



SOCIAL AND BEHAVIORAL SCIENCES. Rehabilitation

ORIGINAL RESEARCH



Inhalation Therapy: An Analysis of Inhalation Technique Errors in Metered-Dose Inhaler and Dry Powder Inhaler Users



Authors' Contribution:
A – Study design;
B – Data collection;
C – Statistical analysis;
D – Data interpretation;
E – Manuscript preparation;
F – Literature search;
G – Funds collection

Chaudhary K.¹ ABCDEF , Kumar A.¹ ABCDEF

¹ Employees' State Insurance Corporation Medical College, India

Received: 08.01.2023; Accepted: 08.02.2023; Published: 30.06.2023

Background and Aim of Study:

Abstract

Decreased efficacy of metered dose inhaler and dry powder inhalers are associated with errors in inhalational techniques.

The aim of the study: to study the association of errors in the technique for using two types of inhalers with demographic and other variables.

Material and Methods:

Five hundred adult patients with respiratory diseases who were currently using an inhaler device were enrolled in this study. Patient's demographics and duration of inhaler therapy and assessment of inhaler technique were recorded by interview and direct observation.

Results:

Out of 500 enrolled patients, 465 patients were using the device with wrong technique. Among 465 patients, 188 patients were using metered dose inhaler and 277 patients were using dry powder inhalers. Technical errors were common in both the devices but more common with metered dose inhaler device. Failure to exhale before the inhale through device was most common error with metered dose inhaler (68.6%) and dry powder inhalers (71.4%). Association of errors with female gender is seen in both metered dose inhaler and dry powder inhalers users. Reduction in the numbers of errors is seen with increase in the duration of therapy and regular training on follow-up visits.

Conclusions:

Dry powder inhalers and metered dose inhalers are commonly used in management of respiratory patients. Therefore, the errors in using these devices, technique and handling errors are common in both dry powder inhalers and metered dose inhaler users. More error was found in old age, female and short-term users. However regular training on follows up visits can solve this current problem.

Keywords:

metered dose inhaler, dry powder inhalers, inhalational technique, technical errors, demographic, respiratory diseases, aerosol therapy

Copyright:

© 2023 Chaudhary K., Kumar A. Published by Archives of International Journal of Science Annals

DOI and UDC

DOI <https://doi.org/10.26697/ijsa.2023.1.5> UDC 612.215

Conflict of interests:

The authors declare that there is no conflict of interests

Peer review:

Double-blind review

Source of support:

This research did not receive any outside funding or support

Information about the authors:

Chaudhary Kamran – <https://orcid.org/0000-0001-6697-2409>; MD, Assistant Professor, Department of Pulmonary Medicine, Employees' State Insurance Corporation Medical College, Faridabad, India.

Kumar Avinash (Corresponding Author) – <https://orcid.org/0000-0002-3009-0866>; akrshiv.dr@gmail.com; MD, Assistant Professor, Department of Pulmonary Medicine, Employees' State Insurance Corporation Medical College, Faridabad, India.



Introduction

Respiratory diseases such as asthma, chronic obstructive pulmonary disease (COPD) and post tuberculosis obstructive disease (PTOD) is affecting large population globally. These diseases cause the third most frequent cause of death worldwide (EBSCO, 2020). The abundance presence of beta-adrenergic, cholinergic and glucocorticoid in lungs, which lead to concept evolution of inhalation therapy. The inhalation therapy holds many advantages such as lower dosage needed, fast response and minimum side effect over systemic therapy as in even in pregnancy, hypertension, cardiac diseases and diabetes mellitus they are considered safe. Inhalation therapy is also known as aerosol drug therapy in which special device is used to deliver drug in a form of fine mist particles directly to the lungs, which may use in treating various type of respiratory diseases. The particle ideal size ranges from 1 to 5 microns as smaller particles acts as gas and passes through lungs like gas. Particles travelling speed (travelling very fast or very slow) might damage the walls of the upper airways. The particle hit the target site when moves in right speed. The oral inhalation of medications is the first-line treatment for lung diseases; inhaler technique comprises a set of procedures for drug delivery to the respiratory system (Chorao et al., 2014). The advantages offered by this method are financial affordability, convenience, portability, quick and local action, and negligible systemic side effects (Virchow et al., 2008).

The therapeutic index will be maximized, with direct delivery of drug to the respiratory tract by inhale devices. There are many anti-asthma drugs out there but efficiency depends on selection of right drug, device used and technique used. There are wide range of inhaling devices available in market, selecting the right one is very important, which is done on the bases of disease severity, patient type, and pricing or reimbursement controls (Pritchard & Giles, 2014). There for it is necessary to have a proper study of device, drug and patient education for the success of inhaler.

Metered dose inhalers, dry powder inhalers, and nebulizers are the most common inhaler devices used to administer aerosolized medication in routine respiratory practice (Cochrane et al., 2000; Pritchard et al., 2015). Metered dose inhaler (MDI) is most commonly used inhaler device. When it is activated, it releases fixed amount of drug dose from multidose canister. Some important elements of MDI are protective cover; medicine mixed with surfactant and propellant in canister, which is fitted with valve; device body and mouthpiece for the release of medicine.

Metered dose inhalers are inexpensive, compact, and portable, can be hold multidose. It can have fixed and defined dose (Newman, 2005).

Although after all these advantages MDI does have few disadvantages too such as they are not eco-friendly as chlorofluorocarbon (CFC) causes ozone depletion, patient need good coordination of hand and breath and needs training for hand breath coordination (Tsangarides et al., 2018).

According to Newman et al. (1991), ideal technique to use MDI would be: shake before use, then remove the cap, breath out slowly to functional residual capacity (FRC), wide open the mouth holding the device in between lips in upright position starting with slow breathing and actuate MDI simultaneously, till total lung capacity (TLC) continue inspiration, for 5-10 sec hold breath, at last exhale for next puff, at least wait for a minute, after done washing and rinsing mouth is important.

Dry powder inhaler (DPI) contains medicine in powder form in which particle size is in respirable size and these are present with carriers such as lactose or glucose with which they make loose bound. Separation could happen easily among micro sized individual respirable particles; carriers are needed to decrease cohesive forces in micro sized medicine powder. Patient's inspiratory flow provides all the energy needed to disaggregation (Prime et al., 1997). In 1960s, the DPI was introduced since then there are many types of DPI available in India market some are single dose, some are multidose.

Single dose inhales are Lupihaler, Revolizer, Respihaler, Rotahaler; and some of multidose inhalers are Diskhaler, Turohaler and Multihaler. In multidose inhalers, numbers of doses are inserted in the inhaler already (Atkins, 2005).

Dry powder inhalers have many advantages, as they are portable, easy to carry with you due to their small size. They can be used easily with some training, but they do not need any hand breath coordination. They are ecofriendly because they do not have any cold freon effect as propellant is not required in them.

Despite all these advantages, they do hold few disadvantages too, as they are quite expensive. They are not ideal for acute situations and severe respiratory distress. They also need quite high inspiratory flow rate that is about 60L/min or even more. Lactose might cause some irritation cough mostly in lactose intolerant patients. If not kept in dry area, the humidity might cause powder to aggregate and soften of capsule (Crompton, 1991).

In the opinion of Newman et al. (1991), ideal technique of using DPI is: device assembling, if single, no shaking of the device, slowly exhale to FRC, around the mouth seal it, forcefully and deeply inhale, need to hold the breath for 4 to 8 sec, repeat the process if needed, after finish gargle and rinsing mouth is important.

Inhaler technique comprises a set of procedures for drug delivery to the respiratory system. The technique of oral inhalation of medications is a major factor governing the efficiency of the inhaled medication. Using the proper inhaler technique ensures sufficient drug deposition in the distal airways, optimizing therapeutic effects and reducing side effects (Usmani et al., 2018). Although metered dose inhalers are considered more difficult to use than dry powder inhalers, errors in inhaler technique are very common among COPD and asthma patients in daily real-life practice. Inhaler mishandling is very common in patients with chronic airflow obstruction (Melani et al., 2011).



Using inhalers without imparting adequate education regarding proper technique of their usage may result in suboptimal clinical improvement and wastage of medication.

We evaluated the technique of patients using manually operated inhaler devices, metered dose inhaler and dry powder inhalers to study the association of poor inhaler technique with patient demographics and other variables.

The aim of the study. To study the association of errors in the technique for using two types of inhalers with demographic and other variables.

Materials and Methods

A total of 500 adult patients with respiratory diseases who were currently using at least one inhaler device for at least 1 month were included in this cross-sectional, observational study conducted at Department of Tuberculosis and Chest Diseases, in a tertiary care hospital of North India.

Most commonly used devices metered dose inhaler and dry powder inhalers were assessed in this study.

Use of inhaler therapy for less than a month, lack of attendance of regular control visits, confirmed or

suspected pregnancy, breastfeeding, allergy, sensitivity or intolerance to asthma or COPD therapy, and being on nebulizer therapy were the exclusion criteria of the study.

Demographic details of patients, type and duration of inhaler therapy, and assessment of inhaler technique (correct, incorrect) were recorded.

Inhaler technique was assessed using a protocol described by Melani (2007). This protocol documents the performance of ten essential inhaler technique steps by means of closed dichotomous response options (well performed/poorly performed). All assessments were made by two investigators with ten years of experience in the follow-up of asthma patients. After assessment, all patients were given supplemental instruction on inhaler technique by a health professional, in the form of a demonstration.

Results

Out of 500 enrolled patients, 465 patients were using the device with wrong technique. Out of these 465 patients, 188 were using metered dose inhaler (Table 1) and 277 were using dry powder inhaler (Table 2).

Table 1

Errors in Inhalation Technique with Metered Dose Inhaler (n=188)

Inhalation technique	Number of patients who made errors	
	people	percentage
Take off the inhaler cap	16	8.5
Shake the metered dose inhaler before use	79	42.0
Hold the metered dose inhaler in a vertical position	47	25.0
Hold your head in a vertical position	53	28.1
Exhale before use	129	68.6
Put the mouthpiece in your mouth, and close your lips	33	17.5
Press the canister when inhaling slowly	126	67.0
Inhale deeply	91	48.4
Hold your breath for 10 seconds	71	37.7
Exhale and wait for 30-60 seconds before the other puff	32	14.3

Table 2

Errors in Inhalation Technique with Dry Powder Inhaler (n=277)

Inhalation technique	Number of patients who made errors	
	people	percentage
Pull off the aerolizer cover	19	6.8
Open the mouthpiece of dry powder inhaler	16	5.7
Remove the capsule from the package and put it into the space	47	16.9
Press the buttons on both sides of dry powder inhaler	79	28.5
Hold your head in a vertical position	61	22.0
Turn your head away from dry powder inhaler and exhale	198	71.4
Put the mouthpiece in your mouth, and close your lips	26	9.3
Inhale deeply	119	42.9
Hold your breath for 10 seconds	97	35.0
Dispose of the capsule and put the cover back on the dry powder inhaler	36	12.9

Each step of metered dose inhaler use is observed and documented. Out of 188, 129 patients (68.6%) did not exhale before inhaler use, 126 patients (67.0%) failed to press the canister while inhaling slowly, and 91 patients

(48.4%) did not inhale deeply after pressing canister. 79 patients (42.0%) did not shake the inhaler before use, 71 patients (37.7%) did not hold their breath for 10 seconds, 47 patients (25.0%) failed to hold the inhaler in



vertical position, while 53 patients (28.1%) failed to hold their head in vertical position. 33 patients (17.5%) forgot to close their lips after putting mouthpiece in mouth, 32 patients (14.3%) did not wait before for 30-60 seconds before next inhalation, 16 patients (8.5%) did not take off the inhaler cap.

The most common error while using dry powder inhaler is patient did not exhale before using inhaler like metered dose inhaler users. Out of 277, 198 patients (71.4%) did not exhale before the use of inhaler, 119 patients (42.9%) fail to inhale deeply, and 97 patients (35.0%) did not hold the breath for 10 seconds. The most uncommon error was, not removing cap of inhaler like in metered dose inhaler users.

It was observed dry powder inhalers is the most commonly used device as shown by other studies (Castel-Branco et al., 2017; Chorao et al., 2014; Melani et al., 2011). Poor inhaler technique and device handling is common in both metered dose inhaler and dry powder inhalers users. That metered dose inhalers require a good

ability of hand-lung coordination and is therefore considered inherently more difficult to use than dry powder inhalers (Pothirat et al., 2015; Rootmensen et al., 2010).

Therefore, errors related to device handling were common among metered dose inhaler users than among dry powder inhalers users. Failure to exhale before using the metered dose inhaler is the most common error, followed by lack of coordination and failure to inhale deeply.

In dry powder, inhaler users the most common error is to exhale before using dry powder inhalers, followed by failure to inhale deeply and failure to hold breath for 10 seconds.

These errors are more common with female gender as study shows that the errors in using the inhaler devices both metered dose inhaler and dry powder inhalers are more common in females. These errors are reduced with increasing duration of therapy and regular training. (Table 3).

Table 3
Correlation of Errors with Various Parameters

Parameters	Age of patient (Mean, years)	Gender of patients		Duration of therapy (Mean, years)	Regular training on every visit
		Male	Female		
Take off the inhaler cap					
Incorrect use	61	11.9	88.1	1.2	7.9
Correct use	54	59.1	38.9	5.8	68.9
P-value	>0.001	<0.001		<0.001	<0.001
Hold the metered dose inhaler in a vertical position					
Incorrect use	65	27.8	72.2	1.8	9.1
Correct use	52	36.3	63.7	6.1	79.6
P-value	>0.001	<0.001		<0.001	<0.001
Hold your head in a vertical position					
Incorrect use	62	20.4	79.6	2.1	6.7
Correct use	56	32.7	57.3	7.3	76.9
P-value	>0.005	<0.001		<0.001	<0.001

Reduction in the numbers of errors is seen with increase in the duration of therapy and regular training on follow-up visits.

Discussion

Not many researches have been conducted in India to study the errors in inhalation techniques of metered dose inhaler and dry powder inhalers users.

It was observed that inhaler technique errors are very common and regular training can significantly reduce the disease burden. Errors were more common with dry powder inhalers than with metered dose inhaler. Although, the study done by Nainwal et al. (2022), DPI are considered, more advanced and more advantageous due to its stability and ability to deliver a high dose of the drug to the lungs. Inability to exhale properly before use is the most common error followed by error in shaking the device before use.

Similar results were observed in other studies. In a study conducted by Castel-Branco et al. (2017), similar results were obtained. The study involved 67 patients from four community pharmacies. In the dry powder inhalers techniques, the most frequent errors were “no previous

forced expiration” (46=61.3%) and “no 10 second apnea after inhalation” (51=68.0%); in the 16p metered dose inhalers techniques common errors were “lack of hand-lung coordination” (7=43.8%), “no previous forced exhalation” (8=50.0%), and “no apnea after inhalation” (10=62.5%). This is similar to observations made in our study.

In another study conducted by Melani et al. (2011), the errors in technique of inhalation was evaluated in trained patient. Independently of the inhaler, they found a strong association between inhaler misuse and older age (p=0.008), lower schooling (p=0.001) and lack of instruction received for inhaler technique by health caregivers (p<0.001). Inhaler misuse was associated with increased risk of hospitalization (p=0.001), emergency room visits (p<0.001), courses of oral steroids (p<0.001) and antimicrobials (p<0.001) and poor disease control evaluated as an Asthma Control Test (ACT) score for the asthmatics (p<0.0001) and the whole population (p<0.0001). This was similar to our study, where we observed older age and lesser training was associated with more errors in inhalation technique.



Chorao et al. (2014) observed that patients over 60 years vs. younger age ($p=0.002$) and COPD vs. asthma patients ($p=0.016$) required more attempts to ensure correct use. 41.0% of the study participants chose one of the devices they already used as the most preferred inhaler.

In another study conducted on COPD patients of mean age 70.9 ± 8.3 years using metered-dose inhaler by Choomuang et al. (2022). It was observed that only 16% ($p<0.001$) was using correct technique, 25% ($p<0.026$) was having correct flow and only 7% ($p<0.001$) was using both correct technique and correct flow but after one month of training 34% ($p<0.001$) was using correct technique, 37% ($p<0.026$) was having correct flow and only 22% ($p<0.001$) was using both correct technique and correct flow.

Thus, incorrect use of inhaler is a prevalent problem across countries. The problem can be significantly reduced with proper training and retraining.

Conclusions

It is observed that errors in using the device and handling are common in both dry powder inhalers and metered dose inhaler users. But in old age, female and short-term users more errors were found compared to young age, male and long-term users. The error associated with both users are mainly with handling the devices, technique of using the devices and safekeeping of the devices. To overcome problems related to these devices people need more and proper regular training of handling and using these devices. Patient needs training in how to keep devices clean and use it safely. Patient needs more follow up visits in which proper training could be provided.

Ethical Approval

The study protocol was consistent with the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the Institution's Human Research Committee.

Funding Source

This research did not receive any outside funding or support.

References

Atkins, P. J. (2005). Dry powder inhalers: An overview. *Respiratory Care*, 50(10), 1304-1312. <https://pubmed.ncbi.nlm.nih.gov/16185366/>

Castel-Branco, M. M., Fontes, A., & Figueiredo, I. V. (2017). Identification of inhaler technique errors with a routine procedure in Portuguese community pharmacy. *Pharmacy Practice*, 15(4), 1072. <https://doi.org/10.18549/PharmPract.2017.04.1072>

Choomuang, W., Pothirat, C., Chaiwong, W., Liwsrisakun, C., Theerakittikul, T., Phetsuk, N., & Chanayat, P. (2022). The effectiveness of large group demonstration training method on the use of pressurized metered-dose inhaler in elderly with chronic obstructive pulmonary disease. *Journal of Thoracic Disease*, 14(4), 919-926. <https://doi.org/10.21037/jtd-21-1612>

Chorao, P., Pereira, A. M., & Fonseca, J. A. (2014). Inhaler devices in asthma and COPD – An assessment of inhaler technique and patient preferences. *Respiratory Medicine*, 108(7), 968-975. <https://doi.org/10.1016/j.rmed.2014.04.019>

Cochrane, M. G., Bala, M. V., Downs, K. E., Mauskopf, J., & Ben-Joseph, R. H. (2000). Inhaled corticosteroids for asthma therapy: patient compliance, devices, and inhalation technique. *Chest*, 117(2), 542-550. <https://doi.org/10.1378/chest.117.2.542>

Crompton, G. K. (1991). Dry powder inhalers: Advantages and limitations. *Journal of Aerosol Medicine*, 4(3), 151-156. <https://doi.org/10.1089/jam.1991.4.151>

EBSCO. (2020, November 16). *Dynamic health in action: COPD*. <https://www.ebsco.com/resources/dynamic-health-action-copd>

Melani, A. S., Bonavia, M., Cilenti, V., Cinti, C., Lodi, M., Martucci, P., Serra, M., Scichilone, N., Sestini, P., Aliani, M., & Neri, M. (2011). Inhaler mishandling remains common in real life and is associated with reduced disease control. *Respiratory Medicine*, 105(6), 930-938. <https://doi.org/10.1016/j.rmed.2011.01.005>

Melani, A. S. (2007). Inhalatory therapy training: A priority challenge for the physician. *Acta Bio-Medica: Atenei Parmensis*, 78(3), 233-245. <https://pubmed.ncbi.nlm.nih.gov/18330086/>

Nainwal, N., Sharma, Y., & Jakhmola, V. (2022). Dry powder inhalers of antitubercular drugs. *Tuberculosis (Edinburgh, Scotland)*, 135, 102228. <https://doi.org/10.1016/j.tube.2022.102228>

Newman, S. P. (2005). Principles of metered-dose inhaler design. *Respiratory Care*, 50(9), 1177-1190. <https://pubmed.ncbi.nlm.nih.gov/16122401/>

Newman, S. P., Weisz, A. W., Talae, N., & Clarke, S. (1991). Improvement of drug delivery with a breath actuated pressurised aerosol for patients with poor inhaler technique. *Thorax*, 46(10), 712-716. <https://doi.org/10.1136/thx.46.10.712>

Pothirat, C., Chaiwong, W., Phetsuk, N., Pisalthanapuna, S., Chetsadaphan, N., & Choomuang, W. (2015). Evaluating inhaler use technique in COPD patients. *International Journal of Chronic Obstructive Pulmonary Disease*, 10(1), 1291-1298. <https://doi.org/10.2147/COPD.S85681>

Prime, D., Atkins, P. J., Slater, A., & Sumby, B. (1997). Review of dry powder inhalers. *Advanced Drug Delivery Reviews*, 26(1), 51-58. [https://doi.org/10.1016/S0169-409X\(97\)00510-3](https://doi.org/10.1016/S0169-409X(97)00510-3)

Pritchard, J. N., & Giles, R. D. (2014). Opportunities in respiratory drug delivery. *Therapeutic Delivery*, 5(12), 1261-1273. <https://doi.org/10.4155/tde.14.78>

Pritchard, J. N. (2015). Industry guidance for the selection of a delivery system for the development of novel respiratory products. *Expert Opinion on*



- Drug Delivery*, 12(11), 1755-1765. <https://doi.org/10.1517/17425247.2015.1056148>
- Rootmensen, G. N., Van Keimpema, A. R., Jansen, H. M., & de Haan, R. J. (2010). Predictors of incorrect inhalation technique in patients with asthma or COPD: A study using a validated videotaped scoring method. *Journal of Aerosol Medicine and Pulmonary Drug Delivery*, 23(5), 323-328. <https://doi.org/10.1089/jamp.2009.0785>
- Tsangarides, A. A., Wilkinson, A., & Mir, F. (2018). Disadvantages of salbutamol pressurised metered-dose inhalers (pMDIs). *Thorax*, 73(Suppl. 4), A193-A194. <https://doi.org/10.1136/thorax-2018-212555.327>
- Usmani, O. S., Lavorini, F., Marshall, J., Dunlop, W. C. N., Heron, L., Farrington, E., & Dekhuijzen, R. (2018). Critical inhaler errors in asthma and COPD: A systematic review of impact on health outcomes. *Respiratory Research*, 19, 10. <https://doi.org/10.1186/s12931-017-0710-y>
- Virchow, J. C., Crompton, G. K., Dal Negro, R., Pedersen, S., Magnan, A., Seidenberg, J., & Barnes, P. J. (2008). Importance of inhaler devices in the management of airway disease. *Respiratory Medicine*, 102(1), 10-19. <https://doi.org/10.1016/j.rmed.2007.07.031>

Cite this article as:

Chaudhary, K., & Kumar, A. (2023). Inhalation therapy: An analysis of inhalation technique errors in metered-dose inhaler and dry powder inhaler users. *International Journal of Science Annals*, 6(1), 47-52. <https://doi.org/10.26697/ijssa.2023.1.5>

The electronic version of this article is complete. It can be found online in the IJSA Archive <https://ijssa.culturehealth.org/en/arhiv>



This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (<http://creativecommons.org/licenses/by/4.0/deed.en>).