Journal of Complementary and Alternative Medical Research

15(3): 1-13, 2021; Article no.JOCAMR.72142
ISSN: 2456-6276

Importance of Following Proper Inhalation Techniques and Awareness Regarding Asthma among Clinical Patients

Sumali Gunasekara[1*], Thanushika Ranawaka[1], Dilan Chathuranga[1], Upekshi Kankanamge[1] and Aindralal Balasuriya[2]

[1]Department of Pharmacy, Sir John Kotelawala Defence University, Sri Lanka.
[2]Faculty of Medicine, Sir John Kotelawala Defence University, Sri Lanka.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JOCAMR/2021/v15i330266
Editor(s):
(1) Prof. Arun Singh, Bareilly International University, India.
Reviewers:
(1) Elena Dantes, Universitatea „Ovidius" din Constanța, Romania.
(2) Zhaoxia XU, The Shanghai University of Traditional Chinese Medicine, China.
Complete Peer review History: https://www.sdiarticle4.com/review-history/72142

Original Research Article

Received 01 June 2021
Accepted 03 August 2021
Published 14 August 2021

ABSTRACT

Aims: Asthma is one of the biggest health burdens on the Sri Lankan population. Achievement of treatment goals isdetermined mainlythrough pharmacological management. The main objective of this study was to evaluate the patient inhaler handling techniques and their awareness regarding their disease condition, as well as to find out how an educational intervention effects patients' inhaler handling techniques.
Study Design: A Prospective cross sectional study used.
Place and Duration of Study: National Hospital for Respiratory Diseases, Welisara and Colombo South Teaching Hospital, Kalubowila between June 2017 to August 2017.
Methodology: Clinically diagnosed asthma patients were randomly divided into Control and Test groups. Control comprised 94 patients and the test comprised 93 patients. Their baseline knowledge about asthma and inhaler-using technique were assessed in 1st month by using an interviewer-administered questionnaire and checklist respectively. The test group was given both information leaflet and verbal instructions. Again, all the participants were assessed for the inhaler techniques on their next clinic day by using the same questionnaire and the checklist.

**Corresponding author: E-mail: sumalidasuni@gmail.com;*

Results: After the educational intervention, there was a statistically significant improvement in the test group, in the adherence to the nine steps, including critical steps, regarding all 3 device types (PMDI, DPI, and PMDI with Spacer) in the 2nd-month visit. (at *P* =.05) When considering awareness about asthma in the total population, most participants were knowledgeable regarding asthma.

Conclusion: We observed gaps in knowledge between current practice and what is expected in patients with asthma regarding their inhaler therapy. This might be due to the quality of instructions delivered by health care providers being insufficient and them lacking the time to observe patients individually for the inhaler techniques. Awareness regarding asthma and inhalation techniques can be raised by using information leaflets as well as through verbal counseling.

Keywords: Asthma; dry powder inhaler; pressurized metered dose inhaler; spacer; critical steps; inhaler technique; educational intervention.

ABBREVIATIONS

PMDI : Pressurized Metered Dose Inhaler.
DPI : Dry Powder Inhaler.
COPD : Chronic Obstructive Pulmonary Disease.
AIS :Asthma Instability Score.
SD :Standard Deviation.
WHO : Word Health Organization

1. INTRODUCTION

Asthma is defined by the history of respiratory symptoms such as wheeze, shortness of breath, chest tightness, and cough that vary over time, and intensity, together with variable expiratory limitations [1]. World Health Organization (2016) indicates that asthma is a non – communicable disease that affects 339 million patients in the world, with approximately 417,918 asthma patients dying in 2016 [2]. According to the Sri Lankan national survey on self–reported health conducted in 2014, asthma was found to be the 3rd most reported disease in the country, which accounted for 13.8% of the total cases reported [3].

"Status asthmaticus" causes potential respiratory failure in severe asthma attacks. This is life-threatening and requires immediate medical attention. The symptoms of a severe asthma attack include persistent shortness of breath, the inability of uttering a full sentence, and a feeling of tightness of the chest [4]. Asthma has no cure and is categorized as a long-term disease. Control of risk factors of asthma plays a major role in disease management. These risk factors for asthma can be classified as modifiable and non-modifiable. Modifiable risk factors include, smoking, maternal smoking during pregnancy, obesity, occupational triggers, exercises, and athletics whereas non-modifiable risk factors include age, sex, family history, allergic hypersensitivity reactions, indoor air pollution, and environmental factors [5]. As far as the pharmacological management of asthma is taken into account, the inhalation route is regarded as a safer method in comparison to oral treatment due to lesser systemic side effects. As the drugs can be delivered directly into the airways, the inhalation route provides a more rapid onset of action [6].

There are different types of devices that have been used to deliver inhaled medications, including Dry Powder Inhaler (DPI), Pressurized Metered Dose Inhaler (PMDI), and Nebulizer, etc. Pressurized Metered Dose Inhalers are considered the most common device being used in the routine management of asthma [7]. PMDI and DPI are each associated with their own advantages and disadvantages. The patient's preference for the inhaler device is determined by using the patient's skills preferences and experience with inhalers, available medication, and cost [8]. According to many studies, patients will not get the full value of their inhaled medications due to incorrect use of their inhalers, and it is considered to be a major public health problem [9]. Knowledge, adherence, and inhaler techniques are the main areas of asthma education [10]. The most common error for experienced patients with asthma was device mishandling [8]. Correct inhalation techniques can exert a beneficial impact in achieving appropriate health outcomes in patients receiving anti-asthma medicines for inhalation [11]. The ability of the healthcare workers and patients to take healthcare decisions can be enhanced by knowledge of asthma symptoms and signs. Poor health literacy is a barrier to the knowledge of asthma among children and adults [12]. Asthma education programs are limited [2]. This study was conducted to describe awareness of

asthma and inhaler handling techniques among asthmatics, attending medical clinics at National Hospital for Respiratory Diseases – Welisara and Colombo South Teaching Hospital – Kalubowila.

2. METHODOLOGY

This study was a prospective cross-sectional study conducted at the Respiratory clinics at the National Hospital for Respiratory Diseases - Welisara and Colombo South Teaching Hospital – Kalubowila. Ethical approval was obtained from National Hospital for Respiratory Diseases - Welisara and Colombo South Teaching Hospital. In addition, ethical approval was received from General Sir John Kotelawala Defence University.

The sample size was calculated by using the equation of $N = Z^2. P (1-P) / d^2$

where N = calculated sample size of the study,
Z = Standard Normal Deviation 95% confidence interval (Z =1.96),
P = Prevalence of Asthma in Sri Lanka taken as 13.8%, (National survey on self-reported health in Sri Lanka, 2014)
d = Standard error allowed for the estimation of proportion (*d* = .05).
Calculated sample size of 184 became 192 after adding 5% for non response and then rounded off to 200

200 patients with a history of asthma were recruited randomly from respiratory clinics at National Hospital for Respiratory Diseases - Welisara and Colombo South Teaching Hospital - Kalubowila. Every third patient in the clinic record books was selected randomly from both hospitals. After selecting these patients, they were alternatively divided into control and test group, with the initial patient being assigned a group via random draw. Patients, both male or female, with a confirmed diagnosis and history of asthma who are aged between 15 to 75 years, who are currently on pharmacotherapy by using DPI / PMDI / or PMDI with spacer inhaler devices were included for this study. Patients who do not use PMDI, DPI, and PMDI with spacer for disease management and who did not give the consent, as well as pregnant women, were not accepted.

An interviewer administrated questionnaire and checklist were used to collect data from both groups. A 9-point checklist was used for dry powder inhalers and pressurized metered-dose inhalers with or without spacer, use which was adapted from the American Thoracic Society and a study conducted in Italy in 2011 [11,13]. For the selection of critical steps, recommendations by Newman were used [14]. The data was collected with regard to demographic details, awareness regarding asthma, and the checklist containing correct inhalation technique steps related to the PMDI, PMDI with spacer, and DPI separately. Awareness regarding asthma in patients was evaluated in the 1st month. Awareness regarding asthma was determined in both groups by asking questions on the causative factors of asthma.

After evaluating the patient's knowledge of the disease, patients in both groups were asked to use their inhaler practically and the asthma instability score (AIS) was recorded by the interviewer according to their inhaler handling steps. When the patient used their own inhaler, a total of 9 scores were obtained for DPI, PMDI with spacer, and PMDI users separately. If they followed all 9 steps including critical steps (*) correctly, they were determined to be the correct user. Failing this, they were categorized as an incorrect user. According to their asthma instability score of following all 9 steps including critical steps, they were assessed as below. After checking AIS, a patient information leaflet was distributed to the test group of patients with additional verbal and practical instructions about the correct inhaler handling techniques regarding their currently used inhalers. In order to develop the patient information leaflet, several reliable sources were used [15,16]. The Control group did not receive any verbal or written instructions and served as the control group. As this was a follow-up study, the selected patients were followed again at the next clinic date after one month, after an education intervention, and the same data was collected, and a baseline was obtained from both control and test groups by using the questionnaire and checklist.

All collected experimental data was entered into an Excel data sheet and transferred into statistical software (SPSS version 19.0) and the result obtained was interpreted, with *P* = .05 considered as significant.

3. RESULTS

The total number of patients selected was 200. We excluded 13 patients because of missing in the second-month follow-up visit. The final sample, therefore, consisted of 187 patients.

Control comprised 94 patients and the test comprised 93 patients. According to Table 1, a total of 26.7% were male and 73.2% were female. All patients had been diagnosed with asthma. The well-presented age group was the 61 -75-year group, having 48.6% of total patients. The mean age for the total population was 58.67 years. Of the enrolled patients, when considered device usage, 13.9% of the total population were PMDI users, 61% were DPI users and 25.1% were PMDI + spacer users. 62% of users reported that they were fully satisfied with their own inhaler using the technique, 34.8% reported as satisfied and 3.2% reported as not satisfied. When the population is classified by educational level in both groups, a majority had studied up to Ordinary Level (54.5%) and 15.5% had studied up to Grade 5. The work of 48.6% of participants involved dust in the workplace.

Table 2, compares the correct (who correctly performed all nine steps correctly) and incorrect users (at least one step wrong) between the 1st month and 2nd month. Inhaler devices were mostly used by the 61 – 75 age categories, which contributed to a higher overall incorrect user percentage (47.5%) and only 1% correct user's percentage during the 1st month. 9.1% of improvement was seen in the 61-75 age category in the 2nd month. 35.8% and 10.6% of participants were using their inhalers incorrectly in the age groups 46-60 and 31-45 respectively in the 1st month. 6.9% and 4.8% improvement was observed respectively by the 2nd month. When considering educational level, most of the participants were found to belong to the educational category of up to O/L education. 53.4% and 15.5% of participants in the up to Ordinary Level and up to Grade 5 levels respectively were using their inhalers incorrectly in the 1st month. After 2nd month, a reduction of 14.4% and 3.8% in incorrect users was seen in the up to Ordinary Level and up to Grade 5 respectively. The up to Grade 5 educational level category shows a 3.7% improvement in correct users, while the no schooling category shows 0.5% improvement among correct users in the 2nd month. The graduate educational level shows no difference between the 1st month and the 2nd month. According to gender, incorrect inhaler use had been observed in females (70.5%) and males (25.6%) in 1st month. An improvement of 5.9% and 16.6% in the correct use in the male and female categories respectively were seen in the 2nd month.

Table 3 results on the PMDI inhaler error observed between test and control group during the first-month visit show that 3rd, 4th, 5th, and 7th steps were common errors in the control group, and 2nd, 3rd, 6th, and 7th were the common errors found in the test group. In the 3rd step, failure to breathe out before firing was an error observed with high frequency among patients using PMDI in both groups. In the 2nd month, (after the educational intervention), fewer erroneous steps were observed in the test group population when compared to the control group. While handling PMDI, the 3rd, 4th, and 5th steps were the most common errors found in patients in the control group. Failure to inhale by mouth was the most frequent error in the test group. However, all 9 steps, including the critical steps, showed improvement in the test group. The most prominent steps to show improvement, step 2 (Failure to shake inhaler) where the frequency was decreased from 5(5.37%) to 0, step 3 (Failure to breathe out before firing) which decreased from 5 (5.37%) to 1 (1.07%), step 4 (failure to hold the inhaler upright between index and thumb) which decreased from 4(4.3%) to 1(1.07%), step 5 (Failure to place the mouthpiece between teeth and lips close around it) which decreased from 4 (4.3%) to 1 (1.07%), and step 6 (Failure to fire while breathing in deeply and slowly) which decreased from 5(5.37%) to 0.

According to Table 4 in the analysis of DPIs during the 1st month, many frequent errors were found in all 9 steps, including the critical steps in both groups. Failure to breathe out fully seems to be the most frequent error (n=95) by the DPI inhaler users during the 1st-month visit in both groups. The 4th step was the most common secondary error in both groups during the 1st month. A study by Hilton found similar most frequent errors to the current study, including failure to exhale before inhalation, wrong positioning of inhalers, and incorrect loading [17]. During the 2nd month's visit, errors of all 9 steps were reduced compared to the 1st month in the test group. The steps that showed the most improvement, step 2 (failure to correctly insert the capsule) which decreased from 13(13.97%) to 1(1.07%), step 4 (failure to hold the inhaler upright) which decreased from 39(41.93%) to 6 (6.45%), and step 6 (failure to place the mouthpiece in mouth) which decreased from 28(30.10%) to 3(3.22%).

As seen in Table 5 the results obtained in the study of PMDI with spacer users identified

many frequent errors in all 9 steps including the critical steps in the 1st month in both groups. The most common errors were the failure to breathe out slowly and fully (n=46), and the failure to shake the inhaler, which showed a higher rate of error than the other steps in the control group during 1st months. In the 2nd month, all 9 steps show positive improvement in the test group. The most improved steps were step 2 (failure to shake the inhaler) in which the error rate was reduced to 0%, step 5 (failure to breathe out slowly and fully) which decreased by 7.53%, and step 8 (failure to hold the breath for about 10 seconds/breathe in 5-6 times and breathe out slowly) which decreased by 12.9%.

As seen in Table 6, among PMDI device control users 0% followed all critical steps correctly in the 1st month while 2.1 % followed all the critical steps correctly in the 2nd month. However, when considering the test group during the 1st month 2.2% followed all critical steps correctly while 4.2% followed all the critical steps correctly by the 2nd month. DPI is the most frequently used device among the participants. Of the DPI device using participants, in the 1st month, 20.2% of the participants under the control group performed all the critical steps correctly while 31.9% of participants performed all the critical steps correctly by the 2nd month. In comparison, among test group participants 20.4% of participants followed all the critical steps correctly during the 1st-month visit, while 58.1% performed all the critical steps correctly during the 2nd month. In the spacer device users under the control group during the 1st month, only 1.1% performed all critical steps correctly, which increased to 4.3% by the 2nd month. In comparison, the test group showed a 7.4% improvement in following all critical steps correctly by the 2nd month. Considering the users who performed all 9 steps correctly, the control population for PMDI device users had 0% in the 1st month which improved to 1.0%, while the test group improved from 1.1% to 2.0%. PMDI+ spacer device users showed an increase in performing all nine steps correctly from 1.1% to 3.2% in the control group, while the test group improved from 0% to 7.5%. In the DPI device users, the control population improved from 2.1% to 10.6%, while the test group improved from 2.2% to 28%. No statistically significant difference was found between the control and test groups of PMDI, DPI, or PMDI + Spacer groups regarding either correct critical step use or correct use in all 9 steps within the first month. After the education session, PMDI, PMDI+ spacer, and DPI (P =.05) all show a statistically significant difference between the control and test groups among users who followed critical steps correctly, as well as those who followed all 9 steps correctly by the 2nd month.

According to Table 7, 78.7% and 77.4% of participants performed the critical step in-correctly in the control group and test group respectively in the 1st month. Participants who performed all 9 steps incorrectly in the control and test groups in 1st month are 96.8% and 96.7% respectively. No significant association was found between the control and test groups regarding either critical step use or all 9 steps use between the control and test group. In the 2nd month, 61.7% and 30.1% of participants were incorrectly using their inhalers in the control group, and test group respectively. Participants who did not follow all 9 steps correctly in the control and test groups are 85.1% and 62.3% respectively. When considering whether all 9 steps and critical steps are followed correctly or incorrectly, there is a statistically significant association between the control and test groups by the 2 months. The control group appears to follow more incorrect steps, while the test group followed fewer incorrect steps during the 2nd month.

According to the results of Table 8, most patients demonstrated awareness regarding asthma. 97.3%, 61.4%, 98.3%, and 58.2% of correct answers were given by the patients regarding smoking tobacco, non-smoking tobacco, dust, and obesity causing asthma respectively. Most of the participants (92.5%) knew asthma could cause death. Furthermore, 95.1% of participants knew asthma was not communicable, and 95.7% of participants knew inhalers did not cause side effects. However, 48.7% of participants had thought malnutrition caused asthma.

4. DISCUSSION

In Sri Lanka, few research studies have been done to investigate inhaler handling techniques in asthma patients. The current study is a small-scale investigation to evaluate the inhaler handling techniques of patients and their awareness regarding their disease condition, as well as to investigate the effects of an educational intervention on patients' inhaler handling technique.

Table 1. General characteristics of the study participants (n = 187)

Variables	Categories	Test group	Control	Total
Sex	Male	27 (29.0%)	23 (24.5%)	50 (26.7%)
	Female	66 (71.0%)	71 (75.5%)	137 (73.2%)
Education level	No schooling	2 (2.2%)	3 (3.2%)	5 (2.6%)
	Up to grade 5	15 (16.1%)	14 (14.9%)	29 (15.5%)
	Up to O/L	58 (62.4%)	44 (46.8%)	102 (54.5%)
	Ordinary Level	9 (9.7%)	14 (14.9%)	23 (12.2%)
	Advanced Level	7 (7.5%)	18 (19.1%)	25 (13.3%)
	Graduate	2 (2.2%)	1 (1.1%)	3 (1.6%)
Age category	Age 15 to 30	3 (3.2%)	1 (1.1%)	4(2.1%)
	Age 31 to 45	16 (17.12%)	6 (6.4%)	22 (11.7%)
	Age 46 to 60	31 (33.3%)	39 (41.5%)	70 (37.4%)
	Age 61 to 75	43 (46.2%)	48 (51.1%)	91 (48.6%)
Type of inhaler using	PMDI	10 (10.8%)	16 (17.0%)	26 (13.9%)
	DPI	65 (69.9%)	49 (52.1%)	114 (61%)
	PMDI + Spacer	18 (19.4%)	29 (30.9%)	47 (25.1%)
Confidence of the inhaler	Fully satisfied	56 (60.2%)	59 (62.8%)	116(62%)
	Satisfied	34 (36.5%)	32 (34.0%)	65 (34.8%)
	Not satisfied	3 (3.2%)	3 (3.2%)	6 (3.2%)
Age in years	mean	56.98	59.94	58.67
Occupation	Involving dust	50 (53.7%)	41 (43.6%)	91 (48.6%)

Table 2. Inhaler technique behavior among age, educational level, gender (n = 187)

Variables	Categories	Inhaler technique behavior 1st month		Inhaler technique behavior 2nd month	
		Correct	incorrect	Correct	incorrect
Age	15 – 30	0 (0)	4 (2.1)	3 (1.6)	1 (0.5)
	31 - 45	2 (1.0)	20 (10.6)	11 (5.8)	11 (5.8)
	46 - 60	3 (1.6)	67 (35.8)	16 (8.5)	54 (28.8)
	61 - 75	2 (1.0)	89 (47.5)	19 (10.1)	72 (38.5)
Educational level	No schooling	1 (0.5)	4 (2.1)	2 (1)	3 (1.6)
	Up to grade 5	0 (0.0)	29 (15.5)	7 (3.7)	22 (11.7)
	Up to Ordinary level	2 (1.0)	100 (53.4)	29 (15.5)	73 (39)
	Ordinary level	0 (0.0)	23 (12.2)	5 (2.6)	18 (9.6)
	Advance level	3 (1.6)	22 (11.7)	6 (3.2)	19 (10.1)
	Graduate	1 (0.5)	2 (1)	1 (0.5)	2 (1)
Gender	Male	2 (1.0)	48 (25.6)	13 (6.9)	37 (19.7)
	Female	5 (2.6)	132 (70.5)	36 (19.2)	101 (54)

Age, sex, and level of education were considered as critical aspects in asthma management in previous studies, as Fink and Rubin (2005) revealed variations in the above aspects lead to different results with regard to correct usage [18].

The presence of females was higher than that of males in this study solely due to the fact that patients were selected randomly for the test and control groups, and more females were present in this clinic at the time of selection. According to the present study, a higher percentage of correct users were of the female gender. However, no significant association was found between gender and inhaler technique behavior, in contrast to some previous studies that suggested that the female gender was more liable to show critical errors than the male gender [19].

The mean age of the participants was 58.67, the minimum age was 15 and the maximum was 75. In the asthma clinic, a majority of the participants were above 40, due to immunity being lower in older patients. In the analysis of inhaler technique behavior, 156 patients from the total population in the ages between 46 to 60 and 61 to 75 were incorrectly using their inhaler

in the 1st month. By the 2nd month, the number of patients among the total population that was incorrectly using their inhaler had reduced by 30. The 61-75 age group, which is the older group, shows relatively higher positive improvement regarding all 3 devices. This can be due to the majority of people belonging to that age category, or due to the patients in that age category on average tending to have fewer demands on their time. Therefore, they tend to have more time to spend at the clinics, and they are more prone to sharing their ideas with each other. Some older patients find it difficult to understand inhaler techniques, and some were not attentive when they were being educated on the inhaler technique. Incorrect inhaler technique may affect the adherence to medication and the control of the disease, leading to the quality of life being affected. Giraud and Roche showed a correlation of inhaler handling improvement with age [20].

When considering education level, the 136 patients (72.7%) from the total population had education levels only up to O/L or below. However, the study did not find any significant association with regard to education level. In the second month, only 43 patients from the total population who previously incorrectly used their inhalers were following the correct techniques. Surprisingly, the educational category of graduate and above showed no improvement from their incorrect use. This might be due to an unlikeliness to change their behavior associated with their educational status.

Low education level can increase difficulty in understanding inhaler techniques. However, other reasons such as the conditions of their employment may also affect their compliance. Most of the patients in the low education level group were working as farmers, laborers, or in cleaning services, where many find it difficult to handle inhalers within working hours. Additionally, 48.6% of their jobs involved working in places with dust, therefore even when using their inhalers correctly the disease was not adequately controlled due to repeated exposure. A majority of patients desire to know the correct technique and to cure their disease. Some previous studies support the present study in suggesting that the educational level was unrelated to devise mastery [20,21]. However, some studies indicate a strong relationship between education level and inhaler handling improvement [22]. Findings from the current study in the 1st month show that many errors were found in all 9 steps including the critical steps regarding PMDI, DPI, and PMDI + Spacer. However, no statistically significant difference (P =.05) was found with regards to the critical steps or with regards to all 9 steps between the control and test groups in the 1st month, as before the educational intervention their inhaler handling knowledge might remain the same among the randomly assigned control and test groups. A study done by Crane et al. identified a statistically significant improvement in participants with correct technique in the active group at their 3 months follow-up (P =.001) as well as at the 12 months follow-up, and no changes were observed in the passive group [23]. The present study found that in comparison of the 1st month and 2nd month, the test group showed a significant improvement in comparison to the control group, with a positive improvement of all 9 steps including the critical steps in the test group. Therefore, there was a statistically significant improvement (P =.05) in the critical steps as well as in all 9 steps between the test and control groups in the 2nd-month visit among PMDI, DPI, and PMDI + Spacer users. Therefore, the statistical relationship clearly confirmed that the patient's inhaler technique improved after the education section.

Patients who carefully listened to and followed instructions correctly showed significant improvement by the 2nd month. Positive improvement was also seen in the control group when comparing 1st month to the 2nd month, which may be attributed to interactions between groups, due to people listening or seeing our demonstration regarding the inhaler devices or due to the leaflet being shared with their friends which were provided by the researchers to the test group. However, more errors were seen in the control group than in the test group after the education session. Many of the participants had not received correct instructions from health care professionals, even when using the devices for the first time.

Correct inhaler handling technique and device handling were contributed to symptom control of asthma. Ease of handling of inhaler is important to promote patient's acceptance [8]. This result confirms that many participants did not know to handle their inhalers correctly. Some participants use their inhaler with much difficulty of use, which may also affect correct inhaler technique. Therefore, it is suggested that changing their inhaler type may lead to them having a better inhaler technique.

Table 3. Frequency of PMDI inhaler errors (n = 187)

	Type of error (PMDI	Control Group n (%) 1st month	Control Group N (%) 2nd month	Test Group N (%) 1st month	Test Group n (%) 2nd month
1	Fail to remove mouthpiece cap	0 (0)	0 (0)	0 (0)	0 (0)
2	Fail to shake inhaler*	7 (7.4)	6 (6.38)	5 (5.37)	0 (0)
3	Fail to breath out before firing	12 (12.7)	8 (8.51)	5 (5.37)	1 (1.07)
4	Fail to hold the inhaler upright between index finger and thumb	9 (9.57)	8 (8.51)	4 (4.30)	1 (1.07)
5	Fail to place the mouthpiece in your mouth between your teeth and close your lips around it*	9 (9.57)	8 (8.51)	4 (4.30)	1 (1.07)
6	Fail to fire while breathing in deeply and slowly*	6 (6.38)	6 (6.38)	5 (5.37)	0 (0)
7	Fail to inhale by mouth*	9 (9.57)	6 (6.38)	5 (5.37)	4 (4.30)
8	Fail to hold breath for 10 seconds	6 (6.38)	4 (4.25)	4 (4.30)	3 (3.22)
9	Fail to rinse mouth or gargle with water after inhaling each dose	6 (6.38)	5 (5.31)	2 (2.15)	0 (0)

**critical steps*

Table 4. Frequency of DPI inhaler errors (n = 187)

#	Type of error (DPI)	Control group n (%) 1st month	Control group n (%) 2nd month	Test Group n (%) 1st month	Test Group n (%) 2nd month
1	Fail to remove/ Turn cover*	0 (0)	0 (0)	0 (0)	0 (0)
2	Fail to correctly insert capsule*	8 (8.51)	6 (6.38)	13 (13.97)	1 (1.07)
3	Fail to pierce capsule by pressing buttons/ Rotate the base and separate the two halves of the capsule*	4 (4.25)	4 (4.25)	4 (4.30)	1 (1.07)
4.	Fail to hold inhaler upright	22 (23.40)	11 (11.70)	39 (41.93)	6 (6.45)
5	Fail to breath out fully	40 (42.55)	32 (34.04)	55 (59.13)	27 (29.03)
6	Fail to place the mouthpiece in mouth between teeth and close lips around it*	14 (14.89)	6 (6.38)	28 (30.10	3 (3.22)
7	Fail to breath in through your mouth as deeply as you can*	19 (20.21)	11 (11.70)	21 (22.58)	6 (6.45)
8	Fail to hold breath for 10 seconds	15 (15.95)	10 (10.63)	31 (33.33)	6 (6.45)
9	Fail to rinse mouth or gargle with water after inhaling each dose	9 (9.57)	7 (7.44)	16 (17.20)	3 (3.22)

**critical steps*

Table 5. Frequency of PMDI + Spacer inhaler errors (n = 187)

#	Type of error (PMDT +Spacer)	Control group n(%) 1st month	Control group n (%) 2nd month	Test Group n(%) 1st month	Test Group n(%) 2nd month
1	Fail to remove inhaler mouthpiece cap	0 (0)	0 (0)	0 (0)	0(0)
2	Fail to shake the inhaler*	20 (21.27)	17 (18.08)	14 (15.05)	0(0)
3	Fail to connect inhaler mouthpiece with the Spacer properly and remove the spacer mouthpiece cap if available	2 (2.12)	2 (2.12)	1 (1.07)	0(0)
4	Fail to hold the inhaler upright	9 (9.57)	7 (7.44)	0 (0)	0(0)
5	Fail to breathe out slowly and fully, then tilt the head back slightly*	28 (29.78)	20 (21.27)	18 (19.35)	11(11.82)
6	Fail to keep mouthpiece of the spacer in your mouth*	7 (7.44)	5 (5.31)	3 (3.22)	0(0)
7	Fail to Hold spacer level and press down firmly on inhaler canister once then breathe in slowly and deeply./ Breathe in and out normally for 5 or 6 breaths*	3 (3.19)	4 (4.25)	4 (4.30)	0(0)
8	Fail to hold breathe for about 10 seconds, while holding breathe remove spacer from mouth and breathe out gently./ breathe in 5 -6 times and breathe out slowly through nose	19 (20.21)	15 (15.95)	13 (13.97)	1(1.07)
9	Fail to rinse your mouth or gargle with water after inhaling each dose	5 (5.31)	4 (4.25)	2(2.15)	2(2.15)

**critical steps*

Table 6. Summary of data analysis (i) (n = 187)

Variables	Categories	Control group	Test group	P value
Critical step correctly used 1st month	PMDI	0 (0%)	2 (2.2%)	0.603 #
	DPI	19 (20.2%)	19 (20.4%)	0.198 #
	PMDI + Spacer	1 (1.1%)	0 (0%)	0.763 #
All 9 step correctly used 1st month	PMDI	0 (0%)	1 (1.1%)	0.173 #
	DPI	2 (2.1%)	2 (2.2%)	0.942 #
	PMDI + Spacer	1 (1.1%)	0 (0%)	0.152 #
Critical step correctly used 2nd month	PMDI	2 (2.1%)	4 (4.2%)	0.030 *
	DPI	30 (31.9%)	54 (58.1%)	0.000 *
	PMDI + Spacer	4 (4.3%)	7 (7.4%)	0.005 *
All 9 step correctly used 2nd month	PMDI	1 (1.0%)	2 (2.0%)	0.006 *
	DPI	10 (10.6%)	26 (28%)	0.000 *
	PMDI + Spacer	3 (3.2%)	7 (7.5%)	0.002 *

The level of statistical significance was set at P =.05, # - Not Significant, - Significant*

Table 7. Summary of data analysis (ii) (n = 187)

Variables	Categories	Group		p value
		Control	Test	
Critical step followed patients 1st month	correctly	20 (21.2)	21 (22.5)	0.938 #
	incorrectly	74 (78.7)	72 (77.4)	
All 9 step followed patients 1nd month	correctly	3 (3.1)	3 (3.2)	0.763 #
	incorrectly	91 (96.8)	90 (96.7)	
Critical step followed patients 2nd month	correctly	36 (38.2)	65 (69.8)	0.043 *
	incorrectly	58 (61.7)	28 (30.1)	
All 9 step followed patients 2nd month	correctly	14 (14.8)	35 (37.6)	0.000 *
	incorrectly	80 (85.1)	58 (62.3)	

The level of statistical significance was set at P =.05,# - Not Significant , - Significant*

Table 8. Awareness regarding asthma in the total population (n = 187)

Variables	Correct	Incorrect
Does smoking cause asthma?	182 (97.3%)	5 (2.6%)
Does nonsmoking tobacco cause asthma?	115 (61.4%)	72 (38.6%)
Does dust cause asthma?	184 (98.3%	3 (1.7%)
Does obesity cause asthma?	109 (58.2%)	78 (41.8%)
Does asthma cause death?	173 (92.5%)	14 (7.5%)
Does malnutrition cause asthma?	96 (51.3%)	91 (48.7%)
Does asthma communicable or not?	178 (95.1%)	9 (4.9%)
Do inhalers cause side effects?	179 (95.7%)	8 (4.3%)

When considering awareness about asthma in patients, many participants had given correct answers regarding asthma, and they were generally educated on the causes of asthma. Awareness of asthma is very important to control the disease. However, a leaflet regarding asthma was given to the patients who had given incorrect answers in order to increase their knowledge of asthma. Instructions about safety precautions were also given to the patients who were exposed to dust in their workplaces.

According to final outcome of this research, we suggest to health care professionals provide proper instruction and counseling regarding inhaler technique to patients by using posters, patient information leaflets, newspapers, TV programs as well as reinforce proper technique

by examining their inhaler technique during each clinical visit.

5. CONCLUSIONS

We observed gaps of knowledge between current practice and what is expected in patients with asthma regarding their inhaler usage. This might be due to the quality of instructions given by health care providers is not sufficient and the lack of time to observe patients individually for their inhaler techniques. Patients' awareness regarding Asthma and their inhaler usage can be raised using information leaflets as well as verbal counseling. Continue regular treatment is a must. Applied face-to-face training must be provided to the patients. It will be more beneficial if inhaler device training clinical pharmacist or nursing officer assign for that task. Media support should be used to increase the awareness of asthma and treatment in the community. Our study used hardly any expenses other than a short duration of extra time. Therefore, it can be used as a cost-effective program for raising awareness.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication and a copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

This study was approved by National Hospital for Respiratory Diseases – Welisara and Colombo South Teaching Hospital (589, 21 june 2017). In addition, ethical approval was received from General Sir John Kotelawala Defence University (RP/S/2017/18).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous. Global initiative of asthma: Global strategy for asthma management and prevention.
   (accessed on 03 Jan 2021).
   Available:www.ginasthma.org.
2. Naeem M, Dailah H. Facilitators, challenges and usefulness of an asthma educational programme. Health Education Journal;2020.
   Available:https://doi.org/10.1177/0017896920981620
3. Dias HR, Gunawardena DCA, Wijebandara WAC. National Survey on Self-reported Health in Sri Lanka. 3rd ed. Department of Census and Statistics; Ministry of National Policies and Economic Affairs. Sri Lanka; 2014.
4. Laura J. Martin. Severe Asthma Attacks. 2016.
   Accessed on 29th Dec 2020.
   Available:http://www.webmd.com/asthma/guide/status-asthmaticus#3.
5. Asher MI, Ellwood P. The global Asthma Report; 2014.
6. Brown M, Bennett P. Clinical Pharmacology. 11th ed. Churchill Livingstone: United Kingdom; 2012.
7. Deerojanawong J, Prapphal N, Hanrutakorn C, Sritippayawan S. evaluation of metered-dose inhaler administration technique among asthmatic children and their caregivers in Thailand. Asian Pacific Journal Of Allergy and Immunology. 2009;27:87-93.
8. Schreiber J, Sonnenburg T, Luecke E. Inhaler devices in asthma and COPD patients – a prospective cross-sectional study on inhaler preferences and error rates. BMC Pulmonary Medicine. 2020; 20: 1-12.
9. George CM, Schrock MD. Inhalation therapy: help patients avoid these mistakes. The Journal of family practice. 2011; 60.
10. Zarmouh A. Does clinic-based education have a sustainable impact on asthma patient awareness?. Libyan Journal of Medicine. 2019; 14.
11. Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, et al. Inhaler mishandling remains common in real life and is associated with reduced disease control, Respiratory medicine. 2011;105: 930-938.
12. Ndarukwa P, Chimbari M, Sibanda E. Development of a framework for increasing asthma awareness in Chitungwiza, Zimbabwe. Asthma Research and Practice. 2019; 5: 1-7.
13. Anonymous. American thoracic society. USA patient information series using your metered dose inhaler (MDI).

(Accessed on 15 Dec 2020).
Available:https://www.thoracic.org/patients/patient-resources/resources/metered-dose-inhaler- mdi.pdf.

14. Newman SP. Inhaler treatment options in COPD, European Respiratory Review. 2005;14:102-108.
Available:https://DOI:10.1183/09059180.05.00009605
15. Anonymous. Cipla. Patient Leaflet; 2013.
(Accessed on 19 Feb 2020)
Available:http://www.cipla.co.za/wpcontent/uploads/2013/10/sep_dp- haler.pdf.
16. Anonymous. Harvard medical school-patient education center, asthma brochure.
(Accessed on 6 May 2021).
Available:http://www.patienteducationcenter.org/emedia/asthma-brochure.
17. Hilton S. An audit of inhaler technique among asthma patients of 34 general practitioners. British Journal of General Practice. 1990;40: 505-506.
18. Fink JB, Rubin BK. Problems With Inhaler Use: A Call for Improved Clinician and Patient Education, Respiratory care. 2005;50:1360-1375.
19. Westerik JA, Carter V, Chrystyn H, Burden A, Thompson SL, Ryan D, et al. Characteristics of patients making serious inhaler errors with a dry powder inhaler and association with asthma-related events in a primary care setting, Journal of Asthma. 2016;53:321-329.
20. Giraud V, Roche N. Misuse of corticosteroid metered inhaler is associated with decreased asthma stability, European Respiratory Journal. 2002;19:246- 251.
21. Sandler N, Holländer, Långström D, Santtila P, Saukkonen A, Torvinen S. Evaluation of inhaler handling-errors, inhaler perception and preference with Spiromax, Easyhaler and Turbuhaler devices among healthy Finnish volunteers: a single site, single visit crossover study (Finhaler), BMJ Open Respiratory Research. 2016; 3:119.
22. Lavorini F, Magnan A, Dubus JC, Voshaar T, Corbetta L, Broeders M. et al. Effect of incorrect use of dry powder inhalers on management of patients with asthma and COPD, Respiratory Medicine. 2008;102: 593-604.
23. Crane MA, Jenkins CR, Goeman DP, Douglass JA. Inhaler device technique can be improved in older adults through tailored education: findings from a randomized controlled trial, NPJ Primary Care RespiratoryMedicine.2014;24: 14034.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/72142