

1 **Title:** Patient perception of inhaler use and its implications in inhaler management.

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1 **Conflicts of Interest Statement:**

2 Based on ICMJE guidelines, there are no potential conflicts of interest to disclose.

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4 **Key Words:**

5 COPD; Medical Error, Patient Safety, Quality of Care

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7 **Total Word Count:**

8 1870

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1 **Abstract:**

2 **Objectives:** Literature has shown a high prevalence of poor inhaler technique amongst COPD

3 patients throughout the past several decades. We aim to study the patients’ perspective on the use of

4 inhalers to understand how inhaler therapy can be better approached.

5 **Methods:** COPD patients who were regularly using pressurized metered-dose inhaler(s) (pMDI)

6 with or without spacers were recruited to complete a survey regarding their perception of inhaler

7 use.

8 **Results:** One hundred and one patients participated in the study. 91 (90.1%) reported that they use

9 their inhaler correctly and 80 (79.2%) indicated that using their inhaler is easy. 35 (34.7%) indicated

10 that they prefer to consolidate all of their inhalers. When asked about previous training, 25 (24.8%)

11 reported that they have not been shown how to use inhalers before.

12 **Conclusions:** Despite high prevalence of poor inhaler technique, COPD patients may not be aware

13 of their poor technique—patients are confident in their use of inhalers and find its use easy. This

14 discrepancy has not been discussed in literature before. Increasing patient awareness regarding poor

15 inhaler technique and the importance of correct use of the device may be the key next step to

16 address poor inhaler technique amongst COPD patients.

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1 **Additional Information:**

2 What is already known about this topic?

- 3 • Inhaler misuse is prominent in asthma and COPD patients. Literature has shown that more
4 than 30% of patients incorrectly use their inhalers.
- 5 • Despite this awareness and increased educational efforts, there has been no improvement in
6 patients' inhaler technique for the past several decades.

7 What does this article add?

- 8 • Our study assessed the patient's perception of their inhaler technique, which has not been
9 studied previously.
- 10 • Most patients reported that they use inhalers correctly and found them easy to use. The
11 discrepancy in the patients' view of their inhaler technique and their actual assessed
12 technique may explain the difficulty in improving patients' inhaler technique despite
13 numerous efforts.

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1 **1. Introduction**

2 Chronic Obstructive Pulmonary Disease (COPD) is a chronic respiratory condition characterized by
3 persistent airflow limitation leading to chronic symptoms of cough, dyspnea, and sputum
4 production. COPD management aims to reduce those symptoms and reduce acute exacerbations.
5 Inhalational therapy is the preferred route of administration of COPD medications, since it evades
6 potent adverse effects associated with systemic dosing (Courtney Broaddus & Mason, 2016). Long-
7 acting beta agonist (LABA), long-acting muscarinic antagonists (LAMAs), and inhaled
8 corticosteroids (ICS) are the available maintenance inhaler classes. They are effective in providing
9 symptomatic relief, improving health related quality of life, and reducing exacerbations (Kew et al.
10 2013; Koch et al. 2014).

11
12 As inhalers serve as the principal medium for medication in COPD patients, it is extremely
13 important that patients use the inhaler with optimal technique for adequate drug delivery.
14 Unfortunately, high prevalence of poor inhaler technique in COPD and asthma patients has been
15 reported in literature (Usmani et al. 2018). A recent study demonstrated that correcting this poor
16 inhaler technique has shown to improve the quality of life of COPD patients as evidenced by
17 improved FEV1 and COPD Assessment Test (CAT) scores (Khurana, 2019). This highlights the
18 impact of correct inhaler technique in improving overall COPD management.

19
20 Given the high prevalence of poor inhaler technique, the aim of our study was to assess the
21 perception of inhaler use in patients with COPD. We aimed to assess patients' perception of their
22 own technique, satisfaction of inhaler treatment, and perspectives on inhaler devices and inhaler
23 education and training. We believe that learning about the patients' view may provide us with the
24 key in improving the overall COPD management via inhalers.

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26 **2. Methods**

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Design and Participants

This study was a survey of patients with a diagnosis of COPD carried out at a single tertiary center in the outpatient pulmonary clinic. The manuscript authors developed the study design and survey questions after extensive literature review on inhaler use and patient perspectives on treatments in healthcare. The survey was not formally validated, however, was tested in three healthcare professionals. We enrolled patients from June 2018 and April 2019 and the survey was conducted in person by members of the research team. A clear explanation of the study was provided to each patient and informed consent was obtained. The Saint Louis University institutional review board approval was obtained prior to recruitment of participants. There was no funding for this study.

Adults aged ≥ 18 years and ≤ 90 years with a diagnosis of COPD who were regularly using pressurized metered-dose inhaler(s) (pMDI) with or without spacers were recruited for this study. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria for airflow limitation ($FEV_1/FVC < 0.70$) was utilized (Singh et al. 2019). Patient exclusion criteria included any patients with a concurrent diagnosis of asthma, a diagnosis of COPD but not meeting GOLD criteria, patients with COPD not using pMDIs, and patients aged < 18 years and > 90 years. After the above screening, written informed consent was obtained for each participant.

Survey items development and analysis

The survey consisted of 7 close-ended questions investigating patients' views on their number of inhalers, correct use, difficulty of use, previous training, need of refresher training, and efficacy in symptom relief (Table 1). A member of the research team was always accompanying when completing the survey and was available to answer any clarifying questions regarding the survey.

1 Survey answers were manually added into a data sheet using Microsoft Excel. Descriptive statistics
2 were performed on each survey question.

3

4 Table 1.

1.	With regards to inhalers, do you feel you need: (more, just right, less inhalers)
2.	Do you prefer to consolidate all of your inhalers in one inhaler? (agree, doesn't matter, disagree)
3.	Do you use your inhaler correctly? (yes or no)
4.	Difficulty using inhaler (difficult, doable, easy)
5.	Have you ever had someone show you how to use your inhaler? (yes or no)
6.	Do you need a refresher training for inhaler use? (yes or no)
7.	Do you think your inhalers provide symptom relief? (yes or no)

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7 **3. Results**

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1 One hundred and one patients (mean age 64.74 years; 61.4% female) met the study criteria and
2 participated in the study (Figure 1). Patients utilized a range of 1 to 4 different inhalers, with 58
3 (57.4%) patients utilizing 3 inhalers. The majority of patients were prescribed a combination of
4 tiotropium bromide, budesonide-formoterol, and albuterol sulfate (Figure 2).

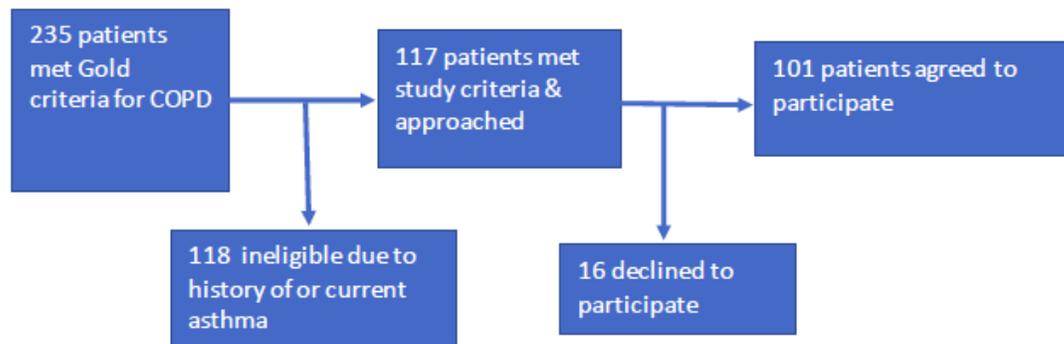
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6 All recruited patients succeeded in completing the survey. Most patients indicated that they have
7 just the right amount of inhalers, with 17 (16.8%) saying that they need more inhalers, 75 (74.3%)
8 that the number of inhalers they have are just right, and 9 (8.9%) that they need less inhalers (Graph
9 1). 35 (34.7%) indicated that they would prefer to consolidate all of their inhalers into one, 55
10 (54.5%) said that it doesn't matter, and 11 (10.9%) said that they do not prefer to consolidate all of
11 their inhalers into one (Graph 2).

12
13 When asked about inhaler use, the majority of patients believed that their inhalers are easy to use
14 and that they use it correctly. 91 (90.1%) reported that they use their inhaler correctly while 10
15 (9.9%) said that they use it incorrectly (Graph 3). 80 (79.2%) indicated that using their inhaler is
16 easy, 18 (17.8%) indicated that it is doable, and only 3 (3.0%) indicated that they have difficulty
17 using their inhaler (Graph 4).

18
19 When asked about training, 76 (75.3%) reported that they have had someone show them how to use
20 their inhaler before, while 25 (24.8%) reported that they have not. 24 (23.8%) reported that they
21 need a refresher course, while 77 (76.2%) reported that they do not (Graph 5). Finally 92 (91.1%)
22 reported that they think their inhalers provide symptom relief, while 9 (8.9%) reported that they do
23 not (Graph 6).

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25 Figure 1. Patient Recruitment



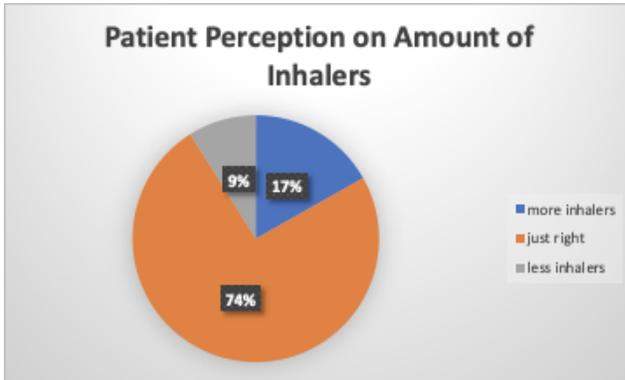
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Figure 2: Demographics

		Male (n = 40)	Female (n = 61)
Mean age		64.2	63.5
Race	African American	52.5%	55.7%
	Caucasian	40.0%	41.0%
	Other	7.5%	3.3%
Smoking		47.4% *2 patients declined to answer	42.1% *2 patients declined to answer
Mean number of inhalers		2.6	2.6
Most common inhaler combination		Tiotropium bromide, Budesonide-formoterol, and Albuterol sulfate	Tiotropium bromide, Budesonide-formoterol, and Albuterol sulfate

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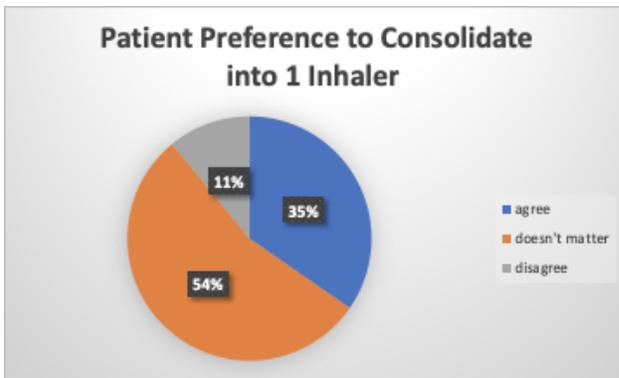
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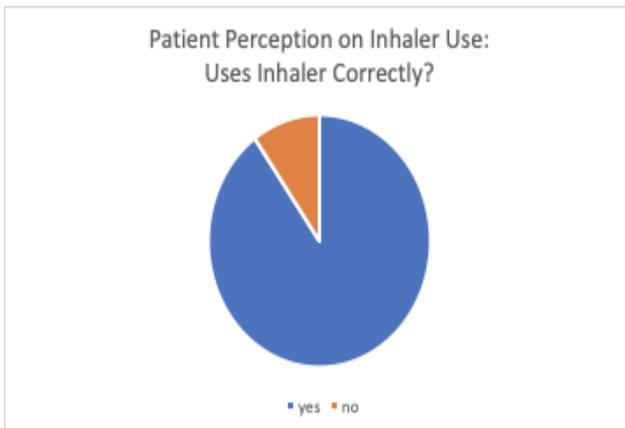
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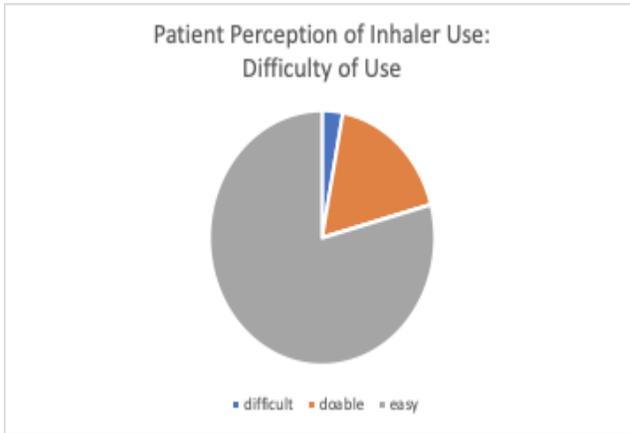
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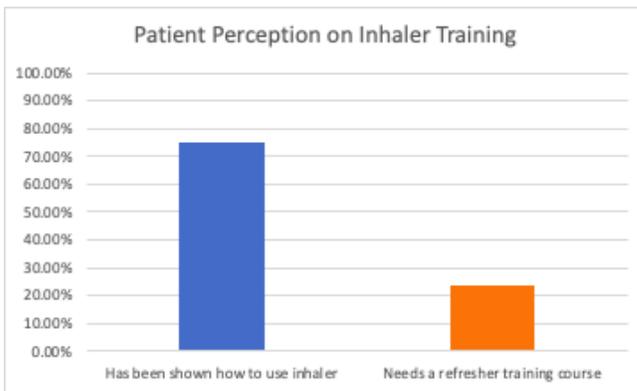
2 Graph 4.



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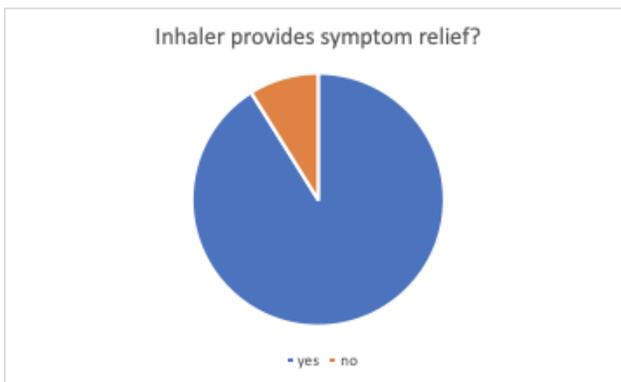
5 Graph 5.



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8 Graph 6.



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1 **4. Discussion and Conclusion**

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3 **4.1. Discussion**

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5 A key finding of our study was that the majority of the patients had a self-perception of adequate
6 inhaler technique. This finding contradicts the current literature reports on the high prevalence of
7 poor inhaler technique. A systematic review of articles from 1975 to 2014 revealed that only 31% of
8 inhaler users demonstrated correct technique regardless of the year of investigation (Sanchis et al.,
9 2016). The discrepancy between patients' perception of their technique and current evidence of
10 poor technique can suggest that while many patients are not using their inhalers correctly, they are
11 not aware of it.

12

13 Many factors can lead to poor inhaler technique: the variety of inhaler types, difficulty of steps, age
14 of the COPD patient population, comorbidities, and efficacy of inhaler technique education. One
15 study discussed the discrepancy in the perception of inhaler technique counseling between
16 healthcare professionals and patients. While healthcare professionals reported providing counseling
17 of inhaler technique, patients reported being dissatisfied with the information provided (Gultekin,
18 2019). It highlighted the need for improvement in understanding patients' perception of inhaler use
19 and its effectiveness. The patients' perception may be of critical importance in determining what we
20 have been missing in the effort to improve better inhaler use amongst COPD patients.

21

22 One finding that provides further insight into this is that a large number of patients found the use of
23 inhalers to be "easy." The majority of patients also reported that they did not need a refresher
24 training. Given the evidence in literature of poor inhaler technique, this is an unexpected finding
25 that both patients and providers may have overlooked. It provides a potential explanation in the

1 continuing difficulty in improving inhaler technique--since patients are not aware of their mistakes,
2 they are not actively seeking correction.

3
4 Combining treatments into various combinations of inhalers is another area that is important to
5 evaluate from a patient's perspective. Studies investigating the perception and preference of patients
6 with regards to their navigation of multiple inhalers have shown that fixed triple therapy and once a
7 day dosing was preferred, resulting in an increase in adherence (Molino, 2018; Bogart et. al, 2019).
8 One study conducted via patient surveys also showed that patients believe they would have an
9 easier time using their inhaler(s) if there were fewer operational steps, easier coordination of
10 breathing maneuver, and confirmation of dose delivery (Molimard and Colthorpe, 2015).

11
12 In our study, it is notable that a majority of patients (57.4%) utilized a total of 3 different inhalers
13 including pMDIs and DPIs. While the majority of patients reported having just the right amount of
14 inhalers and having no preference in consolidating their inhalers, a significant proportion (34.7%) of
15 patients preferred to consolidate their inhalers into one. As discussed above, utilizing multiple
16 inhalers that have different steps in inhaler technique may be difficult, result in poor compliance,
17 and potentially worsen patients outcomes (Bosnic-Anticevich et al. 2016). Patients may ultimately
18 benefit from consolidating their inhalers into one.

19
20 Despite the high number of patients in our study reporting that they've been trained on using their
21 inhaler, not all of them did. According to GOLD guidelines, inhaler technique should be assessed
22 regularly (Singh et al. 2019). More importantly, all patients should be coached on how to use their
23 inhaler when first provided with it. A few studies have shown that healthcare professionals'
24 knowledge regarding the use and maintenance of inhalation devices are limited (Braman, 2018; De
25 Tratto, 2014). The limitation in adequate inhaler education reveals another challenge in optimizing
26 patients' technique.

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2 Having 91.1% of patients report symptoms relief with inhaler use demonstrates the subjective
3 effectiveness of inhaler therapy even with suboptimal medication delivery. As evidenced by
4 improved FEV1 and CAT scores by correcting inhaler technique (Khurana, 2019), we anticipate
5 even greater satisfaction of inhaler therapy with optimal medication delivery via correct inhaler
6 technique.

7

8 Study Limitations:

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10 One limitation of the study was the close-ended nature of the questions. Most of the questions were
11 simple yes or no questions or had three answer choices to pick from. Although this format of
12 questions provided the benefit of quantitative analysis via comparing the proportion of patients'
13 responses, it limited the investigation of patients' specific opinions on their use of inhalers.
14 Moreover, it was difficult to determine what exactly patients meant when they found the use of
15 inhalers easy. Different patients may have referred to different degrees of ease. Having the
16 opportunity to subjectively explain their answers may have provided further insight.

17

18 Another limitation of the study was the limited variety of the study population. The study was
19 performed in one urban academic outpatient clinic. The majority of the study population were
20 Caucasian or Black and the vast majority of patients used 3 inhalers. The lack of heterogeneity of
21 the study population may limit the generalizability of results.

22

23 **4.2. Conclusion**

24

25 Despite literature evidence of high prevalence of poor inhaler technique, patients with COPD may
26 not be mindful of their poor technique. Patients are generally satisfied with the inhalational therapy

1 and are confident in their use of inhalers. This discrepancy has not been highlighted in literature
2 thus far and may explain past difficulties in improving patients' inhaler technique. Increasing
3 patients' awareness may be a key point to address in future efforts to improve inhaler therapy in
4 COPD management.

5
6 We believe a key first step in improving inhaler technique is to increase awareness amongst COPD
7 patients about the high prevalence of poor inhaler technique and the importance of correct use of the
8 device. Having providers point out particular key steps (e.g. remembering to exhale to clear out the
9 lungs before inhaler administration) that many patients omit would be very useful. We also
10 recommend consolidation of inhalers as well as thorough inhaler technique education both at the
11 initiation of the inhaler therapy and on subsequent visits to best help patients' adherence.

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13 **5. Acknowledgements**

14

15 We thank our Pulmology office and all physicians, nurses, and staff in the office for allowing us to
16 proceed with this study. We disclose no external funding for this study.

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References:

1. Bogart, M., Stanford, R. H., Laliberté, F., Germain, G., Wu, J. W., & Duh, M. S. Medication adherence and persistence in chronic obstructive pulmonary disease patients receiving triple therapy in a USA commercially insured population. *International Journal of Chronic Obstructive Pulmonary Disease*. 2019;14:343-52. doi:10.2147/copd.s184653.
2. Braman, S. S., Carlin, B. W., Hanania, N. A., Mahler, D. A., Ohar, J. A., Pinto-Plata, V., ... Dhand, R. Results of a Pulmonologist Survey Regarding Knowledge and Practices With Inhalation Devices for COPD. *Respiratory Care*. 2018;63:840–8. doi: 10.4187/respcare.05717
3. Duarte-de-Araújo A, Teixeira P, Hespanhol V, Correia-de-Sousa J. COPD: Analysing factors associated with a successful treatment. *Pulmonology*. 2020;26:66-72. doi:10.1016/j.pulmoe.2019.05.012
4. Duarte-de-Araújo A, Teixeira, P, Hespanhol V, Correia-de-Sousa J. COPD: misuse of inhaler devices in clinical practice. *International Journal of Chronic Obstructive Pulmonary Disease*. 2019;14:1209-17.
5. Gültekin, O., Abdi, A. M., Al-Baghdadi, H., Akansoy, M., Rasmussen, F., & Başgut, B. Counseling of inhalation medicine perceived by patients and their healthcare providers: insights from North Cyprus. *International Journal of Clinical Pharmacy*. 2019;41:1272–81. doi: 10.1007/s11096-019-00882-8.

6. Kew, K. M., Dias, S., & Cates, C. J. (2014). Long-acting inhaled therapy (beta-agonists, anticholinergics and steroids) for COPD: a network meta-analysis. *The Cochrane database of systematic reviews*, (3), CD010844. <https://doi.org/10.1002/14651858.CD010844.pub2>.
7. Khurana A, Dubey K, Goyal A, Pawar K, Phulwaria C, Pakhare A. Correcting inhaler technique decreases severity of obstruction and improves quality of life among patients with obstructive airway disease. *Journal of Family Medicine and Primary Care*. 2019;8:246-50.
8. Koch, A., Pizzichini, E., Hamilton, A., Hart, L., Korducki, L., De Salvo, M. C., & Paggiaro, P. (2014). Lung function efficacy and symptomatic benefit of olodaterol once daily delivered via Respimat® versus placebo and formoterol twice daily in patients with GOLD 2-4 COPD: results from two replicate 48-week studies. *International journal of chronic obstructive pulmonary disease*, 9, 697–714. <https://doi.org/10.2147/COPD.S62502>.
9. Lipson, D. A., Barnhart, F., Brealey, N., Brooks, J., Criner, G. J., Day, N. C., ... Pascoe, S. J. Once-Daily Single-Inhaler Triple versus Dual Therapy in Patients with COPD. *New England Journal of Medicine*. 2018;378:1671–80. doi: 10.1056/nejmoa1713901.
10. Melzer AC, et al. Patient characteristics associated with poor inhaler technique among a cohort of patients with COPD. *Respiratory Medicine*. 2017;123:124-30. doi:10.1016/j.rmed.2016.12.011.
11. Molimard, M., & Colthorpe, P. Inhaler Devices for Chronic Obstructive Pulmonary Disease: Insights from Patients and Healthcare Practitioners. *Journal of Aerosol Medicine and Pulmonary Drug Delivery*. 2015;28:219-28. doi:10.1089/jamp.2014.1142.

12. Molino, A., Calabrese, G., & Maniscalco, M. Patient considerations in the treatment of COPD: focus on the new combination inhaler fluticasone furoate/umeclidinium/vilanterol. *Patient Preference and Adherence*. 2018;12:993–1001. doi: 10.2147/ppa.s152179.
13. Rogliani, P., Ora, J., Puxeddu, E., Matera, M. G., & Cazzola, M. Adherence to COPD treatment: Myth and reality. *Respiratory Medicine*. 2017;129:117–23. doi: 10.1016/j.rmed.2017.06.007.
14. Sanchis, J., Gich, I., and Pederson, S. Systematic Review of Errors in Inhaler Use: Has Patient Technique Improved Over Time? *Chest*. 2016;150:394-406. doi: 10.1016/j.chest.2016.03.041.
15. Singh, D., Papi, A., Corradi, M., Pavlišová, I., Montagna, I., Francisco, C., ... Vestbo, J. Single inhaler triple therapy versus inhaled corticosteroid plus long-acting β 2-agonist therapy for chronic obstructive pulmonary disease (TRILOGY): a double-blind, parallel group, randomised controlled trial. *Lancet*. 2016;388:963–73. doi: 10.1016/s0140-6736(16)31354-x.
16. Tratto, K. D., Gomez, C., Ryan, C. J., Bracken, N., Steffen, A., & Corbridge, S. J. Nurses' Knowledge of Inhaler Technique in the Inpatient Hospital Setting. *Clinical Nurse Specialist*. 2014;28:156–60. doi: 10.1097/nur.0000000000000047.
17. Vanfleteren, L., Fabbri, L. M., Papi, A., Petruzzelli, S., & Celli, B. Triple therapy (ICS/LABA/LAMA) in COPD: time for a reappraisal. *International Journal of Chronic Obstructive Pulmonary Disease*. 2018;13:3971–81. doi: 10.2147/copd.s185975.
18. Vestbo, J., Papi, A., Corradi, M., Blazhko, V., Montagna, I., Francisco, C., ... Singh, D.

Single inhaler extrafine triple therapy versus long-acting muscarinic antagonist therapy for chronic obstructive pulmonary disease (TRINITY): a double-blind, parallel group, randomised controlled trial. *Lancet*. 2017;389:1919–29. doi: 10.1016/s0140-6736(17)30188-5.