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## Assessment of metered dose inhalation technique in patients with chronic lung disease at a tertiary health care center

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### Abstract

**Introduction:** Poor inhalation technique among patients using Metered Dose Inhaler (MDI) is one of the most common causes of increased acute exacerbations and hospital visits and leads to poor health outcome. Hence, the purpose of this research is to evaluate the correctness of inhalation steps in patients using MDI visiting Patan Hospital.

**Method:** A total of 128 patients participated in the research. The study involved collection of basic sociodemographic information and visual observation of the inhalation technique of the patients using a standard checklist. Any mistakes made during the procedure were recorded. They were also asked to say each step as they performed it so that all of the steps could be clearly observed.

**Result:** Out of 128 participants, only 3(2.34%) of the participants were able to perform all the eight steps correctly. Holding breath for five second was the most commonly made mistake 80(62.7%) followed by failure to exhale to residual volume 74(57.7%). Majority of participants were able to perform five steps correctly 29(22.6%). There seemed to be no association of inhalation technique with age, sex and educational status of the patient.

**Conclusion:** Majority of the patients were unable to perform the inhalation steps correctly indicating the need for regular training programs to improve the inhalation technique and improve health outcome.

**Keywords:** chronic lung disease, inhalation steps, metered-dose inhaler

## Introduction

Inhalation therapy is the mainstay of treatment in patients with Chronic Obstructive Pulmonary Disease (COPD) and Asthma as recommended by international strategy guidelines and is needed in any stage of the disease.<sup>1,2</sup> The correct use of inhaler devices is one of the most important aspects to be taken into account when evaluating the progress of disease treatment among individuals with COPD and Asthma, and guidelines emphasize the importance of assessing inhalation techniques to improve the efficiency of drug delivery.<sup>2</sup>

Incorrect usage of inhalers is a significant problem for both asthma and COPD management because it may result in diminished therapeutic effect, resulting in poor control of symptoms and thereby insufficient disease management. Many MDI users fail to demonstrate appropriate inhaler techniques, despite various educational methods. Studies have shown that only 10-50% of patients are able to use their inhalers without errors.<sup>3</sup> A study done in Teaching Hospital, Nepal showed that out of 84% of patients who did not use inhalers correctly, the most common errors were “not exhaling to residual volume” and “not holding breath for 5 seconds.”<sup>4</sup> This study was conducted using a checklist to know inhalation techniques among patients visiting Patan Hospital as this has never been done before.

The main objective was to assess inhalation technique, know the cause if any mistakes were made, and make a proper plan to educate, implement, and teach appropriate practical measures by conducting regular training programs, frequent follow-ups, and providing adequate knowledge about their disease as well as the importance of using the device correctly.

## Method

This is a hospital-based prospective cross-sectional study. It was conducted at the Chronic Care Clinic of Patan Hospital from

November 2018 to November 2019. The study involved the collection of basic sociodemographic information and visual observation of the inhalation technique of the patients using a standard checklist. Any mistakes made during the procedure were recorded. They were also asked to say each step as they performed it so that all of the steps could be clearly observed. The checklist for inhalation technique has eight steps<sup>3</sup> that include the following steps in order:

1. Removing the cap and shaking the inhaler
2. Holding inhaler upright
3. Exhaling to residual volume
4. Keeping head upright or slightly tilted
5. Putting mouthpiece between teeth and lips
6. Inhaling slowly and pressing canister
7. Continuing slow and deep inhalation
8. Holding breath for 5 seconds.

The steps in which most patients made mistake was recorded and corrective steps were taught. All patients who used metered dose inhalers and attended the Chronic Care Clinic of Patan Hospital and were able to demonstrate the inhalation steps were included in the study whereas pediatric patients, those who were not able to demonstrate the steps (critically ill), and those who required assistance from others were excluded from the study.

Approval of the study was obtained from the Institutional Review Committee (IRC) of PAHS. A written consent was obtained from all participants. A generic PAHS format in English and Nepali was used for written consent. The participants could withdraw from the research at any time without giving any reason during the study. The confidentiality of all the participants was maintained. A statement indicating that the participant has understood all the information in the consent form and is willing to participate voluntarily was obtained. Participants were explained about the research detail, its significance, and the benefits and harm in the language he or she understood before obtaining consent, and their queries were answered.

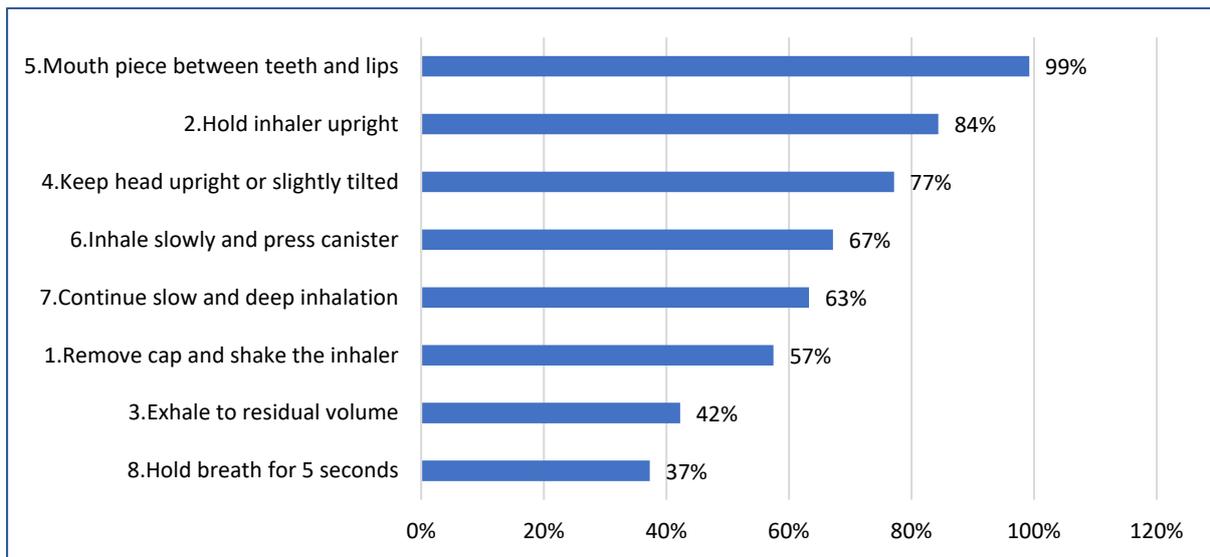
Data was entered in EPI-INFO and Microsoft Excel and analyzed in EPI-INFO and Easy R software. Results are presented in tables and graphs. A comparison of categorized data was done using the Chi-square test. Multiple logistic regression was used to evaluate the association of the technique with demographic variables. A p-value of 0.05 or less was considered significant.

**Result**

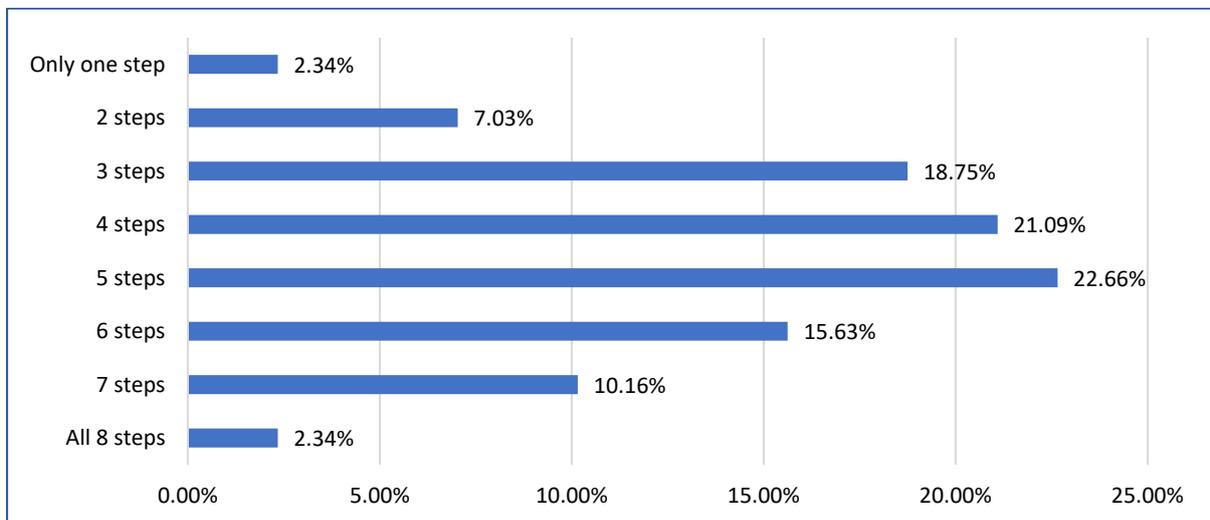
Out of 128 patients meeting the inclusion criteria, 60 were male and 68 were female. The number of patients above 60 y of age was

112(87.50%), and 111(86.72) patients had no form of schooling.

Out of 128 patients who fulfilled the criteria, only 3(2.34%) of the participants were able to perform all 8 steps correctly, Figure 2. Not holding breath for 5 seconds was the most commonly made mistake 48(37%) followed by failure to exhale to residual volume 53(42%), Figure 1. The majority of participants were able to perform 5 steps correctly 29(22.6%). There was no association of the inhalation technique with the age and educational status of the patient, Table 1 & 2.



**Figure 1. Patients performing each step of MDI correctly**



**Figure 2. Patients performing no. of steps of MDI correctly**

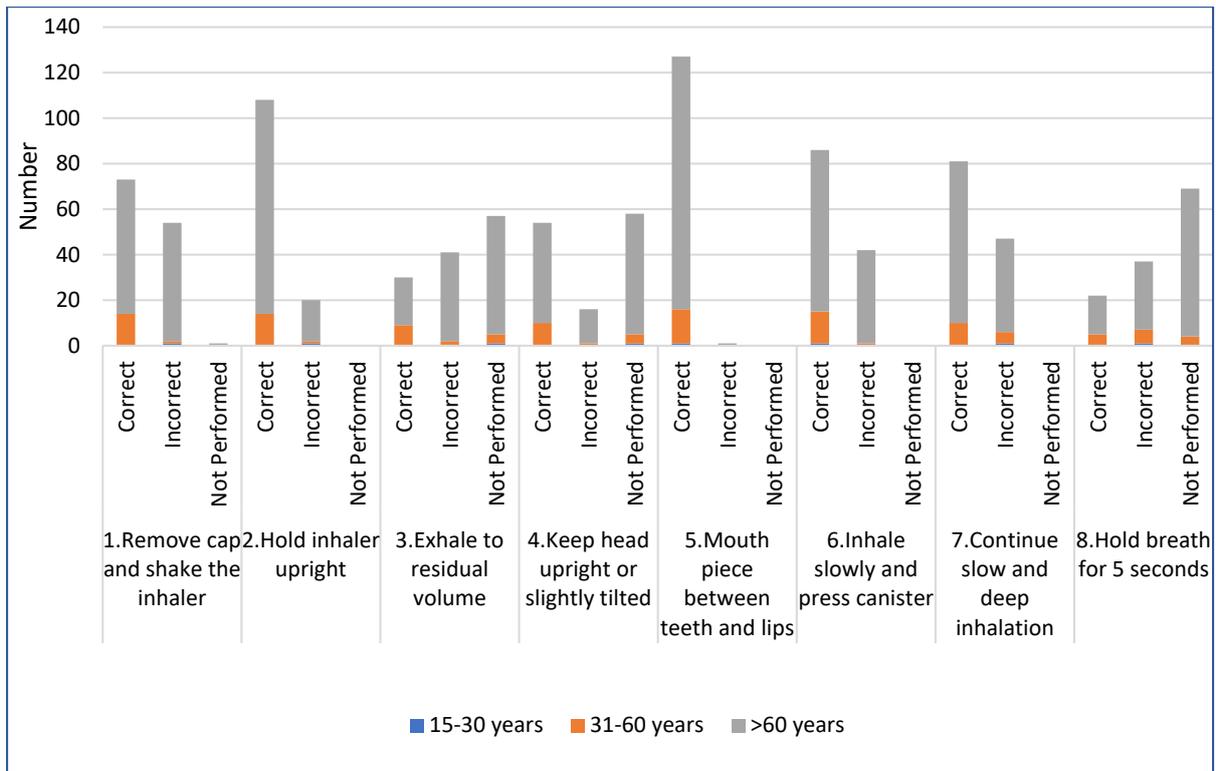


Figure 3. Inhalation technique of MDI according to age

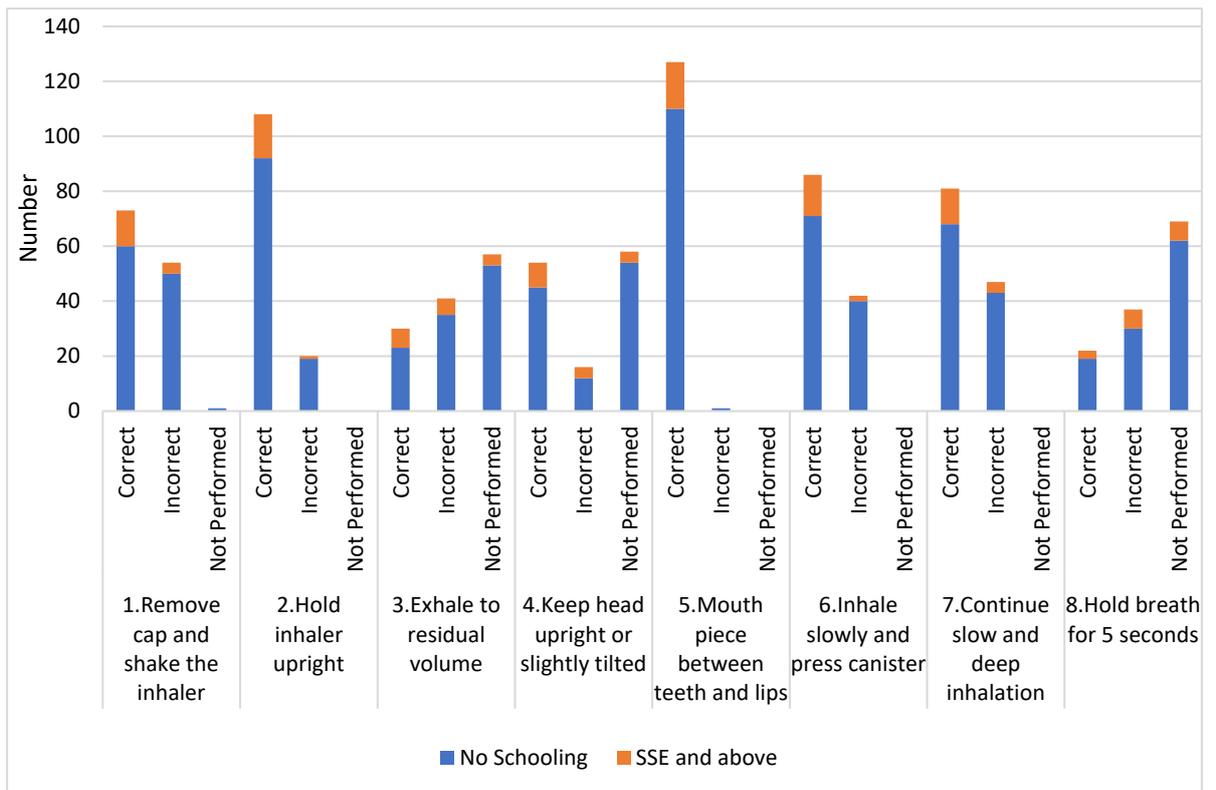


Figure 4. MDI technique among COPD patients according to educational status

Table 1. Association between inhalation technique and age

Inhalation Technique	Process	Age group of patient		Total N(%)	$\chi^2$	
		≤ 60 Years	> 60 Years			
		N(%)	N(%)			
1. Remove cap and shake the inhaler	Correct	14(87.5%)	59(53.2%)	73(57.5%)	$\chi^2$	6.750
	Incorrect	2(12.5%)	52(46.8%)	54(42.5%)	df	1
	Total	16(100%)	111(100%)	127(100%)	Sig.	<b>.009*</b>
2. Hold inhaler upright	Correct	14(87.5%)	94(83.9%)	108(84.4%)	$\chi^2$	.135
	Incorrect	2(12.5%)	18(16.1%)	20(15.6%)	df	1
	Total	16(100%)	112(100%)	128(100%)	Sig.	.713 <sup>a</sup>
3. Exhale to residual volume	Correct	9(81.8%)	21(35.0%)	30(42.3%)	$\chi^2$	8.351
	Incorrect	2(18.2%)	39(65.0%)	41(57.7%)	df	1
	Total	11(100%)	60(100%)	71(100%)	Sig.	<b>.004*,a</b>
4. Keep head upright or slightly tilted	Correct	10(90.9%)	44(74.6%)	54(77.1%)	$\chi^2$	1.403
	Incorrect	1(9.1%)	15(25.4%)	16(22.9%)	df	1
	Total	11(100%)	59(100%)	70(100%)	Sig.	.236 <sup>a</sup>
5. Mouthpiece between teeth and lips	Correct	16(100%)	111(99.1%)	127(99.2%)	$\chi^2$	.144
	Incorrect	0(0%)	1(0.9%)	1(0.8%)	df	1
	Total	16(100%)	112(100%)	128(100%)	Sig.	.704 <sup>a,b</sup>
6. Inhale slowly and press canister	Correct	15(93.8%)	71(63.4%)	86(67.2%)	$\chi^2$	5.852
	Incorrect	1(6.3%)	41(36.6%)	42(32.8%)	df	1
	Total	16(100%)	112(100%)	128(100%)	Sig.	<b>.016*</b>
7. Continue slow and deep inhalation	Correct	10(62.5%)	71(63.4%)	81(63.3%)	$\chi^2$	.005
	Incorrect	6(37.5%)	41(36.6%)	47(36.7%)	df	1
	Total	16(100%)	112(100%)	128(100%)	Sig.	.945
8. Hold breath for 5 seconds	Correct	5(41.7%)	17(36.2%)	22(37.3%)	$\chi^2$	.124
	Incorrect	7(58.3%)	30(63.8%)	37(62.7%)	df	1
	Total	12(100%)	47(100.0%)	59(100.0%)	Sig.	.725 <sup>a</sup>

Table 2. Association between inhalation technique and educational status

Inhalation Technique	Process	Educational status		Total N(%)	$\chi^2$	
		No Schooling	SEE and above			
		N(%)	N(%)			
1. Remove cap and shake the inhaler	Correct	60(54.5%)	13(76.5%)	73(57.5%)	$\chi^2$	2.896
	Incorrect	50(45.5%)	4(23.5%)	54(42.5%)	df	1
	Total	110(100%)	17(100%)	127(100%)	Sig.	.089
2. Hold inhaler upright	Correct	92(82.9%)	16(94.1%)	108(84.4%)	$\chi^2$	1.411
	Incorrect	19(17.1%)	1(5.9%)	20(15.6%)	df	1
	Total	111(100%)	17(100%)	128(100%)	Sig.	.235 <sup>a</sup>
3. Exhale to residual volume	Correct	23(39.7%)	7(53.8%)	30(42.3%)	$\chi^2$	.876
	Incorrect	35(60.3%)	6(46.2%)	41(57.7%)	df	1
	Total	58(100%)	13(100%)	71(100%)	Sig.	.349
4. Keep head upright or slightly tilted	Correct	45(78.9%)	9(69.2%)	54(77.1%)	$\chi^2$	.567
	Incorrect	12(21.1%)	4(30.8%)	16(22.9%)	df	1
	Total	57(100%)	13(100%)	70(100%)	Sig.	.452 <sup>a</sup>
5. Mouthpiece between teeth and lips	Correct	110(99.1%)	17(100%)	127(99.2%)	$\chi^2$	.154
	Incorrect	1(0.9%)	0(0%)	1(0.8%)	df	1
	Total	111(100%)	17(100%)	128(100%)	Sig.	.694 <sup>a,b</sup>
6. Inhale slowly and press canister	Correct	71(64.0%)	15(88.2%)	86(67.2%)	$\chi^2$	3.939
	Incorrect	40(36.0%)	2(11.8%)	42(32.8%)	df	1
	Total	111(100%)	17(100%)	128(100%)	Sig.	<b>.047*</b>
7. Continue slow and deep inhalation	Correct	68(61.3%)	13(76.5%)	81(63.3%)	$\chi^2$	1.468
	Incorrect	43(38.7%)	4(23.5%)	47(36.7%)	df	1
	Total	111(100%)	17(100%)	128(100%)	Sig.	.226
8. Hold breath for 5 seconds	Correct	19(38.8%)	3(30.0%)	22(37.3%)	$\chi^2$	.274
	Incorrect	30(61.2%)	7(70.0%)	37(62.7%)	df	1
	Total	49(100%)	10(100%)	59(100%)	Sig.	.601 <sup>a</sup>

## Discussion

In our study, out of the total 128 participants, only 3(2.34%) performed all the steps correctly. Holding breath for five seconds was the most common error made followed by failure to exhale to residual volume. Almost 99% of patients held the mouthpiece between teeth and lips followed by knowing how to hold the inhaler upright. Similar to our study finding, another study only had 14% of patients who were able to perform all steps correctly; the most common error was not holding breath for 10 seconds which was similar to our finding.<sup>5</sup> Another study revealed that the most common error performed was slow inhalation while pressing the canister (71%) followed by continuing slow and deep inhalation (66%).<sup>6</sup>

Our study showed a very low percentage of patients (2.34%) performing all the steps correctly unlike a study that revealed 22.1% of the patients were able to complete all the steps of inhalation.<sup>7</sup> The difference may be due to illiteracy, patients not being taught by a physician initially, lack of regular follow-up, not knowing the importance of using the device correctly, and ignorance.

Similar to our study, research done in India in 2012 and in Yemen in 2016 revealed that the majority of patients used the inhaler incorrectly. The result improved significantly after physical demonstration of the technique hence emphasizing regular educational interventions to help patients using inhalers.<sup>8,9</sup> Another study done in a tertiary hospital in Nepal in 2015 revealed that 70% of patients were able to perform all of the steps correctly face to face training from pharmacists and counseling about their inhaler devices.<sup>10</sup>

There was no association of inhalation technique with the age and education status of the patients in our study. In contrast, a study from Nepal showed that patients in age group 61-70 years and those who had primary education used their MDI correctly.<sup>4</sup> A study

found that the proportion of error was greater among patients in the 60 years and above age group and among those of lower economic status.<sup>11</sup> Another study showed that the rate of correct use increased significantly as the education level increased.<sup>12</sup> Similarly, in another study, the results revealed that 50% of the patients that were educated showed better understanding after instructions were provided on the correct use of inhalers.<sup>13</sup> Lack of association with the education status of the patient in our study may be due to the majority of patients falling in the illiterate group.

In our setting, a suspected case of Chronic lung disease is sent to the Chronic Care Clinic for spirometry and further other investigations. After a patient is diagnosed with a case of Chronic lung disease and plans to start on inhalers, the doctor explains the inhalation instructions to the patient while checking whether the patient understands or not. Then the patient is asked to follow up regularly in the Chronic Care Clinic. The majority of the patients coming to the Chronic Care Clinic were illiterate and only a few knew the importance of taking the inhaler correctly and timely which could be the reason why a lot of patients were unable to perform all the steps correctly.

Our study showed that the most common mistakes were associated with coordination and breath-holding steps. 99% of the patient did not hold their breath for 5 seconds after inhalation of the inhaler whereas many had difficulty exhaling fully before inhalation. Such errors could lead to unsuccessful delivery of medications to the lungs. Overcoming problems associated with incorrect inhalation technique should start with prescribing the correct inhalation device followed by proper training from a trained healthcare physician before starting the inhalation device, educating the patient and patient's family regarding their disease, and scheduling regular follow-ups and training to maintain the proper level of patient skill.<sup>14</sup> The patients should be given proper training regarding

inhalation techniques by the prescribing physician, specialized nurse, or pharmacist; whoever is responsible must be adequately trained themselves and have proper knowledge regarding the disease and skill. Lack of knowledge and ability to use MDI devices among medical personnel who teach patients also leads to incorrect use.<sup>15</sup> Educational interventions such as physical demonstration of inhalation technique or pictorial leaflet rather than written or verbal instruction is more effective to ensure better use of the MDI.<sup>16</sup> A study done in 2017 revealed that educational intervention improved inhaler techniques in the short term further emphasizing periodic intervention reinforcement and longer follow-up studies.<sup>17</sup> Many other studies have also demonstrated persistently increased rates of incorrect use even after educational re-enforcements and training.<sup>12,18</sup> Since most patients with COPD are long-term smokers and older, physical issues such as tremors, poor hand-breath coordination, lower cognitive abilities to operate and inability to hold breath may make a person less adherent to the device due to perceived complexities.<sup>19,20</sup> Thus, for some patients with difficulty using the MDIs, alternative devices like nebulizers can also be suggested which doesn't need breath holding and hand-breath co-ordination for effective delivery of drug.

The limitation of the study was with the limited sample size since this study was conducted only in Chronic Care Clinic of Patan Hospital and was not multi-centric. Hence, the conclusion cannot be generalized and the results may also have been affected by small number of participants. As most patients also used dry powder inhaler regularly along with metered dose inhaler, it was difficult to interpret the result. Though we check the inhalation steps in patients using the inhaler, it was not possible to ascertain whether these patients were trained properly at the beginning or not. Hence, impact of previous teaching of inhalation technique could not be properly assessed.

## Conclusion

The majority of the patients performed the inhalation steps incorrectly. Hence, patients using Metered Dose Inhalers for chronic lung diseases should have their inhalation technique checked routinely and should be given proper inhalation instructions if found to be poor.

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## Conflict of Interest

None

## Funding

None

## Author Contribution

Concept, design, planning: DD, SA, YA; Literature review: DD; Data collection: DD; Data analysis: DD, SA, YA; Draft manuscript: DD; Revision of draft: DD, SA; Final manuscript: DD, SA, YA; Accountability of the work: DD, SA, YA; Guarantor: DD

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