 Overall, 1188 HCPs (44.4% female) completed the online survey between 1 August and  
44 31 December 2022. Most of the respondents (75%) worked in government hospitals,  
45 while 14.5% worked in rehabilitation centers, and 10.5% worked in primary care clinics.  
46 Most of the participants had a bachelor's degree (68.4%), and 55 (4.6%) of them had  
47 completed residency or fellowship programs. Respiratory therapists accounted for 30%  
48 of the participants, followed by family physicians (19.3%), and nurses (15.6%). The  
49 majority of respondents had 3–4 (34.8%) or 5–6 (28.1%) years of clinical experience in  
50 caring for individuals with COPD, while 22.8% had 1–2 years. **(Table1)**  
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Table 1. Characteristics of the study participants.

<b>Gender</b>	<b>Frequency (%)</b>
Male	661 (55.6%)
Female	527 (44.4%)
<b>Age</b>	
20–30	699 (58.8%)
31–40	329 (27.7%)
41–50	114 (9.6%)
51–60	38 (3.2%)
>60	8 (0.75%)
<b>Nationality</b>	
Saudi	1023 (86.1%)
Non-Saudi	165 (13.9%)
<b>Medical centers</b>	
Governmental/private hospitals	891 (75.0%)
Rehabilitation centers	172 (14.5%)
Primary care clinics	125 (10.5%)
<b>Geographical location</b>	
Central Region	184 (15.5%)
Eastern Region	218 (18.4%)
Northern Region	122 (10.3%)
Southern Region	452 (38.0%)
Western Region	212 (17.8%)
<b>Academic and clinical qualifications</b>	
Associate diploma	105 (8.8%)
Bachelor's degree	812 (68.4%)
Master's degree	159 (13.4%)
Medical Board Residency/Fellowship	55 (4.6%)
PhD degree	56 (4.7%)
<b>Role (Profession)</b>	
General physicians	135 (11.4%)
Family physicians	229 (19.3%)
Pulmonary physicians	98 (8.2%)
Nursing staff	185 (15.6%)
Respiratory therapists	356 (30%)
Physiotherapists	67 (5.6%)
Others	118(9.9%)
<b>Years of experience with COPD patients</b>	
1–2 years	271(22.8%)
3–4 years	413(34.8%)
5–6 years	341(28.7%)
7–8 years	76(6.4%)
> 8 years	87(7.3%)

**Note:** Data are presented as frequencies and percentages. **COPD**, chronic obstructive pulmonary disease.

### Awareness of mucus clearance devices

The second theme in the survey dealt with awareness regarding MCDs. 54.2% of the respondents were aware of flutter and 23.8% of acapella devices, followed by 5.4% for the positive expiratory pressure (PEP) mask. For COPD care, 40.7% of the respondents chose acapella, and 22.3% chose flutter as their preferred device; these are the most commonly prescribed MCDs. As an option for COPD care, 15.1% of the respondents chose PEP mask, 11.5% chose Aerobika, 7.5% chose Bubble PEP, and 2.6% chose Aerosure. **Figure 1.**

### Recommending MCDs for COPD management in clinical practice

The third theme in the survey dealt with recommending MCDs for COPD management in clinical practice. Of the respondents, 75% said they would usually or always consider the use of an MCD with a COPD patient who had daily difficulty clearing mucus, whereas 55.9% of the respondents said they would sometimes or usually consider the use of an MCD with a COPD patient who produced the mucus and was able to clear it with a cough. Of the respondents, 63% said they would sometimes or usually consider the use of an MCD with a COPD patient who produced mucus in the morning only.

When the HCPs were asked about how often they would recommend using an MCD for COPD patients with exacerbations, there was a range in their responses. 51.6% said they would rarely or sometimes consider using an MCD for a COPD who had exacerbations 0–1 times per year, 59.7% would sometimes or usually consider using an MCD for a COPD patient who had 2–3 exacerbations per year, and 58.7% of the HCPs would sometimes or usually consider using an MCD with a COPD patient who had >4 exacerbations. **Figure 2**

### Clinical practice for using MCDs

When the participants were asked about how many patients with COPD had started on MCDs in the last six months, 441 (37.1%) of the respondents had started flutter, 297 (25%) of the respondents started acapella, 295 (24.8%) started aerobika, and 253 (21.3%) started a PEP mask in at least one COPD patient. **Table 2**

In providing MCDs in clinical practice, 380 (32%) of the respondents said they would prescribe MCDs, 378 (31.8%) said they would give MCDs without prescriptions, 314 (26.4%) would not provide them at all, and 116 (9.8%) would only advise patients about them (Figure 3). Most of the respondents prescribed or recommended MCDs for COPD patients based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline for COPD (20.1%), followed by the Saudi Thoracic Society (STS) guidelines (20%). Supplemental Table.

*Table 2. Clinical practice for using MCDs in the last six months (n=1188).*

MCDs	Frequencies for using MCDs			
	1–2 patients	3–5 patients	>5 patients	None
Flutter	441 (37.1%)	134 (11.3%)	56(4.7%)	557 (46.4%)
Acapella	297 (25.0%)	313 (26.3%)	60(5.1%)	518 (43.6%)
Aerobika	295 (24.8%)	153 (12.9%)	77(6.5%)	663 (55.8%)
PEP mask	253 (21.3%)	191 (16.1%)	75(6.3%)	669 (56.3%)
Other MCDs	279 (23.5%)	201 (16.9%)	91(7.7%)	617 (51.9%)

**Note:** Data are presented as frequencies and percentages. **MCDs**, mucus clearance devices

## Discussion

This is the first Saudi national study to report the use of MCDs in clinical practice. The results demonstrate that awareness about MCDs in clinical practice exists in general but there are differences in preferences for device among HCPs as well as around the threshold of symptoms where a device would be recommended. flutter and acapella were the most frequently prescribed devices compared to other MCDs in COPD management. Among all the participants, using MCDs were accepted in such management but there were different responses regarding the use of MCDs with exacerbated patients. The data on prescribing MCDs revealed that the acapella and flutter devices were favored in the clinical setting. The treatment recommendation for COPD was based on the GOLD guidelines.

In clinical settings, patients with COPD with persistent productive coughs are common but there are few steps taken to deal with this.(6 21) Our results demonstrate that awareness about assisting COPD patients with MCDs is present among HCPs in Saudi Arabia but there are differences in their responses regarding the role of MCDs in treating COPD. This is perhaps because of the lack of evidence that emphasizes the importance of using non-pharmacological treatment in COPD management.(8 13) In addition, MCDs have received less attention as a treatment for stable and exacerbated COPD patients. This is, perhaps, owing to a lack of knowledge (13 15 16) or the lack of adopting guideline recommendations about the potential role of MCDs in COPD management.(15)

HCPs had a strong preference for flutter and acapella for mucus clearance. But with COPD management, acapella, particularly, was the most favored device. This is consistent with a survey that was carried out previously in the UK concerning MCDs for COPD patients.(3) In that research, HCPs were more likely to use acapella for COPD management compared to other MCDs.(3)

Current evidence supports the use of both acapella and flutter as common options for airway clearance therapy for COPD, but there are many other MCDs available. (22-24) It is the case that MCDs receive less attention in clinical practice because of the lack of awareness about their effectiveness in COPD management. However, evidence is still emerging to support their use in this management.(9 10) For example, a recent

1  
2  
3 randomized clinical trial of using acapella treatment versus the active cycle of breathing  
4 technique in stable COPD patients over three months yielded promising results. The  
5 study demonstrated significant values for the regular use of these devices. After three  
6 months of regular use of the acapella in stable COPD patients, cough-related quality of  
7 life, as well as mucus clearance, significantly improved.(8 9)  
8  
9

10 In COPD management, increased mucus clearance and the control of symptoms via  
11 MCDs is a desirable goal, and clinicians must consider this in treating COPD patients.(22  
12 25) Our analysis has revealed that recommendations for MCDs for COPD patients were  
13 following different guidelines to those being used to prescribe them. This is an indicator  
14 that clinical practice is missing the best practice strategy by not recommending MCDs.(15  
15 16 26)However, it must be remembered that domestic clinical practice guidelines cannot  
16 be generalized to fit all clinical centers and hospitals in Saudi Arabia as there are other  
17 aspects to be considered, such as maturity of COPD care in the kingdom as well as the  
18 cost and availability of the devices. (13 16 27)  
19  
20

21 Our findings show that, in general, most clinicians would give MCDs to COPD patients  
22 with or without prescriptions. This is attributed to the fact that these devices, like any other  
23 non-pharmacological treatments, have fewer contraindications compared to  
24 pharmacological treatment.(5) In addition, managing COPD and controlling symptoms  
25 require a bundle of treatments, of which MCDs are but one. (28)  
26  
27

28 At the clinician level, family physicians numbered the fewest clinicians in terms of  
29 providing MCDs for COPD patients. This may be because of the physicians' generally  
30 limited perception concerning the benefits of non-pharmacological treatments, including  
31 MCDs in COPD management. This was explored by Al dahair et al., who reported the  
32 perceptions of Saudi Arabian physicians concerning non-pharmacological treatment for  
33 COPD.(16) A lack of experience and lack of enough information were considered to be  
34 challenges in clinical practice.(16) Perhaps real-time clinical data on MCD prescriptions  
35 would give us a clearer picture of their use in clinical settings.  
36  
37

38 Our findings show that recommending MCDs is usually driven by medical judgment rather  
39 than clinical guidelines. Similarities have been found regarding MCD prescribing in  
40 different parts of the world.(5 24 29) This may be attributed to the growing clinical  
41 evidence regarding MCD effectiveness in COPD management.(8) In Saudi Arabia, there  
42 are a limited number of advanced COPD clinics that provide comprehensive COPD  
43 management, including MCD training.(16 27 30) The use of MCDs, like any other airway  
44 clearance technique, needs training for both patients and HCPs.(31) The establishment  
45 of telehealth approaches to deliver training, conduct follow-ups with patients, and to  
46 monitor adherence to MCD guidelines has already been proposed.(9) This approach was  
47 found suitable and effective during the COVID-19 outbreak for demonstrating, instructing,  
48 and following up with COPD patients who used MCDs.(9 32 33)  
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52 According to this study, MCD preference could be driven by their availability at the clinical  
53 center or the features of the MCD itself. For example, acapella devices have certain  
54 mechanical advantages, such as being gravity-independent, which allow the patient to  
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3 use the device in any position. (34) This field of research is growing globally and there  
4 are always new devices that provide the same functions and help COPD patients with  
5 sputum clearance. Future research may focus on comparing these devices one-to-one to  
6 further inform the medical guidelines, as well as help reach a clinical consensus.  
7

8  
9 As this is the first national survey about MCDs in Saudi Arabia, several lessons have been  
10 learned from this research. First, we have found that the perceived benefits of MCDs  
11 among clinicians vary. Second, it seems that medical judgment and recommendations  
12 guide the application of MCDs rather than the clinical guidelines. At present, the clinical  
13 guidelines for COPD management in Saudi Arabia still neglect the use of MCDs. Third,  
14 there is still insufficient data related to the use of MCDs compared to mucolytics or  
15 medications. It is hoped that the data from this study will inform the current practice  
16 regarding MCDs in general, as well as with COPD patients, as an option in clinical  
17 practice.  
18

### 19 20 Strengths and Limitations

21  
22 This study has several strengths. First, it is the first national Saudi cross-sectional study  
23 to explore and report on MCDs use in clinical practice. Second, the participants in this  
24 study were from multiple clinical centers, and they were all dealing with COPD, thus,  
25 offering extended validity for the results presented here. These results could serve as a  
26 baseline for future work in this growing field of the evaluation of MCD use. However, they  
27 must be interpreted with caution. The survey focused on four MCDs while there are many  
28 more in use in clinical practice. Even though our sample covers HCPs from multiple  
29 backgrounds, we may not have captured the full response to and all the perceptions of  
30 others regarding the use of MCDs in clinical practice. It would be helpful if future research  
31 compared our data with clinical or prescription data.  
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33

### 34 35 Conclusion

36  
37 HCPs are aware of the existence of MCDs and their benefits for sputum clearance. HCPs  
38 believe that MCDs are beneficial in sputum clearance with stable and exacerbated COPD  
39 patients. However, real-time clinical data recording the use of MCDs is lacking, and  
40 further efforts are required to explore the actual usage of MCDs.  
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48 Twitter: @COPDdoc @saeedmordy  
49

50  
51 Contributors: SMA and NSH were responsible for the conceptualization, designing,  
52 obtaining ethical approval for the study, and wrote the first version of the manuscript.  
53 AAA, YMA, AAR, ASA, and RAS did the acquisition of the data and data validity. AHA,  
54 AMA, JSQ, AMZ, STJ and BA planed and run statistical analysis of the data and interpret  
55 data. SMA, NSH, AAA, YMA, AAR, ASA, RAS, AHA, AMA, JSQ, AMZ, STJ and BA  
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3 contributed to and approved the final version of this manuscript. SMA has full  
4 responsibility for the work and/or the conduct of the study, had access to the data, and  
5 controlled the decision to publish.  
6

7  
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9 agency.  
10

11 Competing interests: None  
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13 Patient consent for publication: None.  
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15 Data sharing statement: Data are available upon reasonable request.  
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18 Word count: 3105  
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## 50 **Figure legends**

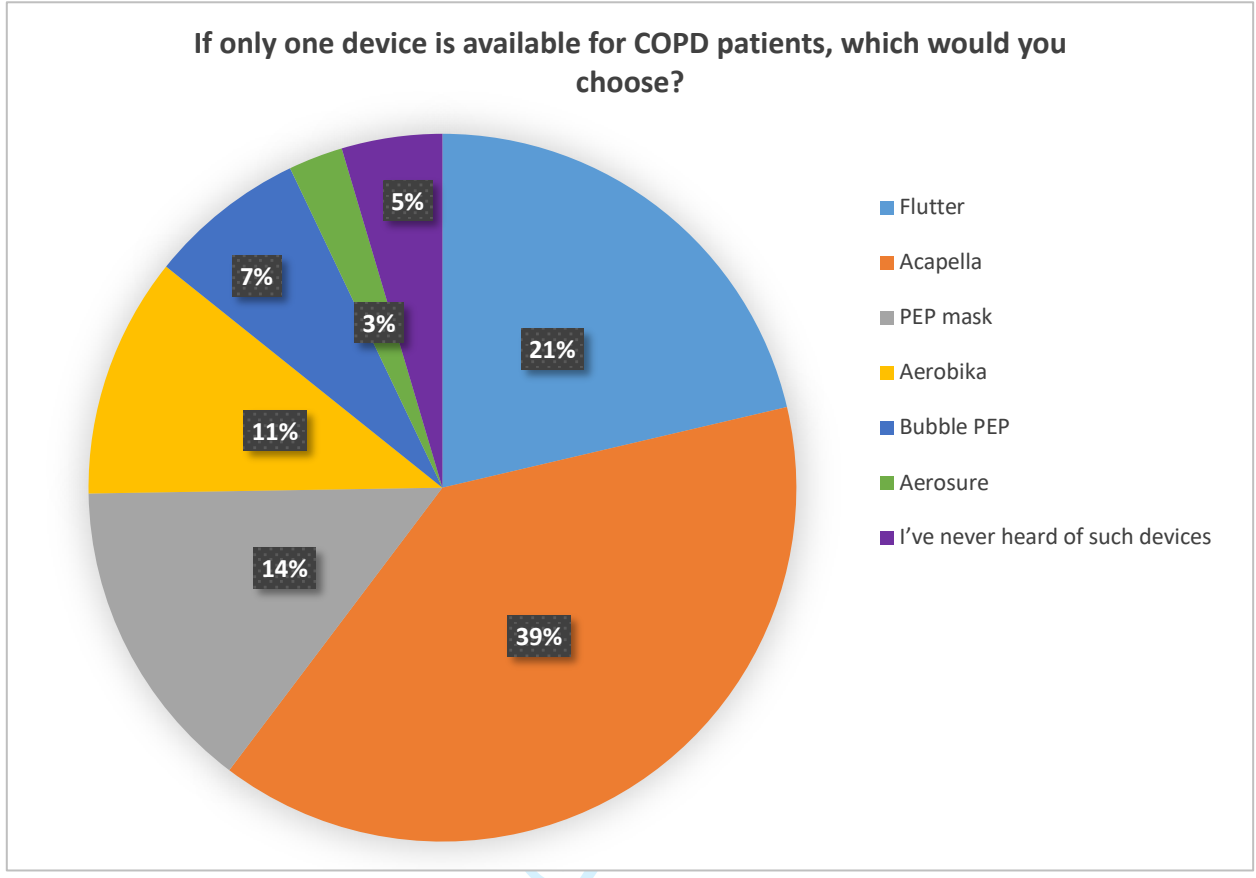
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52 Figure 1. Mucus clearance device preference (n=1188).  
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3 Figure 2. Threshold to consider use of mucus clearance devices for COPD  
4 management (n=1188).  
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7 Figure 3. Clinical practice for using MCDs in the last six months (n=1188).  
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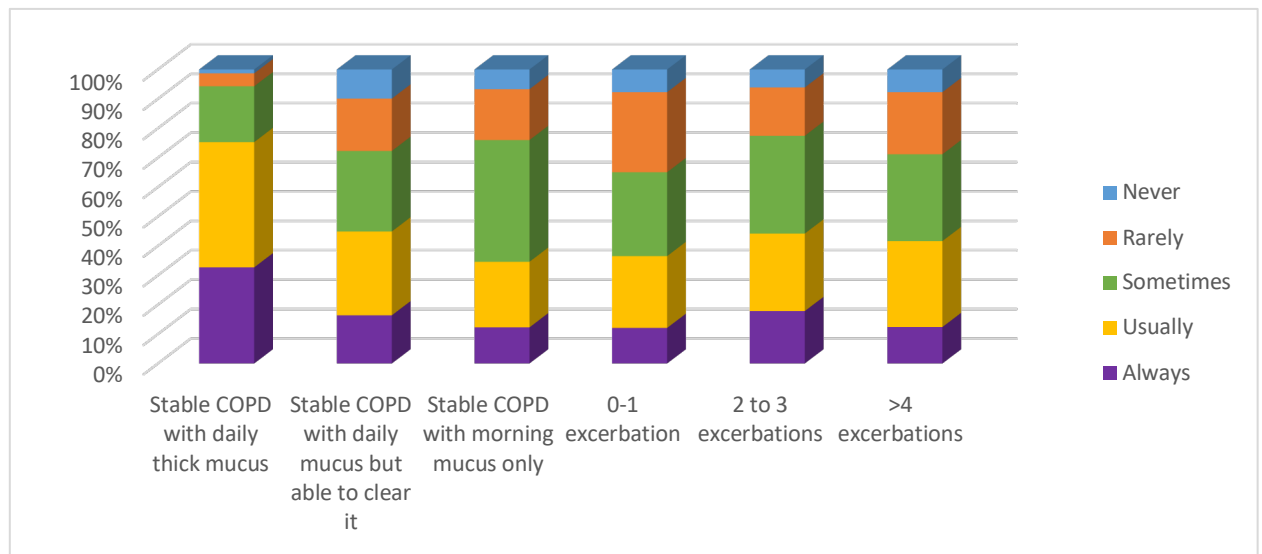
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Figure 1. Mucus clearance device preference (n=1188).



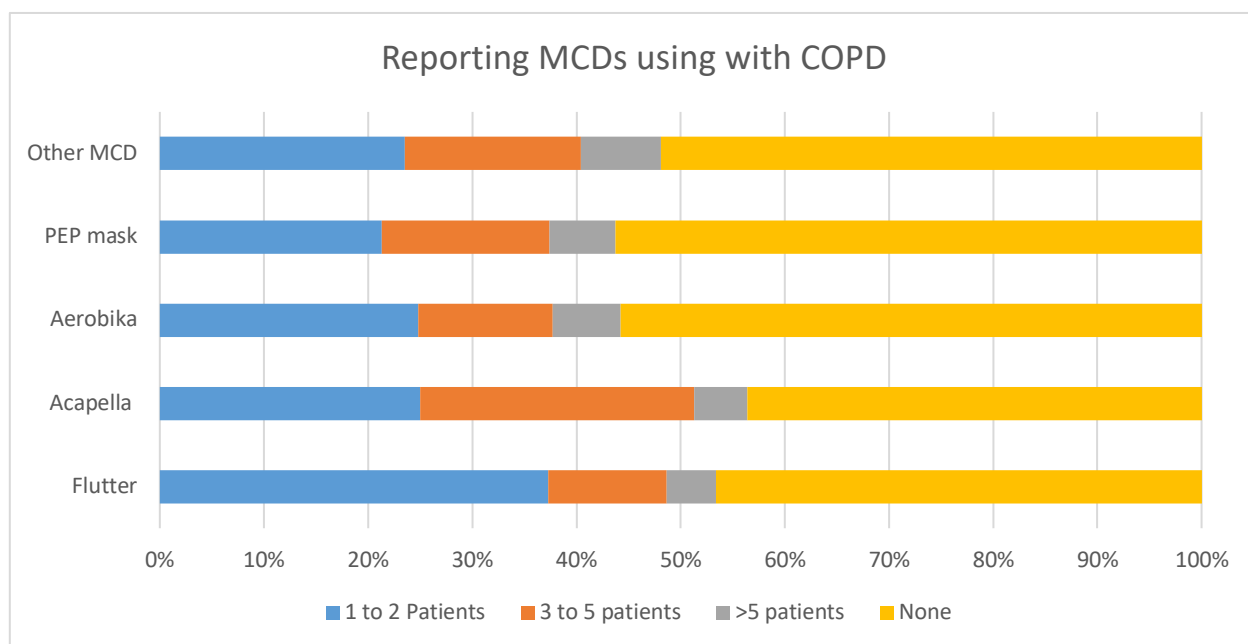
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Figure 2. Threshold to consider use of mucus clearance devices for COPD management (n=1188).



Peer review only

Figure 3. Clinical practice for using MCDs in the last six months (n=1188).





# Use of sputum clearance devices in patients with COPD in Saudi Arabia

Sputum clearance devices like the Acapella and Flutter can be used to aid sputum clearance. We are interested in finding out about health professionals' experience with their use in people with COPD.

The survey is about short-term and long-term home and clinical use. The results will be analysed anonymously by researchers at Umm Al-Qura University. There are no right or wrong answers, we are trying to find out about professional's attitudes and experiences. The survey should take less than 5 minutes to complete.

If you have any questions please free to contact the project coordinator

By completing the survey questions, you freely agree to engage in this study and offer your agreement to utilize your anonymous data for research purposes.

\* Indicates required question

## Demographic data

1. Please indicate your age \*

Mark only one oval.

- 20 - 30
- 31-40
- 41-50
- 51-60
- 61-70

2. Please pick your gender \*

Mark only one oval.

- Male
- Female

3. Your nationality \*

Mark only one oval.

- Saudi
- Non-Saudi

4. Geographic location \*

Mark only one oval.

- Central region
- Northern region
- Southern region
- Eastern region
- Western region

5. Academic qualification \*

Mark only one oval.

- Associate diploma
- Bachelor degree
- Master degree
- PhD degree

6. Please tick one box which best describes your role in your clinical centre/ Hospital \*

Mark only one oval.

- General physician
- Family medicine doctor
- Pulmonology
- Respiratory Therapy
- Nurse
- Physiotherapy
- Other: \_\_\_\_\_

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7. Where do you work? - pick one description that fits the best for you \*

Mark only one oval.

- General practice/ Local primary care centre
- Governmental Hospital
- Privet clinic/ Hospital
- Rehabilitation centers

8. Are you still intern/ under training program / under preceptorship program? \*

Mark only one oval.

- Yes
- No

9. How many years you were certified/registered? \*

Mark only one oval.

- 1-2 years
- 3-4 years
- 5-6 years
- 7-8 years
- > 8 years

W only

10. Which of the following sputum clearance devices are you aware of? **Choose all that apply** \*

Tick all that apply.



Flutter



Acapella



Aerobika



Aerosure



Bubble PEP



PEP mask

Other: \_\_\_\_\_

Option 7

11. Device preference - if only one device is available for COPD patients, which would you choose? \*  
pick one

Mark only one oval.

- Flutter
- Acapella
- Aerobika
- PEP mask
- Bubble mask
- Other: \_\_\_\_\_

How often would you consider the use of sputum clearance device to help sputum clearance in the following situation? For this question assume that the person has been taught active cycle of breathing techniques or standard care for sputum clearance in your place.

**Please answer the following scenarios**

12. COPD patient with daily difficult to clear thick sputum \*

Mark only one oval.

- Always
- Usually
- Sometimes
- Rarely
- Never

13. COPD patient producing sputum throughout the day but able to clear it \*

Mark only one oval.

- Always
- Usually
- Sometimes
- Rarely
- Never

14. COPD patient with morning sputum only \*

1  
2 *Mark only one oval.*

- 3  
4  Always  
5  Usually  
6  Sometimes  
7  Rarely  
8  Never  
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15. COPD patient who only has sputum with exacerbations. Has 0-1 exacerbations/year \*

16  
17 *Mark only one oval.*

- 18  
19  Always  
20  Usually  
21  Sometimes  
22  Rarely  
23  Never  
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16. COPD patients who only has sputum with exacerbations. Has 2-3 exacerbations/year \*

28  
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31 *Mark only one oval.*

- 32  
33  
34  Always  
35  Usually  
36  Sometimes  
37  Rarely  
38  Never  
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17. COPD patients who only has sputum with exacerbations. Has >4 exacerbations/year \*

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47 *Mark only one oval.*

- 48  
49  Always  
50  Usually  
51  Sometimes  
52  Rarely  
53  Never  
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18. How many patients with COPD have you actually started on the following devices in the last 12 months? \*

Mark only one oval per row.

	None	1-2	3-5	>5
<b>Flutter</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Acapella</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Aerobika</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>PEP mask</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>Other devices</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

19. How would you usually provide sputum clearance device to a COPD patient (pick the one that applies most commonly)? \*

Mark only one oval.

- I don't provide them
- I have them available to give to patients
- Prescription
- Advise patient to buy their own

#### Policy and Guidelines

20. Do you recommend sputum device in COPD based on clinical practice guidelines? \*

Mark only one oval.

- Yes
- No

21. If yes, which guidelines?

Mark only one oval.

- GOLD guidelines for COPD
- NICE guidelines for COPD
- AARC guidelines for COPD
- Saudi Thoracic Society guidelines for diagnosis and management of COPD
- Domestic clinical practice guidelines at your center/hospital

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## Google Forms

For peer review only



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*Supplemental Table 1: Providing MCDs in clinics*

<b>Item</b>	<b>Frequency (%)</b>
I advise patients to buy their own	116 (9.8%)
I don't provide them	314 (26.4%)
I have them available to give to patients	378 (31.8%)
Prescription	380 (32.0%)
AARC guidelines for COPD	15.70%
Domestic clinical practice guidelines at the center/hospital	16.10%
GOLD guidelines for COPD	20.10%
NICE guidelines for COPD	15.00%
STS guidelines for diagnosis and management of COPD	16.65%

## STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (page 2) (b) Provide in the abstract an informative and balanced summary of what was done and what was found (page 2)
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (Page 4)
Objectives	3	State specific objectives, including any prespecified hypotheses (Page 5)
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper (Page 5)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (Page 5)
Participants	6	(a) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (N/A) <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls (N/A) <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants (Page 5) (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed (N/A) <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case (N/A)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (Page 6)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (Page 5)
Bias	9	Describe any efforts to address potential sources of bias (N/A)
Study size	10	Explain how the study size was arrived at (Page 6)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (Page 6)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (Page 6) (b) Describe any methods used to examine subgroups and interactions (N/A) (c) Explain how missing data were addressed (N/A) (d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed (N/A) <i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (Page 6) (e) Describe any sensitivity analyses (N/A)

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<b>Results</b>		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (Page 6) (b) Give reasons for non-participation at each stage (N/A) (c) Consider use of a flow diagram (N/A)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (Pages 7-10) (b) Indicate number of participants with missing data for each variable of interest (N/A) (c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount) (N/A)
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time (N/A) <i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure (N/A) <i>Cross-sectional study</i> —Report numbers of outcome events or summary measures (Pages 7-10)
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (N/A) (b) Report category boundaries when continuous variables were categorized (N/A) (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (N/A)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (N/A)
<b>Discussion</b>		
Key results	18	Summarise key results with reference to study objectives (Page 11)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (Page 13)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (Pages 11 -13)
Generalisability	21	Discuss the generalisability (external validity) of the study results (Page 13)
<b>Other information</b>		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (Page 13)

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).